Amendments to the "Rules for Classification of Ships"

RFC/002/AMN/018

Effective from 1/1/2022

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List of amendments to Part A – Classification and Surveys

Effective from 1/1/2022

Chapter/Section/Paragraph amended	Reason
Ch 1, Sec 2, Tab 1, Tab 2, [4.8.1], [4.8.3], [4.8.11](new) Ch 4, Sec 10, [1.1.1], [27](new)	to include the **new service notation offshore support vessel (OSV)** to move the OSV requirements - currently published as separate Tasneef Rules for OSV that will be withdrawn on 1 January 2022 - into the Rules for Ships to facilitate their maintenance and alignment with IACS Unified Requirements 113)
Ch 1, Sec 2, [4.8.11](new) Ch 4, Sec 10, [27.3](new)	to introduce the **new additional service feature WIND TURBINE MAINTENANCE for OSV** equipped for maintenance activities of wind farms (Prop. 134)
Ch 1, Sec 2, Tab 1, [4.8.7], [4.8.9] Ch 4, Sec 1, Tab 1 Ch 4, Sec 10, [1.1.1], [10], [12]	to change the names of service notations "pipe laying ship" and "cable laying ship" into "**pipe laying unit**" and "**cable laying unit**" since the most commonly used denomination of these vessels is "unit" instead of "ship" (Prop. 155)
Ch 1, Sec 2, Tab 1, [4.8.12](new) Ch 4, Sec 10, [1.1.1], [28](new)	to introduce the **new service notation wind turbine installation vessel** for ships specially equipped with fixed installations and/or mobile equipment for the installation of fix or floating wind turbine (Prop. 134)
Ch 1, Sec 2, [6.11.1], Tab 3	to correct an oversight by mentioning also in Pt A the additional **notation "Icebreaker" for POLAR CLASS ships** already included in Pt F Ch 10 (Prop. 166)
Ch 5, Sec 12, [1.1.1], [6.1.1], [6.1.2] to [6.1.5](new), [6.1.6], [6.1.7] to [6.1.10](new), [6.2.1], [6.2.2], [6.2.3], [6.2.4], [6.2.5], [6.2.6], [6.2.7] to [6.2.16](new), [7](new)	to update the **survey requirements** of the additional class notation **DYNAPOS** and introduce survey requirements for the additional class notation **DP PLUS**, aligned to the guidelines in IMO MSC.1/Circ.1580 and IMCA M 103 (Prop. 157)

List of Amendments to Part B - Hull and Stability

Effective from 1/1/2022

Chapter/Section/Paragraph amended	Reason
Ch 1, Sec 1, [1.1.1]	to specify - following to the introduction of **URCN to CSR 1 July 2021** and **IACS Rec 10** (Rev.4, Sep 2020) "Chain Anchoring, Mooring and Towing Equipment" - that the requirements for ship equipment in Ch 10, Sec 4, App 2 and App 3 apply to bulk carrier ESP CSR and oil tanker ESP CSR
Ch 1, Sec 3, Tab 2	to specify the plans to be submitted for offshore support vessels (OSV) (Prop. 113)
Ch 4, Sec 1, Tab 1	to correct the mechanical properties of hull steels in line with those in Pt D, Ch 2, Sec 1, [2]
Ch 5, Sec 2, [2.1.2] Ch 5, App 2(new)	to introduce **IACS UR S11** (Rev.10, Dec 2020) "Longitudinal Strength Standard"
Ch 9, Sec 4, Tab 5	to give the possibility to evaluate the minimum thickness of aluminium superstructures and deckhouses on a case-by-case basis for particular arrangements (e.g. small deckhouses in high positions of large passenger ships) (Prop. 159)

Ch 10, Sec 4, [1.2](new), [3.1.3], [3.1.5], [3.1.8], [3.1.9], [3.1.10], [3.1.11], [3.1.14], [3.1.15], [3.1.16], [3.1.17]	to introduce **IACS UR A2** (Rev.5, Sept 2020) “Shipboard fittings and supporting hull structures associated with towing and mooring on conventional ships”
Ch 10, Sec 4, [2.1.2], Fig 1(replaced), Fig 2(new), [3.9.1], [3.9.2], [3.9.4], [3.9.5](new), Figures renumbered	to introduce **IACS UR A1** (Rev.7, Sep 2020 and Corr.1, Sep 2021) “Anchoring Equipment”
Ch 10, Sec 4, [2.1.3]	to clarify that the formula for equipment number for ships with inclined superstructure front bulkhead is applicable to ships in restricted navigation only (to which IACS UR A1 is not applicable) and to include the funnel’s area in the formula for consistency with **IACS UR A1** (Rev.7, Sep 2020 and Corr.1, Sep 2021)
Ch 10, Sec 4, [3.5.1], [3.5.2], [3.5.7], Tab 3, Tab 4 Ch 10, App 2, [1.3.1], [2.1.1], [2.1.2], [2.1.3], [2.2.2], [2.2.3] Ch 10, App 3 (new)	to introduce **IACS Rec 10** (Rev.4, Sep 2020) “Chain Anchoring, Mooring and Towing Equipment"

List of Amendments to Part C - Machinery, Systems and Fire Protection

Effective from 1/1/2022

Chapter/Section/Paragraph amended	Reason
Ch 1, Sec 10, [20.6.2]	to introduce **IACS UR M77** (Rev.2, Dec 2020) “Storage and use of SCR reductants”
Ch 1, App 1, [3.2.1]	to correct a clerical error in a formula for crankshaft strength calculation
Ch 2, Sec 3, [2.3.16]	to introduce **IACS UR M75** (Rev.1, Jan 2021) “Ventilation of emergency generator rooms”
Ch 2, Sec 3, [9.6.2]	to introduce **IACS UR E15** (Rev.4, Dec 2020) “Electrical Services Required to be Operable Under Fire Conditions and Fire Resistant Cables”
Ch 2, Sec 3, [10.1.6], [10.4.3]	to clarify the requirements for electrical equipment permitted to be installed in Zone 2 using a wording in line with IACS UI SC42 (Prop. 148)
Ch 2, Sec 3, [10.4.1], [10.4.2], [10.4.3], [10.4.4](included in 10.4.3), [10.4.5](included in 10.4.3)	to introduce **IACS UR E12** (Rev.2, Dec 2020) "Electrical Equipment allowed in paint stores and in the enclosed spaces leading to paint stores"
Ch 2, Sec 10, [3.1.1]	to update a reference to applicable requirements in relation to the use of plug-and-socket connections for high voltage shore connections (Prop. 151)
Ch 2, App 2	to update the installation requirements for the lithium batteries on battery powered ships, on the basis of the experience gained in latest years and the outcome of the research project SEABAT and to make reference to the new edition of the Rules for the type approval certification of lithium battery systems (NCC.92) (Prop. 28)

List of Amendments to Part D - Materials and Welding

Effective from 1/1/2022

Chapter/Section/Paragraph amended	Reason
Ch 5, Sec 6, [1.1.3], [1.1.4](new), [1.1.5](new), [2.1.2], [2.1.5], Tab 1, [4.3.2], [4.3.4], [4.3.5], [4.3.6], [5.1.1], [6.1.1], [6.1.2](new), [6.1.3], [6.1.4](new), [6.2.1]	to introduce **IACS UR W32** (Rev.1, Sep 2020) "Qualification scheme for welders of hull structural steels"

List of Amendments to Part E - Service Notations

Effective from 1/1/2022

Chapter/Section/Paragraph amended	Reason
Ch 1, Sec 4, Tab 1 Ch 12, Sec 5, Tab 1	to clarify the requirements for electrical equipment permitted to be installed in Zone 2 of ro-ro cargo and passenger ships using a wording in line with IACS UI SC42 (Prop. 148)
Ch 5, Sec 3, [3.1.1] Ch 5, App 1(new)	to introduce **IACS UR S11** (Rev.10, Dec 2020) "Longitudinal Strength Standard"
Ch 11, Sec 3, Tab 3 Ch 12, Sec 3, Tab 3 Ch 13, Sec 2, Tab 18 Ch 14, Sec 2, Tab 2, [4.4.1] Ch 20, Sec 3, Tab 22	to introduce **IACS Rec 10** (Rev.4, Sep 2020) "Chain Anchoring, Mooring and Towing Equipment"
Ch 11, Sec 3, [1.1.6]	to clarify the stability requirements for decked passenger ships of length less than 20 m engaged in still water (Prop. 162)
Ch 14, Sec 2, [2.7.1], Fig 3 (deleted), Figures renumbered	to introduce **IACS UR A1** (Rev.7, Sep 2020 and Corr.1, Sep 2021) "Anchoring Equipment" for tugs with the navigation notation "unrestricted navigation" by specifying that the equipment number EN is to be obtained from Pt B, Ch 10, Sec 4, [2.1.2]
Ch 15, Sec 3, [1.1.1], [6](new)	to introduce requirements for windlass, applicable to both supply vessels and OSV (Prop. 113)
Ch 18, Sec 1, [1.1.1], [1.1.2], [1.2.1], Tab 1 Ch 18, Sec 3, [2.1], [2.1.1] Ch 22, Sec 1, [1.1.1], [1.1.2], [1.2.1], Tab 1	to change the names of service notations "pipe laying ship" and "cable laying ship" into "**pipe laying unit**" and "**cable laying unit**" since the most commonly used denomination of these vessels is "unit" instead of "ship" (Prop. 155)
Ch 32(new), Sec 1, Sec 2, Sec 3, Sec 4 and App 1	to include the requirements applicable to **offshore support vessel (OSV)** - currently published as separate Tasneef Rules for OSV that will be withdrawn on 1 January 2022 - moved into the Rules for Ships to facilitate their maintenance and alignment with IACS Unified Requirements 113)
Ch 32(new), Sec 1, Sec 2, Sec 3	to introduce the requirements applicable to **OSV** having the **additional service feature WIND TURBINE MAINTENANCE** (Prop. 134)
Ch 33(new), Sec 1, Sec 2, Sec 3	to introduce the requirements applicable to **wind turbine installation vessels** (Prop. 134)

List of Amendments to Part F - Additional Class Notations

Effective from 1/1/2022

Chapter/Section/Paragraph amended	Reason
Ch 13, Sec 6, [8.1.6]	to correct a typo in the requirements for the **DYNAPOS** additional class notation (Prop. 157)
Ch 13, Sec 15, [1.1.2], [1.1.3], [1.1.4], [1.2.1], [1.2.2](new), [1.2.3](new), [1.3.1], [2.1.1](new), [2.1.2](new), [2.2.1], [2.2.2], [2.2.3], [2.2.4](new), Tab 1, [2.5.2], [2.7.2], [2.7.3], [2.7.5], [2.7.6], [3](title), [3.2.1], [3.4.4](deleted), [3.6.3], [3.7.1], [3.11.4], [4.2.2](new), [4.3], [4.5.2], [4.6.2] (deleted), [4.8](new), [5.2.1], [5.4.3], [5.4.4]	to update the requirements for the **HIGH VOLTAGE SHORE CONNECTION (HVSC)** additional class notation introducing amendments for alignment with IEC/IEEE 80005-1:2019 requirements, especially regarding: • reference to specific requirements relevant to particular ship's types in the annexes to IEC 80005 • introduction of new definitions • improvement of requirements for plug and socket • addition of periodic verification of equipotential bonding in alternative to the continuous monitoring (Prop. 151)
Ch 13, Sec 25, Tab 1, [3.2.1], Fig 1	to improve the requirements for the **DOLPHIN** additional class notations by correcting some misalignments between the values in the table of measurement parameters and those in the test site requirements; the requirements for hydrophone and signal conditioning; and the figure of hydrophones geometry (Prop. 161)

SECTION 2 CLASSIFICATION NOTATIONS

1 General

1.1 Purpose of the classification notations

1.1.1 The classification notations give the scope according to which the class of the ship has been based and refer to the specific rule requirements which are to be complied with for their assignment. In particular, the classification notations are assigned according to the type, service and navigation of the ship and other criteria which have been provided by the Interested Party, when applying for classification.

The Society may change the classification notations at any time, when the information available shows that the requested or already assigned notations are not suitable for the intended service, navigation and any other criteria taken into account for classification.

Note 1: Reference should be made to Sec 1, [1.3] on the limits of classification and its meaning.

1.1.2 The classification notations assigned to a ship are indicated on the Certificate of Classification, as well as in the Register of Ships published by the Society.

1.1.3

Ships and units, other than those covered in Parts B, C, D, E and F, are to comply with specific Rules published by the Society, which also stipulate the relevant classification notations.

1.1.4 The classification notations applicable to existing ships conform to the Rules of the Society in force at the date of assignment of class, as indicated in Ch 2, Sec 1. However, the classification notations of existing ships may be updated according to the current Rules, as far as applicable.

1.2 Types of notations assigned

1.2.1 The types of classification notations assigned to a ship are the following:

a) main class symbol
b) construction marks
c) service notations with additional service features, as applicable
d) navigation notations
e) operating area notations (optional)
f) additional class notations (optional)

The different classification notations and their conditions of assignment are listed in [2] to [6] below, according to their types.

1.2.2 As an example, the classification notations assigned to a ship may be as follows (the kind of notation shown in brackets does not form part of the classification notation indicated in the Register of Ships and on the Certificate of Classification):

C ✠ HULL ✠ MACH

(main class symbol, construction marks)

oil tanker-chemical tanker-ESP-Flash point > 60°C

(service notation and additional service features)

Unrestricted navigation

(navigation notation)

✠SYS - NEQ

(additional class notation).

2 Main class symbol

2.1 Main class symbol

2.1.1 The main class symbol expresses the degree of compliance of the ship with the rule requirements as regards its construction and maintenance. There is one main class symbol, which is compulsory for every classed ship.

2.1.2

The main class symbol C is assigned to ships built in accordance with the requirements of the Rules or other rules recognised as equivalent, and maintained in a condition considered satisfactory by the Society. The period of class (or interval between class renewal surveys) assigned to a ship is maximum 5 years; see Ch 2, Sec 2, [4].

Except for special cases, class is assigned to a ship only when the hull, propulsion and auxiliary machinery installations, and equipment providing essential services have all been reviewed in relation to the requirements of the Rules.

Note 1: The symbol **C** with the 5 year class period is to be understood as being the highest class granted by the Society.

Note 2: The symbol **C** may be followed by the additional construction feature **light ship** in case of ships or other units having restricted navigation notations and generally having length not greater than 50 m as well as speed greater than 15 knots, whose hull scantlings and outfitting comply with the applicable requirements of Chapters 3 and 6 of the "Rules for the Classification of High Speed Craft", issued separately by the Society.

3 Construction marks

3.1 General

3.1.1 The construction mark identifies the procedure under which the ship and its main equipment or arrangements have been surveyed for initial assignment of the class. The procedures under which the ship is assigned one of the construction marks are detailed in Ch 2, Sec 1.

4.2 Cargo ships

4.2.1 The service notations related to self-propelled ships intended for the carriage of cargo are listed in [4.2.2] to [4.2.17] below.

Table 1 : List of service notations assigned in accordance with the requirements of these Rules *(1/1/2022)*

Service notation	Reference for definition	Reference chapter in Part E
asphalt tanker	[4.5.8]	Part E, Chapter 7
asphalt tanker ESP	[4.5.9]	Part E, Chapter 7
barge	[4.9.1]	Part E, Chapter 19
bulk carrier ch xii	[4.2.16]	**(1)**
bulk carrier ch xii - double side-skin	[4.2.17]	**(1)**
bulk carrier ESP	[4.3.2]	Part E, Chapter 4
bulk carrier ESP CSR	[4.3.3]	Part E, Chapter 4
cable laying ~~ship~~unit	[4.8.7]	Part E, Chapter 7
chemical recovery ship	[4.8.6]	Part E, Chapter 28
car carrier	[4.2.5]	**(1)**
chemical tanker	[4.5.4]	Part E, Chapter 8
chemical tanker - assisted propulsion	[4.5.14]	Part E, Chapter 31
chemical tanker ESP	[4.5.4]	Part E, Chapter 8
cement carrier	[4.2.10]	Part E, Chapter 23
combination carrier/OBO ESP	[4.3.6]	Part E, Chapter 6
combination carrier/OOC ESP	[4.3.7]	Part E, Chapter 6
compressed natural gas carrier	[4.2.11]	Part E, Chapter 24
container ship	[4.2.6]	Part E, Chapter 2
deck cargo ship	[4.2.12]	**(1)**
dredger	[4.7.2]	Part E, Chapter 13
escort tug	[4.8.2]	Part E, Chapter 14
fire-fighting ship	[4.8.4]	Part E, Chapter 16
fishing vessel	[4.10.1]	Part E, Chapter 20
fly ash carrier	[4.2.9]	**(1)**
FLS tanker	[4.5.6]	Part E, Chapter 7
general cargo ship	[4.2.2]	**(1)**
general cargo ship - double-side-skin	[4.2.13]	**(1)**
hopper dredger	[4.7.2]	Part E, Chapter 13
hopper unit	[4.7.2]	Part E, Chapter 13
liquefied gas carrier	[4.5.5]	Part E, Chapter 9
livestock carrier	[4.2.7]	Part E, Chapter 3
marine mobile desalination unit	[4.5.13]	Part E, Chapter 30
offshore support vessel	[4.8.11]	Part E, Chapter 32
oil carrier - assisted propulsion	[4.5.11]	Part E, Chapter 25
oil recovery ship	[4.8.5]	Part E, Chapter 17
oil tanker	[4.5.2]	Part E, Chapter 7

(1) No additional requirements are specified in Part E for this service notation.
(2) No additional requirements are specified in Part E for this service notation; however the requirements of Part F, Chapter 8 for the assignment of the additional class notation **REF-CARGO** are to be applied.
(3) These ships are considered on a case by case basis by the Society according to their type of service.

Service notation	Reference for definition	Reference chapter in Part E
oil tanker ESP	[4.5.2]	Part E, Chapter 7
oil tanker ESP CSR	[4.5.3]	Part E, Chapter 7
ore carrier ESP	[4.3.5]	Part E, Chapter 5
palm oil carrier - assisted propulsion	[4.5.12]	Part E, Chapter 26
passenger ship	[4.6.2]	Part E, Chapter 11
pipe laying ~~ship~~unit	[4.8.9]	Part E, Chapter 22
pontoon	[4.9.2]	Part E, Chapter 19
refrigerated cargo ship	[4.2.5]	**(2)**
research ship	[4.8.8]	Part E, Chapter 21
ro-ro cargo ship	[4.2.3]	Part E, Chapter 1
ro-ro passenger ship	[4.6.3]	Part E, Chapter 12
salvage tug	[4.8.2]	Part E, Chapter 14
Self-Unloading Bulk Carriers ESP	[4.3.8]	Part E, Chapter 4
special service	[4.12.1]	**(3)**
split hopper dredger	[4.7.2]	Part E, Chapter 13
split hopper unit	[4.7.2]	Part E, Chapter 13
sugar carrier	[4.2.8]	**(1)**
supply vessel	[4.8.3]	Part E, Chapter 15
tanker	[4.5.7]	Part E, Chapter 10
transhipping unit **transhipping floating terminal**	[4.11.1]	Part E, Chapter 27
tug	[4.8.2]	Part E, Chapter 14
well stimulation	[4.8.10]	Part E, Chapter 29
wind turbine installation vessel	[4.8.12]	Part E, Chapter 33
wood chip carrier	[4.2.14]	**(1)**

(1) No additional requirements are specified in Part E for this service notation.
(2) No additional requirements are specified in Part E for this service notation; however the requirements of Part F, Chapter 8 for the assignment of the additional class notation **REF-CARGO** are to be applied.
(3) These ships are considered on a case by case basis by the Society according to their type of service.

Table 2 : List of service notations assigned in accordance with the requirements of separate Rules *(1/1/2022)*

Service notation	Separate Rules for reference
HSC (1) (2) (3)	Rules for the Classification of High Speed Craft
MODU	Rules for the classification of floating offshore units at fixed locations and mobile offshore drilling units
Fixed platform	Rules for the Classification of Steel Fixed Offshore Platforms

(1) The notation is completed by one of the following additional service features, specifying the category of the craft in accordance with the IMO "International Code of Safety for High Speed Craft" :
- **A** for a passenger craft which can be defined according to the Code as category A
- **B** for a passenger craft which can be defined according to the Code as category B
- **C** for a cargo craft which can be defined according to the Code as category C.

(2) The notation may also be completed by one of the following additional service features specifying the type of construction:
- **MON** if the craft is a monohull
- **CAT** if the craft is a catamaran
- **HYF** if the craft is a hydrofoil
- **ACV** if the craft is an air-cushion vehicle
- **SES** if the craft is a surface effect ship
- **SWATH** if the craft is a twin hull small waterplane vehicle.

(3) The notation may be followed by the service notations specified in [4], as applicable; for example by the notation **ro-ro passenger ship** for a passenger craft specially equipped to load trains or wheeled vehicles.

~~**(4)** The notation is to be completed by at least one of the following additional service features unless the vessel complies with requirements identified by the Designer that have been considered by the Society as equivalent to those relevant to the additional service feature **supply**:~~
- ~~**supply**~~
- ~~**tug**~~
- ~~**salvage tug**~~
- ~~**fire-fighting**~~
- ~~**oil recovery**~~
- ~~**diving support**~~
- ~~**cable laying**~~
- ~~**pipe laying**~~
- ~~**well stimulation.**~~

~~**(5)**~~ (4)The notation may be completed by the following additional service features:
- **12 m SI** for boats of 12-metre international rating class
- **6 m SI** for boats of 6-metre international rating class.

~~**(6)**~~ (5)The notation may be completed by the following additional service features:
- **Crew Transfer Vessel - CTV**: when workboat is designed to transport technician and other personnel out to sites.
- **Dive Support Vessel - DSV**: when workboat is designed to support the offshore diving operation.
- **MULTICAT**: when the workboat are designed as multi-purpose workboat for offshore works and transport. Normally a mul-ticat is equipped with one or more winches and cranes as well as a spacious flat deck.
- **Patrol and Guard Vessel**: when the workboat is designed to patrol a coastal area or site for security, observation and defense.
- **Pilot boats**: when workboat is designed to transport maritime pilots from harbors to ships that need piloting, or vice versa.
- **Seismic and Geotechnical Survey Vessel**: when workboat is designed for the purpose of research, seismic survey and map-ping at seas
- **Taxi**: when the workboat is designed to transport paying passengers on rivers, canals, or sea coastal area.
- **Windfarm Service Vessel - WSV**: when workboat is designed to transport technician and other personnel to offshore wind farm and to support operations of wind farm maintenance and survey.

Service notation	Separate Rules for reference
FPSO: assigned to units intended for the production, storage and off-loading of liquid hydrocarbons **FSO :** assigned to units intended for the storage and off-loading of liquid hydrocarbons **FSRU:** assigned to units intended for off-loading, storage and/or regasification of liquefied natural gas (LNG) and/or liquefied petroleum gas (LPG) **FLNG:** assigned to units intended for liquefaction, storage and off-loading of natural gas (LNG)	Rules for the classification of floating offshore units at fixed locations and mobile offshore drilling units
~~**offshore support vessel (4)**~~	~~Rules for the Classification of Offshore Support Vessels~~
lifting unit	Rules for loading and unloading arrangements and for other lifting appliances on board ships

(1) The notation is completed by one of the following additional service features, specifying the category of the craft in accordance with the IMO "International Code of Safety for High Speed Craft" :
- **A** for a passenger craft which can be defined according to the Code as category A
- **B** for a passenger craft which can be defined according to the Code as category B
- **C** for a cargo craft which can be defined according to the Code as category C.

(2) The notation may also be completed by one of the following additional service features specifying the type of construction:
- **MON** if the craft is a monohull
- **CAT** if the craft is a catamaran
- **HYF** if the craft is a hydrofoil
- **ACV** if the craft is an air-cushion vehicle
- **SES** if the craft is a surface effect ship
- **SWATH** if the craft is a twin hull small waterplane vehicle.

(3) The notation may be followed by the service notations specified in [4], as applicable; for example by the notation **ro-ro passenger ship** for a passenger craft specially equipped to load trains or wheeled vehicles.

~~**(4)** The notation is to be completed by at least one of the following additional service features unless the vessel complies with requirements identified by the Designer that have been considered by the Society as equivalent to those relevant to the additional service feature **supply**:~~
- ~~**supply**~~
- ~~**tug**~~
- ~~**salvage tug**~~
- ~~**fire-fighting**~~
- ~~**oil recovery**~~
- ~~**diving support**~~
- ~~**cable laying**~~
- ~~**pipe laying**~~
- ~~**well stimulation.**~~

~~**(5)**~~ (4)The notation may be completed by the following additional service features:
- **12 m SI** for boats of 12-metre international rating class
- **6 m SI** for boats of 6-metre international rating class.

~~**(6)**~~ (5)The notation may be completed by the following additional service features:
- **Crew Transfer Vessel - CTV**: when workboat is designed to transport technician and other personnel out to sites.
- **Dive Support Vessel - DSV**: when workboat is designed to support the offshore diving operation.
- **MULTICAT**: when the workboat are designed as multi-purpose workboat for offshore works and transport. Normally a multicat is equipped with one or more winches and cranes as well as a spacious flat deck.
- **Patrol and Guard Vessel**: when the workboat is designed to patrol a coastal area or site for security, observation and defense.
- **Pilot boats**: when workboat is designed to transport maritime pilots from harbors to ships that need piloting, or vice versa.
- **Seismic and Geotechnical Survey Vessel**: when workboat is designed for the purpose of research, seismic survey and map-ping at seas
- **Taxi**: when the workboat is designed to transport paying passengers on rivers, canals, or sea coastal area.
- **Windfarm Service Vessel - WSV**: when workboat is designed to transport technician and other personnel to offshore wind farm and to support operations of wind farm maintenance and survey.

Service notation	Separate Rules for reference
floating dock	Rules for the classification of floating docks
submersible	Rules for the classification of underwater units
submersible pontoon	Rules for the classification of underwater units
submersible pontoon launching	Rules for the classification of underwater units
submarine	Rules for the classification of underwater units
bathyscaphe	Rules for the classification of underwater units
mesoscaphe	Rules for the classification of underwater units
bathysphere	Rules for the classification of underwater units
mesosphere	Rules for the classification of underwater units
MSS	Rules for the classification of underwater units
hyperbaric diving bell	Rules for the classification of underwater units
Isobaric diving bell	Rules for the classification of underwater units
ROV	Rules for the classification of underwater units

(1) The notation is completed by one of the following additional service features, specifying the category of the craft in accordance with the IMO "International Code of Safety for High Speed Craft" :
- **A** for a passenger craft which can be defined according to the Code as category A
- **B** for a passenger craft which can be defined according to the Code as category B
- **C** for a cargo craft which can be defined according to the Code as category C.

(2) The notation may also be completed by one of the following additional service features specifying the type of construction:
- **MON** if the craft is a monohull
- **CAT** if the craft is a catamaran
- **HYF** if the craft is a hydrofoil
- **ACV** if the craft is an air-cushion vehicle
- **SES** if the craft is a surface effect ship
- **SWATH** if the craft is a twin hull small waterplane vehicle.

(3) The notation may be followed by the service notations specified in [4], as applicable; for example by the notation **ro-ro passenger ship** for a passenger craft specially equipped to load trains or wheeled vehicles.

~~**(4)** The notation is to be completed by at least one of the following additional service features unless the vessel complies with requirements identified by the Designer that have been considered by the Society as equivalent to those relevant to the additional service feature **supply**:~~
- ~~**supply**~~
- ~~**tug**~~
- ~~**salvage tug**~~
- ~~**fire-fighting**~~
- ~~**oil recovery**~~
- ~~**diving support**~~
- ~~**cable laying**~~
- ~~**pipe laying**~~
- ~~**well stimulation.**~~

~~**(5)**~~ (4)The notation may be completed by the following additional service features:
- **12 m SI** for boats of 12-metre international rating class
- **6 m SI** for boats of 6-metre international rating class.

~~**(6)**~~ (5)The notation may be completed by the following additional service features:
- **Crew Transfer Vessel - CTV**: when workboat is designed to transport technician and other personnel out to sites.
- **Dive Support Vessel - DSV**: when workboat is designed to support the offshore diving operation.
- **MULTICAT**: when the workboat are designed as multi-purpose workboat for offshore works and transport. Normally a mul-ticat is equipped with one or more winches and cranes as well as a spacious flat deck.
- **Patrol and Guard Vessel**: when the workboat is designed to patrol a coastal area or site for security, observation and defense.
- **Pilot boats**: when workboat is designed to transport maritime pilots from harbors to ships that need piloting, or vice versa.
- **Seismic and Geotechnical Survey Vessel**: when workboat is designed for the purpose of research, seismic survey and map-ping at seas
- **Taxi**: when the workboat is designed to transport paying passengers on rivers, canals, or sea coastal area.
- **Windfarm Service Vessel - WSV**: when workboat is designed to transport technician and other personnel to offshore wind farm and to support operations of wind farm maintenance and survey.

Service notation	Separate Rules for reference
diving-suit	Rules for the classification of underwater units
habitat	Rules for the classification of underwater units
SEALAB	Rules for the classification of underwater units
submersible igloo	Rules for the classification of underwater units
stowage reservoir	Rules for the classification of underwater units
decompression chamber	Rules for the classification of underwater units
diving system	Rules for the classification of underwater units
Y	Rules for the Classification of Pleasure Yachts
$\mathbf{Y_{ch}}$	Rules for the Classification of Yachts designed for commercial use
racing sailing boat ~~(5)~~(4)	Rules for the construction and classification of racing sailing boats
workboat ~~(6)~~(5)	Rules for the Classification of Workboats

(1) The notation is completed by one of the following additional service features, specifying the category of the craft in accordance with the IMO "International Code of Safety for High Speed Craft" :
- **A** for a passenger craft which can be defined according to the Code as category A
- **B** for a passenger craft which can be defined according to the Code as category B
- **C** for a cargo craft which can be defined according to the Code as category C.

(2) The notation may also be completed by one of the following additional service features specifying the type of construction:
- **MON** if the craft is a monohull
- **CAT** if the craft is a catamaran
- **HYF** if the craft is a hydrofoil
- **ACV** if the craft is an air-cushion vehicle
- **SES** if the craft is a surface effect ship
- **SWATH** if the craft is a twin hull small waterplane vehicle.

(3) The notation may be followed by the service notations specified in [4], as applicable; for example by the notation **ro-ro passenger ship** for a passenger craft specially equipped to load trains or wheeled vehicles.

~~**(4)** The notation is to be completed by at least one of the following additional service features unless the vessel complies with requirements identified by the Designer that have been considered by the Society as equivalent to those relevant to the additional service feature **supply**:~~
- ~~**supply**~~
- ~~**tug**~~
- ~~**salvage tug**~~
- ~~**fire-fighting**~~
- ~~**oil recovery**~~
- ~~**diving support**~~
- ~~**cable laying**~~
- ~~**pipe laying**~~
- ~~**well stimulation.**~~

~~**(5)**~~ (4)The notation may be completed by the following additional service features:
- **12 m SI** for boats of 12-metre international rating class
- **6 m SI** for boats of 6-metre international rating class.

~~**(6)**~~ (5)The notation may be completed by the following additional service features:
- **Crew Transfer Vessel - CTV**: when workboat is designed to transport technician and other personnel out to sites.
- **Dive Support Vessel - DSV**: when workboat is designed to support the offshore diving operation.
- **MULTICAT**: when the workboat are designed as multi-purpose workboat for offshore works and transport. Normally a multicat is equipped with one or more winches and cranes as well as a spacious flat deck.
- **Patrol and Guard Vessel**: when the workboat is designed to patrol a coastal area or site for security, observation and defense.
- **Pilot boats**: when workboat is designed to transport maritime pilots from harbors to ships that need piloting, or vice versa.
- **Seismic and Geotechnical Survey Vessel**: when workboat is designed for the purpose of research, seismic survey and map-ping at seas
- **Taxi**: when the workboat is designed to transport paying passengers on rivers, canals, or sea coastal area.
- **Windfarm Service Vessel - WSV**: when workboat is designed to transport technician and other personnel to offshore wind farm and to support operations of wind farm maintenance and survey.

4.5.13 *(9/12/2019)*

Marine mobile desalination unit, for ships intended for production by means of desalination system, storage and carriage of potable water. The additional requirements of Part E, Chapter 30 are applicable to these ships.

4.5.14 *(1/1/2021)*

Chemical tanker - assisted propulsion, for assisted propulsion ships (see [4.9.4]) of limited size (DWT<10000 tonnes) which are intended primarily to carry in restricted areas in bulk chemical products presenting safety and/or pollution hazards. This notation is to be assigned to ships of both single and double hull construction, as well as ships with alternative structural arrangements, provided they are deemed equivalent by the Society.

The additional requirements of Part E, Chapter 31 are applicable to these ships with the limitations indicated therein.

4.6 Ships carrying passengers

4.6.1 The service notations related to ships specially intended for the carriage of passengers are listed in [4.6.2] to [4.6.3] below.

4.6.2 **passenger ship**, for ships intended to carry more than 12 passengers. The additional requirements of Part E, Chapter 11 are applicable to these ships.

The service notation may be completed by the additional service feature **< 36 passengers**, where the ship is intended to carry only such a limited number of passengers.

4.6.3 **ro-ro passenger ship**, for ships intended to carry more than 12 passengers and specially equipped to load trains or wheeled vehicles. The additional requirements of Part E, Chapter 12 are applicable to these ships.

The service notation may be completed by the additional service feature **< 36 passengers**, where the ship is intended to carry only such a limited number of passengers.

4.7 Ships for dredging activities

4.7.1 The service notations related to ships specially intended for dredging activities are listed in [4.7.2]. The additional requirements of Part E, Chapter 13 are applicable to these ships.

4.7.2 The following notations are provided:

a) **dredger**, for ships specially equipped only for dredging activities (excluding carrying dredged material)

b) **hopper dredger**, for ships specially equipped for dredging activities and carrying spoils or dredged material

c) **hopper unit**, for ships specially equipped for carrying spoils or dredged material

d) **split hopper unit**, for ships specially equipped for carrying spoils or dredged material and which open longitudinally, around hinges

e) **split hopper dredger**, for ships specially equipped for dredging and for carrying spoils or dredged material and which open longitudinally, around hinges.

4.7.3 These ships which are likely to operate at sea within specific limits may, under certain conditions, be granted an operating area notation. For the definition of operating area notation, reference should be made to [5.3].

4.8 Working ships

4.8.1 *(1/1/2022)*

The service notations related to ships specially intended for different working services are listed in [4.8.2] to [4.8.1~~0~~2] below.

4.8.2 *(1/11/2016)*

The service notations for ships intended to tow and/or push other ships or units are:

a) **tug**, for ships specially equipped for towing and/or pushing

b) **salvage tug**, for ships specially equipped for towing and/or pushing having specific equipment for salvage

c) **escort tug**, for ships specially equipped for towing and/or pushing having specific equipment for escorting ships or units during navigation.

The additional requirements of Part E, Chapter 14 are applicable to these ships.

These service notations may be completed by the additional service features:

- **barge combined**, when units are designed to be connected with barges and comply with the relevant requirements of Pt E, Ch 14, Sec 3. The barges to which the tug can be connected are specified in an annex to the Certificate of Classification.
- **rescue**, when units are specially equipped for rescue of shipwrecked persons and for their accommodation in accordance with Pt E, Ch 14, Sec 2, [2.10.2].
- **standby**, when the unit is also specially intended to perform rescue and standby services (e.g. **tug-standby**).
- **rescue (X, Y)**, when units are specially equipped for rescue of shipwrecked persons and for their accommodation in specified geographical areas, where Pt E, Ch 14, Sec 2, [2.10.3] applies.

  The values X and Y indicate, respectively:

  X : maximum number of shipwrecked persons for which the unit is designed;

  Y : indication of the geographical areas and/or the maximum distance from the shore where the rescue operations are performed.

The relevant arrangements and equipment are recorded in the ship's status.

4.8.3 *(1/1/2022)*

The service notation **supply vessel** is assigned to ships specially intended for the carriage and/or storage of special material and equipment and/or which are used to provide facilities and assistance for the performance of specified activities.

When the above ships are ~~intended~~primarily designed for offshore support services, ~~underwater activities and other similar activities~~ the service notation **Offshore Support Vessel (OSV)** is assigned.

The service notation is to be completed by the additional service feature **oil product**, when the ship is also specially intended to carry oil products having any flash point.

The service notation is to be completed by the additional service feature **chemical product**, when the ship is also specially intended to carry chemical products having any flash point.

The service notation is to be completed by the additional service feature **standby**, when the ship is also specially intended to perform rescue and standby services for offshore installations (e.g. **supply vessel - standby**).

The service notation is completed by the additional service feature **rescue**, when the ship is specially equipped for rescue of shipwrecked persons and for their accommodation.

The service notation is completed by the additional service features:

- **anchor handling**, when the ship visibility from the bridge and equipment are specially designed for anchor handling operation; or
- **anchor handling stab**, when the ship is specially designed and equipped for anchor handling operation and also fulfils specific stability requirements related to this service.

The additional requirements of Part E, Chapter 15 are applicable to these ships.

4.8.4 The service notation **fire-fighting ship** is assigned to ships specially intended and equipped for fighting fire. The additional requirements of Part E, Chapter 16 are applicable to these ships.

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

- **1** or **2** or **3**, when the ship complies with the applicable requirements of Pt E, Ch 16, Sec 3 and Pt E, Ch 16, Sec 4
- **E** when the characteristics of the fire-fighting system are not those required for the assignment of the additional service features **1**, **2** or **3**, and when the system is specially considered by the Society
- **water-spraying** when the ship is fitted with a self-protection water-spraying system complying with the applicable requirements of Pt E, Ch 16, Sec 4, [3].

4.8.5

The service notation **oil recovery ship** is assigned to ships specially equipped with fixed installations and/or mobile equipment for the removal of oil from the sea surface and its retention on board, carriage and subsequent unloading. The additional requirements of Part E, Chapter 17 are applicable to these ships.

The service notation may be completed by the additional service feature **flash point > 60°C**, where the ship collects only oil with flash point exceeding 60°C.

4.8.6 *(15/2/2016)*

The service notation **chemical recovery ship** is assigned to ships designed for operation in hazardous atmosphere in case of accident involving chemical products and specially equipped with fixed installations and/or mobile equipment for the removal of chemical products from the sea surface and its retention on board, carriage and subsequent unloading. The additional requirements of Part E, Chapter 28 are applicable to these ships.

4.8.7 *(1/1/2022)*

The service notation **cable laying ~~ship~~unit** is assigned to ships specially equipped for the carriage and/or laying, hauling and repair of submarine cables. The addi-tional requirements of Part E, Chapter 18 are applicable to these ships.

4.8.8

The service notation **research ship** is assigned to ships specially intended for scientific or technological research. The additional requirements of Part E, Chapter 21 are applicable to these ships.

4.8.9 *(1/1/2022)*

The service notation **pipe laying ~~ship~~unit** is assigned to ships specially equipped for the carriage and/or laying, hauling and repair of submarine pipes. The addi-tional requirements of Part E, Chapter 22 are applicable to these ships.

4.8.10 *(1/4/2016)*

The service notation **well stimulation** is assigned to ships specially equipped permanently with specific systems for the stimulation of the well to improve their productivity.

The additional requirements of Part E, Chapter 29 are applicable to these ships.

4.8.11 *(1/1/2022)*

The service notation **Offshore Support Vessel (OSV)** is assigned to ships primarily designed for offshore support services.

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

- those described in [4.8.3]
- **W2W**, when the ship is equipped with a Walk-to-Work (W2W) system such as a motion compensated gangway used for personnel transfer from a mobile unit to an offshore facility (e.g. a wind farm) or to another mobile unit
- **WIND TURBINE MAINTENANCE**, for ships specially equipped for maintenance activities of Wind farms.

  Wind farm maintenance may include:

  - being a mother craft for smaller craft transferring technicians to and from offshore wind turbines
  - transferring technicians directly to the wind turbine
  - transferring supplies to the wind turbine
  - perform smaller lifting operations onto the wind turbine.

The additional requirements of Part E, Chapter 32 are applicable to these ships.

4.8.12 *(1/1/2022)*

The service notation **wind turbine installation vessel** is assigned to ships specially equipped with fixed installations and/or mobile equipment for the installation of fix or floating wind turbine.

The service notation is to be completed by the additional service feature **W2W**, when the ship is equipped with a Walk-to-Work system such as a motion compensated gangway used for personnel transfer from the ship to the wind turbine installation.

The additional requirements of Part E, Chapter 33 are applicable to these ships.

4.9 Non-propelled and assisted propulsion units, sailing ships

4.9.1 Barge *(1/6/2021)*

The service notation **barge** is assigned to non-propelled units intended to carry (dry or liquid) cargo inside holds or tanks. The type of cargo may be considered adding an additional service feature, e.g. **barge - oil**, **barge - liquefied gas, barge - LNG bunker, barge - chemical, barge - general cargo**. The additional requirements of Part E, Chapter 19 are applicable to these ships.

This service notation may be completed by the additional service feature **tug combined** when units are designed to be connected with tugs, and comply with the relevant requirements of Pt E, Ch 14, Sec 3. The tugs to which the barge can be connected are specified in an annex to the Certificate of Classification.

In the case of barges equipped with specific arrangements for accommodating on board, when moored, persons other than crew, the additional service feature **accommodation** is added to the notation **barge** (i.e. **barge-accommodation**). It covers units such as floating hotels used for different purposes like offshore industry support or other commercial uses. The notation **barge accommodation** is completed by the additional class notation **MOORING**.

4.9.2 Pontoon *(1/7/2015)*

The service notation **pontoon** is assigned to non-propelled units intended to carry cargo and/or equipment on deck only. This service notation may be completed by the service feature **crane** when a cargo lifting appliance, such as crane or derrick, is permanently fitted on board, the cargo lifting appliance is to be certified by the Society according to the "Rules for loading and unloading arrangements and for other lifting appliances on board of ships", or certified by another QSCS Classification Society according to its equivalent rules. The additional requirements of Part E, Chapter 19 are applicable to these ships.

4.9.3 Other units

Any non-propelled units other than those covered by the service notations listed above will be assigned the additional service feature **no propulsion**, to be added to their own service notation, e.g. **dredger - no propulsion**.

4.9.4 Assisted propulsion units *(1/7/2017)*

Any units having a propulsion system not enabling them to proceed at a speed greater than 7 knots, used for short transit voyages, will be assigned the additional service feature **assisted propulsion** to be added to their own service notation, e.g. **dredger - assisted propulsion**.

In case of units classified with a navigation not more than Coastal area and provided with propulsion system not enabling them to proceed at a speed greater than 7 knots, without any limitation of the length of the voyage, the additional service feature **assisted propulsion unlimited** will be assigned.

4.9.5 Sailing ships

The additional service feature **sailing ships** is assigned to ships having no means of propulsion other than sails. These ships are to comply with the requirements of the "Rules for masting and rigging of sailing ships", issued separately by the Society.

4.9.6 Engine assisted sailing ship *(1/7/2017)*

The additional service feature **engine assisted sailing ship** is assigned to ships which are mainly propelled by sails complying with the following requirement:

$A_s > 7{,}0\ (D_{max})^{2/3}$

where:

A_s : sails surface, in m^2

D_{max} : maximum displacement, in tons [t],

and provided with internal combustion engine for auxiliary and emergency propulsion.

4.9.7 Engine powered sailing ship

The additional service feature **engine powered sailing ship** is assigned to ships propelled primarily by internal combustion engines of power adequate to maintain a speed of at least 7 knots (at continuous service rating, when the ship is fully loaded, in smooth water) when not under sail, but which are provided with sails as an emergency means of propulsion.

4.10 Fishing vessels

4.10.1 The service notation **fishing vessel** is assigned to ships specially equipped for catching and storing fish or other living resources of the sea. The additional requirements of Part E, Chapter 20 are applicable to these ships.

Note 1: Units solely dedicated to service in a fishing flotilla by means of cold storage and/or transformation of fish are not covered by the service notation **fishing vessel**. They will be considered with the service notation **special service**.

4.11 Units intended for the transhipment of dry cargo in bulk

4.11.1 *(1/7/2020)*

The following service notations are assigned to units specially intended for the transhipment of dry cargo in bulk:

a) **transhipping unit**, for units specially intended to tranship the cargo from one delivering unit to one receiving unit; these units may either have or not have cargo storage capability

b) **transhipping floating terminal**, for units specially intended to tranship the cargo between more than one delivering and receiving units simultaneously; these units are normally to have cargo storage capability.

Self-propelled units are allowed to perform transfer voyages of very limited extension, between locations in the same area of operation, for loading/unloading operations or safety reasons. Longer voyages in ballast conditions may be accepted by the Society on a case-by-case basis. The depar-

5.3.2 The following operating area notations may be assigned:

a) notation **specified operating area**, where the specific operating conditions which have been considered by the Society are described in an annex to the Certificate of Classification (i.e. distance from shore or from port of refuge, weather or sea conditions)

b) notation **operation service within 'x' miles from shore**, where the operating service is limited to a certain distance from the shore.

6 Additional class notations

6.1 General

6.1.1 An additional class notation expresses the classification of additional equipment or specific arrangement, which has been requested by the Interested Party.

6.1.2 The assignment of such an additional class notation is subject to the compliance with additional rule requirements, which are detailed in Part F of the Rules.

6.1.3 Some additional class notations, due to the importance of relevant equipment or arrangements, are assigned a construction mark, according to the principles given in [3.1.2]. This is indicated in the definition of the relevant additional class notations.

6.1.4 The different additional class notations which may be assigned to a ship are listed in [6.2] to [6.14], according to the category to which they belong. These additional class notations are also listed in alphabetical order in Tab 3.

6.2 System of Trace and Analysis of Records (STAR)

6.2.1 General

STAR is a System of Trace and Analysis of Records integrating rational analysis with data and records from ship-in-service concerning planned inspection and ship maintenance.

The requirements for the assignment of these notations are given in Part F, Chapter 1.

6.2.2 STAR-HULL

The additional class notation **STAR-HULL** is assigned to ships on which an Inspection and Maintenance Plan (IMP) for the hull is implemented.

The notation may be completed by the suffix **NB** when a structural tridimensional analysis has been performed for the hull structures, as defined in Pt B, Ch 7, App 1 or Pt B, Ch 7, App 2 or Pt B, Ch 7, App 3, as applicable, at the new building stage. The suffix **NB** is removed when the ship enters the **STAR-HULL** survey programme through the implementation of the Inspection and Maintenance Plan (IMP).

6.2.3 STAR-MACH

The additional class notation **STAR-MACH** is assigned to ships on which an Inspection and Maintenance Plan (IMP) for the machinery is implemented. This plan is based on a risk analysis review of the installation.

6.2.4 STAR notation (STAR)

When ships are granted both **STAR-HULL** and **STAR-MACH**, the two separate notations are superseded by the cumulative additional class notation **STAR**.

6.3 Availability of machinery (AVM)

6.3.1 General

The notations dealt with under this heading are relevant to systems and/or arrangements enabling the ship to carry on limited operations when single failure affects propulsion or auxiliary machinery or when an event such as fire or flooding involving machinery spaces affects the availability of the machinery.

In compliance with [6.1.3], these notations are assigned a construction mark, as defined in [3].

The requirements for the assignment of these notations are given in Part F, Chapter 2.

6.3.2 AVM-APS (Alternative propulsion system)

The additional class notation **AVM-APS** or **AVM-APS-NS** are assigned to ships which are fitted with systems and/or arrangements enabling them to maintain operating conditions with some limitations in speed, range and comfort, in the case of any single failure of items relative to the propulsion.

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

6.3.3 AVM-IAPS (Independent alternative propulsion system)

The additional class notation **AVM-IAPS** is assigned to ships which are fitted with an independent propulsion system enabling them to maintain operating conditions with some limitations in power, speed, range and comfort, in the case of any single failure of items relative to the propulsion.

6.3.4 AVM-DPS (Duplicated propulsion system)

The additional class notation **AVM-DPS** or **AVM-DPS-NS** are assigned to ships which are fitted with a duplicated propulsion system enabling them to maintain operating conditions with some limitations in power (but 50% of the main power is to be maintained), speed, range and comfort, in the case of any single failure of items relative to the propulsion.

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

6.3.5 AVM-IPS (Independent propulsion system)

The additional class notation **AVM-IPS** is assigned to ships which are fitted with an independent propulsion system enabling them to maintain operating conditions with some limitations in power (but 50% of the main power is to be

6.9.3 Refrigerating installations for insulated containers (REF-CONT)

The additional class notation **REF-CONT** is assigned to ships fitted with refrigerating plants intended to supply refrigerated air to insulated containers carried in holds of container ships.

6.9.4 Refrigerating installations for domestic supplies (REF-STORE)

The additional class notation **REF-STORE** is assigned to ships fitted with refrigerating plants and spaces exclusively intended for the preservation of ship's domestic supplies.

6.9.5 The above may also be completed by the following notations:

a) **-PRECOOLING** when the refrigerating plants are designed to cool down a complete cargo of fruit and/or vegetables to the required temperature of transportation

b) **-QUICKFREEZE** for the refrigerating plants of fishing vessels and fish factory ships where the design and equipment of such plants have been recognised suitable to permit quick-freezing of fish in specified conditions

c) **-AIRCONT** when the refrigerating plants are equipped with controlled atmosphere installations or any other indication related to the specific features of the installation, when these features have been specially examined by the Society

6.10 Navigation in ice (ICE CLASS)

6.10.1 *(1/7/2020)*

The notations dealt with under [6.10.2] are relevant to ships strengthened for navigation in ice in accordance with the "Finnish-Swedish Ice Class Rules 2017" as adopted on 1 December 2017 by the Finnish Transport Safety Agency (TRAFI).

The requirements for the assignment of these notations are given in Part F, Chapter 9.

These requirements reproduce the provisions of the Finnish-Swedish Ice Class Rules cited above.

6.10.2 The following additional class notations are assigned:

a) **ICE CLASS IA SUPER**, for navigation in extreme ice conditions

b) **ICE CLASS IA**, for navigation in severe ice conditions

c) **ICE CLASS IB**, for navigation in medium ice conditions

d) **ICE CLASS IC**, for navigation in light ice conditions.

Note 1: Attention is drawn to paragraph 9 of the 1985 Finnish-Swedish Ice Class Rules, where it is stated that these notations are assigned to the maximum permissible draught according to the Tonnage and Loadline Certificates.

Note 2: Attention is drawn to paragraph 2 of the above Rules, where it is stated that the requirements of Finnish-Swedish Ice Class Rules published on 6th April 1971 are still in force for ships whose keel was laid, or at a similar stage of construction, before November 1st 1986.

6.10.3

The additional class notation **ICE CLASS ID** is 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 which comply with the specific requirements detailed in Part F, Chapter 9.

6.10.4 *(1/5/2016)*

The above may also be completed by the notation **- HULL** when the reinforcements for navigation in ice are relevant to hull only, according to the relevant requirements in Pt F, Ch 9, Sec 1 and Pt F, Ch 9, Sec 2.

6.10.5

The additional class notation **ICE** is 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] and [6.10.3], when this has been specially considered by the Society.

6.11 Navigation in ice (POLAR CLASS)

6.11.1 *(1/1/2022)*

The following additional class notations are assigned to ships intended for navigation in ice-infested polar waters~~, except icebreakers~~:

- **POLAR CLASS PC1**
- **POLAR CLASS PC2**
- **POLAR CLASS PC3**
- **POLAR CLASS PC4**
- **POLAR CLASS PC5**
- **POLAR CLASS PC6**
- **POLAR CLASS PC7**

The requirements for the assignment of these notations are given in Part F, Chapter 10.

The above class notations may also be completed by the additional notation "**Icebreaker**" for any ship with an operational profile that includes escort or ice management functions, having powering and dimensions that allow it to undertake aggressive operations in ice-covered waters, complying with the relevant requirements in Pt F, Ch 10, Sec 2 and Sec 3.

6.12 WINTERIZATION (temp)

6.12.1

The additional class notation **WINTERIZATION (temp)** is assigned to ships intended to be operated in a cold climate over long periods.

The value **temp**, in brackets, is the design temperature in °C and is to be taken as the lowest mean daily average air temperature in the area where the ship is intended to operate (see Pt F, Ch 11, Sec 1, [2]).

In order for the **WINTERIZATION (temp)** notation to be granted, the ship is to be assigned the additional class notation **GREEN PLUS** or **GREEN STAR 3 DESIGN** or equivalent and one of the following class notations:

- **POLAR CLASS**
- **ICE CLASS IA SUPER**
- **ICE CLASS IA**
- **ICE CLASS IB**
- **ICE CLASS IC**

The requirements for the assignment of this notation are given in Part F, Chapter 11.

7 Other notations

7.1

7.1.1 The Society may also define other notations by means of provisional requirements and guidelines, which may then be published in the form of tentative rules.

Table 3 : List of additional class notations *(1/1/2022)*

Additional class notation	Reference for definition	Reference	Remarks
AIR LUBRICATION SYSTEM (AIR LUB)	[6.14.48]	Pt F, Ch 13, Sec 31	
AIR-MON	[6.14.34]	Pt F, Ch 13, Sec 22	
AUT-CCS	[6.4.3]	Pt F, Ch 3, Sec 2	**(1)**
AUT-PORT	[6.4.4]	Pt F, Ch 3, Sec 3	**(1)**
AUT-UMS	[6.4.2]	Pt F, Ch 3, Sec 1	**(1)**
AVM-APS or AVM-APS-NS	[6.3.2]	Pt F, Ch 2, Sec 1	**(1)**
AVM-IAPS	[6.3.3]	Pt F, Ch 2, Sec 2	**(1)**
AVM-DPS or AVM-DPS-NS	[6.3.4]	Pt F, Ch 2, Sec 3	**(1)**
AVM-IPS	[6.3.5]	Pt F, Ch 2, Sec 4	**(1)**
BATTERY POWERED SHIPS	[6.14.43]	Pt C, Ch 2, App 2	
BIOSAFE SHIP	[6.14.50]	Pt F, Ch 13, Sec 33	
BWM-E	[6.14.15]	NA	**(5)**
BWM-T	[6.14.15]	NA	
CARGOCONTROL	[6.14.9]	Pt F, Ch 13, Sec 9	
CARGO HANDLING	[6.14.31]	NA	
CLEAN-AIR	[6.8.3]	Pt F, Ch 7, Sec 3	**(4)**
CLEAN-SEA	[6.8.2]	Pt F, Ch 7, Sec 4	**(4)**
COAT-WBT	[6.14.12]	Pt F, Ch 13, Sec 12	
COMF-AIR	[6.7.4]	Pt F, Ch 6, Sec 3	
COMF-NOISE	[6.7.2]	Pt F, Ch 6, Sec 1	
COMF-NOISE-PORT	[6.7.5]	Pt F, Ch 6, Sec 4	
COMF-VIB	[6.7.3]	Pt F, Ch 6, Sec 2	
COVENT	[6.14.8]	Pt F, Ch 13, Sec 8	
CYBER RESILIENCE (CYR, CYR-OT and CYR-IT)	[6.14.46]	Pt F, Ch 13, Sec 29	
DANGEROUS GOODS	[6.14.35]	NA	
DIGITAL SHIP	[6.14.47]	Pt F, Ch 13, Sec 30	
DIVINGSUPPORT	[6.14.17]	Pt F, Ch 13, Sec 14	
DOLPHIN QUIET SHIP or DOLPHIN TRANSIT SHIP	[6.14.40]	Pt F, Ch 13, Sec 25	
DORS	[6.14.37]	Pt F, Ch 13, Sec 23	
DMS	[6.14.11]	Pt F, Ch 13, Sec 11	
DYNAPOS	[6.14.6] a)	Pt F, Ch 13, Sec 6	**(1)**
DP PLUS	[6.14.6] b)	Pt F, Ch 13, Sec 6	
EGCS-SOX and/or EGCS-NOX	[6.14.42]	Pt F, Ch 13, Sec 26	

(1) A construction mark is added to this notation.
(2) This notation may be completed by the specific notations **-PRECOOLING**, **-QUICKFREEZE** and/or **-AIRCONT** (see [6.9.5]).
(3) This notation may be completed by the specific notations **-MIDSHIP** and **-TRANSFER** (see [6.14.7]).
(4) When ships are assigned the notations **CLEAN-SEA** and **CLEAN-AIR**, the two separate notations are superseded by the cumulative additional class notation **GREEN STAR 3 DESIGN** (see [6.8.4]).
(5) This notation may be completed by the specific features: **sequential, flow-through, dilution**.
(6) This notation may be completed by the specific notation **-HULL** (see [6.10.4]).
(7) This notation may be completed by the specific notation **Icebreaker** (see [6.11.1]).

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Additional class notation	Reference for definition	Reference	Remarks
LASHING	[6.14.5]	Pt F, Ch 13, Sec 5	
LPG FUELLED	[6.14.52]	Pt C, Ch 1, App 13	
MAN OVERBOARD DETECTION SYSTEM (MOB)	[6.14.44]	Pt F, Ch 13, Sec 27	
MANOVR	[6.14.10]	Pt F, Ch 13, Sec 10	
MLCDESIGN	[6.14.16]	Pt F, Ch 13, Sec 13	
MON-HULL	[6.6.2]	Pt F, Ch 5, Sec 1	
MON-SHAFT	[6.6.3]	Pt F, Ch 5, Sec 2	
MOORING	[6.14.30]	Pt F, Ch 13, Sec 21	
NH3 FUELLED	[6.14.53]	Pt C, Ch 1, App 13	
NH3 FUELLED READY (X1, X2, X3)	[6.14.54]	Pt F, Ch 13, Sec 35	
PERSONS WITH REDUCED MOBILITY (PMR-ITA)	[6.14.49]	Pt F, Ch 13, Sec 32	
PMA	[6.14.14]	NA	
PMS	[6.13.2]	Pt F, Ch 12, Sec 1	
PMS-CM(PROP)	[6.13.3]	Pt F, Ch 12, Sec 2	
PMS-CM(HVAC)	[6.13.4]	Pt F, Ch 12, Sec 3	
PMS-CM(CARGO)	[6.13.5]	Pt F, Ch 12, Sec 4	
PMS-CM(ELE)	[6.13.6]	Pt F, Ch 12, Sec 5	
PMS-CM(FDS)	[6.13.7]	Pt F, Ch 12, Sec 6	
PMS-CM	[6.13.8]	Pt F, Ch 12, Sec 7	
POLAR CLASS	[6.11.1]	Part F, Chapter 10	(7)
REF-CARGO	[6.9.2]	Pt F, Ch 8, Sec 2	**(1) (2)**
REF-CONT	[6.9.3]	Pt F, Ch 8, Sec 3	**(1) (2)**
REF-STORE	[6.9.4]	Pt F, Ch 8, Sec 4	**(1) (2)**
REMOTE SURVEYABLE SHIP (REMOTE)	[6.14.51]	Pt F, Ch 13, Sec 34	
RISK MITIGATION (...)	[6.14.33]	NA	
ROUTE DEPENDENT LASHING (start date - end date)	[6.14.5]	Pt F, Ch 13, Sec 5	
(SAHARA SAHARA	[6.14.32]	Pt F, Ch 13, Sec 20	
SELF-UNLOADING	[6.14.27]	NA	
SPM	[6.14.4]	Pt F, Ch 13, Sec 4	
SPS	[6.14.26]	NA	
SRTP	[6.14.22]	NA	
STAR	[6.2.4]	Part F, Chapter 1	This cumulative notation supersedes the notations **STAR-HULL** and **STAR-MACH**, when both are assigned
STAR-HULL	[6.2.2]	Pt F, Ch 1, Sec 1	
STAR-MACH	[6.2.3]	Pt F, Ch 1, Sec 2	
STRENGTHBOTTOM-NAABSA	[6.14.1]	Pt F, Ch 13, Sec 1	
SUSTAINABLE SHIP	[6.14.55]	Pt F, Ch 13, Sec 36	
SYS-COM	[6.5.4]	Pt F, Ch 4, Sec 3	
SYS-IBS	[6.5.3]	Pt F, Ch 4, Sec 2	**(1)**

(1) A construction mark is added to this notation.
(2) This notation may be completed by the specific notations **-PRECOOLING**, **-QUICKFREEZE** and/or **-AIRCONT** (see [6.9.5]).
(3) This notation may be completed by the specific notations **-MIDSHIP** and **-TRANSFER** (see [6.14.7]).
(4) When ships are assigned the notations **CLEAN-SEA** and **CLEAN-AIR**, the two separate notations are superseded by the cumulative additional class notation **GREEN STAR 3 DESIGN** (see [6.8.4]).
(5) This notation may be completed by the specific features: **sequential, flow-through, dilution**.
(6) This notation may be completed by the specific notation **-HULL** (see [6.10.4]).
(7) This notation may be completed by the specific notation **Icebreaker** (see [6.11.1]).

SECTION 1 GENERAL

1 General

1.1

1.1.1 The purpose of this Chapter is to give details on the scope of surveys of certain ships which, due to the service notation assigned and related equipment, need specific requirements to be verified for the maintenance of their class.

1.1.2 These specific requirements either are additional to or supersede those stipulated in Chapter 3, which gives general requirements for surveys applicable to all types of ships: this is indicated in each Section of this Chapter. These surveys are to be carried out at intervals as described in Ch 2, Sec 2, concurrently with the surveys of the same type, i.e. annual, intermediate or class renewal surveys, detailed in Chapter 3.

1.1.3
Where specific requirements are given in this Chapter for the class renewal survey, they are additional to the applicable requirements for the annual survey.

2 Service notations subject to additional surveys

2.1

2.1.1 The specific requirements detailed in this Chapter are linked to the service notation(s) assigned to the ship at the request of the Owner. Where a ship has more than one service notation, the specific requirements linked to each one are applicable, insofar as they are not contradictory (in such case, the most stringent requirement will be applied).

2.1.2 Tab 1 indicates which service notations are subject to specific requirements, and in which Section or Article they are specified.

Table 1 : Service notations for which specific requirements are applicable *(1/1/2022)*

Service notation assigned	Section or Article applicable in this Chapter	Type of surveys affected by these specific requirements	Remarks
bulk carrier ESP **ore carrier ESP** **bulk carrier ESP CSR**	Sec 2 or Sec 9 (as applicable)	annual survey intermediate survey class renewal survey	Subject to enhanced survey program
asphalt tanker ESP **oil tanker ESP** **combination carrier/OBO ESP** **combination carrier/OOC ESP** **oil tanker ESP CSR**	Sec 3, Sec 4 or Sec 9 (as applicable)	annual survey intermediate survey class renewal survey	Subject to enhanced survey program
chemical tanker	Sec 5	annual survey intermediate survey class renewal survey	Not subject to enhanced survey program
chemical tanker ESP	Sec 5	annual survey intermediate survey class renewal survey	Subject to enhanced survey program
oil tanker	Sec 3	annual survey intermediate survey class renewal survey	Not subject to enhanced survey program
liquefied gas carrier	Sec 6	annual survey intermediate survey class renewal survey	
ro-ro cargo ship **passenger ship** **ro-ro passenger ship**	Sec 7	annual survey class renewal survey	Survey of shell and inner doors is included
general dry cargo ship	Sec 8	annual survey intermediate survey class renewal survey	

Service notation assigned	Section or Article applicable in this Chapter	Type of surveys affected by these specific requirements	Remarks
container ship or ship equipped for carriage of containers	Sec 10, [2]	annual survey class renewal survey	
livestock carrier	Sec 10, [3]	annual survey class renewal survey	
FLS tanker	Sec 10, [4]	annual survey intermediate survey class renewal survey	
dredger **hopper dredger** **hopper unit** **split hopper unit** **split hopper dredger**	Sec 10, [5]	annual survey class renewal survey	
tug **salvage tug** **escort tug**	Sec 10, [6]	annual survey class renewal survey	
supply vessel	Sec 10, [7]	annual survey intermediate survey class renewal survey	
fire-fighting ship	Sec 10, [8]	annual survey class renewal survey	
oil recovery ship	Sec 10, [9]	annual survey class renewal survey	
cable laying ~~ship~~unit	Sec 10, [10]	annual survey class renewal survey	
fishing vessel	Sec 10, [11]	annual survey class renewal survey	
pipe laying ~~ship~~unit	Sec 10, [12]	annual survey class renewal survey	
research ship	Sec 10, [13]	annual survey class renewal survey	
cement carrier	Sec 10, [14]	annual survey class renewal survey	
asphalt tanker	Sec 10, [15]	annual survey intermediate survey class renewal survey	Not subject to enhanced survey program
compressed natural gas carrier	Sec 10, [16]	annual survey class renewal survey	
barge	Sec 10, [17]	annual survey class renewal survey	
oil carrier-assisted propulsion, palm oil carrirer-assisted propulsion	Sec 10, [18]	annual survey intermediate survey class renewal survey	
transhipping unit, transhipping floating terminal	Sec 10, [19]	annual survey class renewal survey	
sugar carrier	Sec 10, [20]	annual survey class renewal survey	
fly ash carrier	Sec 10, [21]	annual survey class renewal survey	
ship additional service feature BC	Sec 10, [22]	annual survey class renewal survey	

Service notation assigned	Section or Article applicable in this Chapter	Type of surveys affected by these specific requirements	Remarks
ship additional service feature BC-XII	Sec 10, [23]	annual survey class renewal survey	
well stimulation	Sec 10, [24]	annual survey class renewal survey	
car carrier with additional service feature H-CNG	Sec 10, [25]	annual survey class renewal survey	
marine mobile desalination unit	Sec 10, [26]	annual survey class renewal survey	

SECTION 10 OTHER SERVICE NOTATIONS

1 General

1.1

1.1.1 *(1/1/2022)*

The requirements of this Section are applicable to ships to be assigned one of the following service notations, and given in the Articles specified below:

- **container ship**, or **ship equipped for the carriage of containers**, in [2]
- **livestock carrier**, in [3]
- **FLS tanker**, in [4]
- dredging units, i.e. ships with the service notations **dredger**, **hopper dredger**, **hopper unit**, **split hopper unit**, **split hopper dredger**, in [5]
- **tug**, **salvage tug**, **escort tug**, in [6]
- **supply vessel**, in [7]
- **fire-fighting ship**, in [8]
- **oil recovery ship**, in [9]
- **cable laying ~~ship~~unit**, in [10]
- **fishing vessel**, in [11]
- **pipe laying ~~ship~~unit**, in [12]
- **research ship**, in [13]
- **cement carrier**, in [14]
- **asphalt tanker**, in [15]
- **compressed natural gas carrier**, in [16]
- **barge, with the additional service features - accommodation, -oil**, **-liquefied gas, -LNG bunker, -chemical,** in [17]
- **oil carrier, palm oil carrier**, in [18]
- **transhipping unit, transhipping floating terminal**, in [19]
- **sugar carrier**, in [20]
- **fly ash carrier**, in [21]
- **ships with additional service feature BC**, in [22]
- **ships with additional service feature BC-XII**, in [23]
- **well stimulation**, in [24]
- **car carrier with additional service feature H-CNG**, in [25]
- **marine mobile desalination unit**, in [26].
- **offshore support vessel**, in [27].
- **wind turbine installation vessel**, in [28].

1.1.2 These requirements are additional to those given in Chapter 3, according to the relevant surveys.

1.1.3 *(1/7/2015)*

When the service notation **special service**, as per Ch 1, Sec 2, [4.12.1], is assigned, regardless of whether any additional survey requirements are indicated in the annex to the Certificate of Classification, the Annual Survey and the Renewal Survey are, in any case, to include the examination, to the extent deemed necessary by the Surveyor, of the equipment and arrangements on the basis of which the service notation has been assigned.

2 Container ship or ship equipped for the carriage of containers

2.1 Annual survey

2.1.1 The survey is to include:

- confirmation of the availability of instructions and instruments for stowage of containers, as required or fitted
- examination of container supports welded to the ship's structure or on to the hatch covers
- examination of cell guides, if fitted.

2.2 Class renewal survey

2.2.1 The renewal is to include:

- examination of container supports welded to the ship's structure or on to the hatch covers, checking for possible cracks and deformations
- examination of cell guides and associated elements, checking for possible cracks, deformations or corrosion.

2.2.2 For ships assigned with the service notation **container ship**, examination of the torsion box girder or equivalent structure at the top sides is carried out. Thickness measurements additional to those related to the transverse sections may be required.

3 Livestock carrier

3.1 Annual survey

3.1.1

The survey is to include a general examination of:

- spaces for the livestock and related hatch covers (to be surveyed according to Ch 3, Sec 3, [2])
- ventilation means, including prime movers
- main, emergency and portable lighting systems in livestock spaces, passageways and access routes
- the drainage system
- fodder and fresh water system.

3.2 Class renewal survey

3.2.1 The equipment related to ventilation, lighting and the related power supply is to be submitted to a survey to the same extent as required for similar equipment at the class renewal survey as indicated in Ch 3, Sec 5.

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- partial test, at the Surveyor's discretion, of fixed foam fire-extinguishing systems
- test of self-protection fixed water-spraying systems, putting into operation the spray nozzles, including the internal examination, as required by the Surveyor, of the relevant pumps
- examination and test of prime movers of machinery relevant to fire-fighting systems and of the air compressor for refilling of air bottles of breathing apparatuses
- examination and test of the electrical generating plant supplying power to fire-fighting systems and searchlights
- test of searchlights.

9 Oil recovery ship

9.1 Annual survey

9.1.1

The survey is to include:

- confirmation of the availability of the operating manual
- examination of cargo tank openings, including gaskets, covers, coamings and screens
- general examination of cargo, ballast and vent piping systems, including control, gauging, alarm and safety devices
- general examination of the cargo pump room, as regards ventilation systems, condition of pumps and piping systems, and signs of any oil leakage
- confirmation that electrical equipment in dangerous areas, cargo pump rooms and other spaces, if fitted, is in satisfactory condition; the Owner or his representative is to declare to the attending Surveyor that this equipment has been properly maintained
- confirmation of the availability and satisfactory condition of the fixed cargo gas detection system, including related alarms, portable gas detection equipment, and oil flash point measurement equipment.

If any inert gas system is fitted, the requirements for the annual survey of such installations given in Sec 3, [3.3] are applicable.

9.2 Class renewal survey

9.2.1 Piping

Cargo, ballast, stripping and vent piping is to be examined to the Surveyor's satisfaction. Dismantling and/or thickness measurements may be required. Tightness or working tests are to be carried out. A hydraulic or hydropneumatic test is to be carried out in the event of repair or dismantling of cargo or ballast piping, or where doubts arise.

Vent line drainage arrangements are to be examined.

It is to be verified that cargo piping is electrically bonded to the hull.

9.2.2 Safety valves

Safety valves on cargo piping and of cargo tanks are to be dismantled for examination, adjusted and, as applicable, resealed.

9.2.3 Pumps

Ballast and stripping pumps are to be internally examined and prime movers checked. A working test is to be carried out.

Maintenance records of cargo pumps are to be made available to the Surveyor.

9.2.4 Cargo pump rooms

Cargo pump room boundaries are to be generally examined. Gastight shaft sealing devices are to be examined. The bottom of cargo pump rooms is to be presented clean for the examination of stripping devices and gutters.

9.2.5 Electrical equipment in dangerous zones

A general examination of the electrical equipment and cables in dangerous zones such as cargo pump rooms and areas adjacent to cargo tanks is to be carried out for defective and non-certified safe type electrical equipment, non-approved lighting and fixtures, and improperly installed or defective or dead-end wiring.

An insulation test of circuits is to be carried out; however, where a proper record of testing is maintained, considera-tion may be given to accepting recent readings effected by the ship’s personnel.

9.2.6 Instrumentation and safety devices

The fixed cargo gas detection system, including related alarms, portable gas detection equipment, and oil flashpoint measurement equipment, is to be tested.

9.2.7 Inert gas system

If any inert gas system is fitted, the requirements for the class renewal survey of such installations given in Sec 3,[7.2] are applicable.

10 Cable laying ~~ship~~unit

10.1 Annual survey

10.1.1

The survey is to include a general examination of sheaves, drums and tensioners for damage, cracks or wastage. The connections of these appliances to the structure are also to be checked.

10.2 Class renewal survey

10.2.1 The equipment mentioned in [10.1.1] is to be dismantled, to the extent deemed necessary by the Surveyor, in order to check its condition. Clearances of sheaves and cable drum axles are to be ascertained.

11 Fishing vessel

11.1 Annual survey

11.1.1 The survey is to include:

- general examination of areas subject to damage, corrosion or wastage, such as the stern ramp, weather deck in way of the working area of the nets, connections to hull structure of masts, gantries, winches and traw gallows (for side trawlers)

- general examination of the measures for the protection of the crew against falling overboard, such as storm rails, means of protection near stern ramp, etc.

11.2 Class renewal survey

11.2.1 For fishing vessels of 10 years age and over, the class renewal survey is to include thickness measurements of structural elements prone to rapid wastage, such as the stern ramp, weather deck in way of the working area of the nets, connections to hull structure of masts, gantries, winches and traw gallows (for side trawlers).

12 Pipe laying ~~ship~~unit

12.1 Annual survey

12.1.1

The survey is to include:

- general examination of the pipe laying and anchoring equipment for damage, cracks or wastage; the connections of these appliances to the structure are also to be checked
- general examination of areas subject to damage, cracks or wastage of the weather deck in way of the working area and pipe storage area.

The annual survey of dynamic positioning equipment is to be carried out in accordance with the requirements of Ch5, Sec12, [6.1].

12.2 Class renewal survey

12.2.1

The equipment mentioned in [12.1.1] is to be dismantled, to the extent deemed necessary by the Surveyor, in order to check its condition. Tests are to be carried out to verify the proper operation of all machinery and equipment intended for pipe laying and anchoring equipment.

The renewal survey of dynamic positioning equipment is to be carried out in accordance with the requirements of Ch5, Sec12, [6.2].

13 Research ship

13.1 Annual and Class renewal survey

13.1.1

The survey is to include the examination, to the extent deemed necessary by the Surveyor, of the equipment and arrangements on the basis of which the service notation has been assigned.

14 Cement carrier

14.1 Annual survey

14.1.1

The survey is to include the general examination of the cement handling system for damage, cracks or wastage; the connections of the system to the hull structure are also to be checked.

14.2 Class renewal survey

14.2.1

The cement handling system is to be dismantled, to the extent deemed necessary by the Surveyor, in order to check its condition; the connections of the system to the hull structure are also to be checked. Tests are to be carried out to verify the proper operation of machinery and equipment intended for the cement handling system.

15 Asphalt tanker

15.1 Annual survey - Hull items

15.1.1 Weather decks

The survey is to include:

a) examination of cargo tank openings, including gaskets, covers, coamings and screens

b) examination of cargo tank pressure/vacuum valves and flame screens

c) examination of flame screens on vents to all bunker tanks

d) examination of cargo, bunker, ballast and vent piping systems, including remote control valves, safety valves and various safety devices

e) confirmation that wheelhouse doors and windows, sidescuttles and windows in superstructure and deckhouse ends facing the cargo area are in satisfactory condition

f) confirmation that pumps, valves and pipelines are identified and distinctively marked.

15.1.2 Cargo pump rooms and pipe tunnels

The survey is to include:

a) examination of all pump room bulkheads and pipe tunnels (if any) for signs of cargo leakage or fractures and, in particular, the sealing arrangements of penetrations in pump room bulkheads

b) examination of the condition of all piping systems, in cargo pump rooms and pipe tunnels (if any)

c) examination of the bilge and ballast arrangements and confirmation that pumps and pipelines are identified.

15.1.3 Independent cargo tanks

The survey is to include, as far as practicable, the general external examination of the structure surrounding the independent cargo tanks for damage, cracks or wastage, including the thermal isolating material and elements supporting and/or securing the cargo tanks.

15.2 Annual survey - Cargo machinery items

15.2.1 Cargo area and cargo pump rooms

The survey is to include:

a) confirmation that potential sources of ignition in or near the cargo pump rooms, such as loose gear, excessive

27 Offshore support vessel

27.1 Offshore support vessel

27.1.1 General *(1/1/2022)*

Offshore support vessels are to comply with the survey requirements stipulated in [7], which are specific to supply vessels.

27.2 Offshore support vessel with additional service feature W2W

27.2.1 Annual Survey *(1/1/2022)*

The Owner or his representative is to declare to the attending Surveyor that no significant alterations have been made without the prior approval of the Society.

The annual survey is to include:

a) a general examination of all components of the W2W system arrangements and installation to verify their satisfactory condition components (connection system, hinges, slewing rings, telescoping mechanical system, etc.)

b) an examination of the hull structures supporting and adjacent to the W2W system arrangements and installation to verify that no deformations or fractures have developed

c) a functional test of electrical systems, control system, alarms and communication systems

d) functional test of emergency shutdown and disconnection

e) an examination of the auxiliaries

f) functional tests of the W2W without loads, simulating the failures defined in the FMEA: functional single failures, abnormal scenarios (blackout, fire, flooding etc.), interfaces with the OSV systems (ESD, emergency stop, etc.) and restart after shutdown

g) review of maintenance actions and periodical tests on the onboard documentation.

27.2.2 Class renewal survey *(1/1/2022)*

The class renewal survey is to include.

a) a close-up examination of all components of the W2W system arrangements and installation to verify their satisfactory conditions (connection system, hinges, slewing rings, telescoping mechanical system, etc.)

b) a close-up examination of the hull structures supporting and adjacent to the W2W system arrangements and installation to verify that no deformations or fractures have developed

c) checking the ship's capability to maintain its position during W2W operations

d) a functional test of electrical systems and communication systems and measurement of insulation resistance

e) functional tests of the W2W without loads, simulating single failures defined in the FMEA

f) functional test of the station keeping and dynamic ballast, as applicable

g) review of maintenance actions and periodical tests on the onboard documentation

h) functional tests of the W2W without loads, simulating the failures defined in the FMEA: functional single failures, abnormal scenarios (blackout, fire, flooding etc.), interfaces with the OSV systems (ESD, emergency stop, etc.) and restart after shutdown

i) review of maintenance actions and periodical tests on the onboard documentation.

Where deemed necessary by the Surveyor, non-destructive tests for measuring thickness deterioration or checking for fractures or other defects may be required.

27.3 Offshore support vessel with additional service feature WIND TURBINE MAINTENANCE

27.3.1 Annual Survey *(1/1/2022)*

The annual survey is to include:

- for OSV with additional service feature **W2W**, the verifications in [27.2.1]
- for OSV with the additional class notations **DYNAPOS** and **DP PLUS**, the verifications in Pt A, Ch 5, Sec 12 [6.1] and [7.1] respectively
- for OSV fitted with anchors and cables for station keeping purposes, examination as far as practicable of:
  - anchor chain or cables
  - winches and relevant foundations
  - hydraulic control systems and relevant piping system.

27.3.2 Class renewal survey *(1/1/2022)*

The class renewal survey is to include:

- for OSV with additional service feature **W2W**, the verifications in [27.2.2]
- for OSV with the additional class notations **DYNAPOS** and **DP PLUS**, the verifications in Pt A, Ch 5, Sec 12 [6.2] and [7.2] respectively

- for OSV fitted with anchors and cables for station keeping purposes, examination as far as practicable of:
  - cable or chain in contact with fairleads, etc.
  - cable or chain in way of winches and stoppers
  - cable or chain in the contact zone of the sea bed
  - damage to mooring system
  - condition and performance of corrosion protection, if applicable
  - wire rope anchor cables; If cables are found to contain broken, badly corroded or bird caging wires they are to be renewed. Chain cables are to be examined. Maximum acceptable diminution of anchor chain in service will normally be limited to a two per cent reduction from basic chain diameter (Basic chain diameter can be taken as the diameter, excluding any design corrosion allowance, which satisfies the Rule requirement for minimum factors of safety)
  - the windlasses or winches
  - structure in way of anchor racks and anchor cable fairleads.

28 Wind turbine installation vessel

28.1 Annual, intermediate and Renewal survey

28.1.1 *(1/1/2022)*

Ships equipped with a self-elevating system are to comply with the following requirements in Tasneef Rules for the Classification of Floating Offshore Units at Fixed Locations and Mobile Offshore Drilling Units, as applicable:

- Pt A, Ch 2, Sec 2
- Pt A, Ch 3
- Pt A, Ch.4, Sec 5

28.2 Wind turbine installation vessel with additional service feature W2W

28.2.1 *(1/1/2022)*

Wind turbine installation vessels with additional service feature **W2W** are to comply with the requirements stipulated in [27.2]

SECTION 12 OTHER NOTATIONS

1 General

1.1

1.1.1 *(1/1/2022)*

The requirements of this Section apply to ships which have been assigned one of the following additional class notations described in Ch1, Sec2, [6.14]:

STRENGTHBOTTOM-NAABSA

GRABLOADING

GRAB [X]

SPM

DYNAPOS

DP PLUS

VCS

COVENT

CARGOCONTROL

COAT-WBT

DIVINGSUPPORT

HVSC

FIRE

SELF-UNLOADING

TAS

EFFICIENT SHIP (S, DWT)

MOORING

CARGO HANDLING

(SAHARA, SAHARA

COMF NOISE, **COMF-NOISE-PORT**

RISK MITIGATION

AIR MON

DANGEROUS GOODS

INF 1, **INF 2**, **INF 3**

INERTGAS A, **INERTGAS B**, **INERTGAS C**

GAS FUELLED, **GAS FUELLED (Main)**, **GAS FUELLED (Aux)**

MAN OVERBOARD DETECTION SYSTEM

CYBER RESILIENCE

DIGITAL SHIP

AIR LUBRICATION SYSTEM

PERSONS WITH REDUCED MOBILITY (PMR-ITA)

BIOSAFE SHIP

REMOTE

SUSTAINABLE SHIP

MARITIME AUTONOMOUS SURFACE SHIPS (MASS)

2 STRENGTHBOTTOM-NAABSA

2.1 Dry-docking survey

2.1.1 The reinforced area of bottom plating and internal associated structures are to be visually examined for possible deformations, fractures or other damage. If deemed necessary, thickness measurements may be required.

3 GRABLOADING and GRAB [X]

3.1 Class renewal survey

3.1.1 The reinforced area of double bottom plating and adjacent associated structures are to be visually examined for possible deformations, fractures or other damage. If deemed necessary, thickness measurements may be required.

4 SPM

4.1 Annual survey

4.1.1 The Owner or his representative is to declare to the attending Surveyor that no significant alterations have been made without the prior approval of the Society.

4.1.2 The annual survey is to include:

- a general examination of all components of the installation (bow chain stoppers, bow fairleads, pedestal roller fairleads, winches and capstans) to verify their satisfactory condition
- an examination of the hull structures supporting and adjacent to the installation to verify that no deformations or fractures have developed.

4.2 Class renewal survey

4.2.1 The class renewal survey is to include:

- a close-up examination of all components of the installation (bow chain stoppers, bow fairleads, pedestal roller fairleads, winches and capstans) to verify their satisfactory condition
- a close-up examination of the hull structures supporting and adjacent to the installation to verify that no deformations or fractures have developed.

Where deemed necessary by the Surveyor, non-destructive tests for measuring thickness deterioration or checking for fractures or other defects may be required.

5 LASHING and ROUTE DEPENDENT LASHING

5.1 General

5.1.1

For the additional class notation **ROUTE DEPENDENT LASHING** the approved route or routes, for which the notation is granted, may by modified. In this case the Society is to be informed in advance and the required modifications are to be reflected in the approved documentation (see Pt F, Ch 13, Sec 5, [1]) and are to be confirmed through an on-board survey having the consistency of a Renewal Survey.

5.2 Class renewal survey

5.2.1

The survey is to include:

a) a review of the required on board documentation (see Pt F, Ch 13, Sec 5, [1])

b) a check of the availability of computer and software in the approved edition.

6 DYNAPOS

6.1 Annual survey

6.1.1 *(1/1/2022)*

The program of the annual survey may be previously agreed with the Society.

Scope of the annual DP trials, if carried out in multiple occasions, is to be agreed in advance with the Society.

The Owner or his representative is to declare to the attending Surveyor that no significant alterations have been made without the prior approval of the Society.

The number of machineries and systems to be tested may be subdivided among the 5 annual surveys provided that they are all tested within the completion of the renewal survey taking in account records of tests credited during previous annual surveys.

Note 1: An alteration means the renewal of the DP controller hardware or software, but an alteration may be constituted also by:

- installation of a new position reference system or other sensor interfaced to the DP-control system
- changes to the thruster system
- software changes
- structural changes
- changes in power system.

6.1.2 *(1/1/2022)*

The following documentation is to be available on board:

- DP FMEA including FMEA proving trials report
- DP operation manual
- maintenance program.

6.1.3 *(1/1/2022)*

The record of following data is to be available on board:

a) the DP control system(s) SW version(s)

b) number and type of position reference systems installed.

6.1.4 *(1/1/2022)*

The dynamic positioning system is to be operated for a reasonable duration to check that it has been properly maintained and is in good working condition.

The operational testing is to be carried out to the Surveyor's satisfaction and the tests are to confirm the level of redundancy established by the DP FMEA.

The operational testing is to be conducted on a representative number of equipment in order to check the DP FMEA (for **DP2** and **DP3**).

Annual DP trials are to be carried out in one single occasion as part of the survey foreseen for the class annual.

Annual survey has to be performed during a sea trial with the ship in automatic DP mode as long as practicable and safe.

6.1.5 *(1/1/2022)*

When it is not feasible to leave the port for the sea trial the survey may be credited based on testing carried out within restricted areas and previously agreed to satisfaction of the attending surveyor; the same agreed test schedule may not be repeated at the subsequent annual survey.

A statement from the Master confirming that the DP system is capable to keep the positioning and heading of the vessel within the environmental conditions reported by the DP capability plot is to be made available or handed over.

6.1.6 *(1/1/2022)*

General examination of following equipment~~The annual survey is to include~~:

- ~~an examination of the log books to verify the proper operation of systems in the period subsequent to the last survey and measures taken to avoid repetition of any malfunctions or failures which have occurred during the same period~~
- ~~general examination of~~ visible parts of thrust units, including their prime movers
- ~~general examination of the~~ electrical power system and switchboards
- controllers and operating stations for DP
- position references systems (including mechanical parts if relevant)
- heading reference systems
- wind sensors
- ~~general examination of~~ control, monitoring and alarm devices
- ~~running test of the installation, including random test by simulation of different alarms and relevant backup systems and switching modes.~~

6.1.7 *(1/1/2022)*

Dynamic positioning system is to be verified according to the following criteria:

a) verify that any DP system hardware changes that may affect the DP class notation for the unit have been submitted, approved, and tested as required

b) confirm that any software revisions since the time of last Survey have been tracked and tested as appropriate by Owner and suitably documented for record

c) any hardware or software changes that have not been tested since the last performance test are to have functionality proven and recorded by a supplementary trials program to verify the effect of the modifications with regard to the approved redundancy arrangements for the unit.

6.1.8 *(1/1/2022)*

The operation of the automatic control system and a manual position control system including manual transfer of control between the two systems is to be confirmed to be functioning satisfactorily. In addition, the following tests are to be performed:

a) operation of the automatic position and heading keeping using the available position reference systems as single input to the DP control system, and in different combinations. Minimum one position reference system is to be made available. Verification of the position data is to be made by comparison of different reference systems. Correct functioning of position reference system operator stations and displays is to be verified. When relevant also electrical and mechanical functions of position reference systems are to be verified

b) during the test required in [6.1.10 a] spot-checks are to be performed to verify the following (as applicable to the installation):
   - verification of views and the information displayed on them, including position reference systems, other sensors and power views
   - selection and deselecting of reference systems when more than one system is available
   - selection and deselecting of heading reference sensors, wind sensors vertical reference sensors and other sensors when installed
   - selection and deselecting of thrusters
   - alarms for loss of position and heading out of limits
   - verification of different operational modes as applicable to the installation, e.g.: thruster allocation modes, different rotation centres, tracking modes, different combinations of surge/yaw/sway control, etc.

c) operation of the automatic position and heading keeping has to be verified using all heading reference systems as input to the DP control system. Verification of the heading data shall be made by comparison of different systems. This can be done as part of the testing in [6.1.10 a]

d) random verification of wind sensors, vertical reference sensors and all other sensors providing input to the automatic DP control system is to be performed by doing automatic position and heading keeping with each available sensor as input to the DP control system. This can be done as part of the testing in [6.1.10 a].

e) operation of the independent joystick system, including automatic heading control, at all control locations

f) operation of emergency stops of thrusters from the DP-control centre

g) transfer of control to independent joystick upon power failure to the DP control system

h) transfer of control to manual thruster levers in case of power failure to the DP control system and independent joystick control system

i) operation of manual control of pitch, speed and azimuth for all thrusters (as applicable). Verify correct functioning of the feedback displays.

6.1.9 *(1/1/2022)*

In addition, when a class notation **DP2** is assigned, the following tests are to be performed:

a) operation of two automatic control systems and a manual position control system including automatic transfer of one automatic control system to another upon failure is to be confirmed to be functioning satisfactorily. Upon failure of the two automatic control systems, it is to be verified that the manual position control is possible

b) verification of redundancy level of the system and equipment reliability. The tests are to be performed through the disconnection or disabling these components to demonstrate the operational capability after the respective failure modes:
   - position reference systems or sensors
   - power management system
   - uninterruptible power supply system
   - network communication systems
   - worst case failure (e.g. switchboard, transformer, engine, or thruster as applicable).

c) verification of blackout preventing system in open and closed bus-tie mode (according to the approved document) on each section of the main switchboard

d) verification of partial blackout recovery sequence in open bus-tie mode on each section of the main switchboard

e) verify the standby capability of auxiliary services that provide essential redundancy identified through the DP FMEA

f) test of thrusters automatic supplying change-over (if applicable)

g) the uninterruptible power systems (UPS) are to be operated and confirmed to be functioning satisfactorily with spot-check. The schedule of batteries is to be examined to verify that the batteries have been maintained

h) power redundancy test. This can be done combined with the test of worst case failure (e.g.: partial blackout). Based on test results and inspections additional testing may be required

i) operation of emergency stops of thrusters from the DP-control center, including loop monitoring is to be verified.

6.1.10 *(1/1/2022)*

In addition, when a class notation **DP3** is assigned, the following tests are to be performed:

a) operation of three automatic control systems and a manual position control system including automatic transfer of one automatic control system to another upon failure is to be confirmed to be functioning satisfactorily. Manual transfer of control is to be verified at the third automatic control system located in the emergency back-up control station. It is to be verified the manual position control upon failure of automatic control systems

b) verification of redundancy level of the compartments and reliability. The tests are to be performed through the disconnection or disabling these component in each compartment to demonstrate the operational capability after the respective failure modes:

- main control station
- worst case failure compartment (e.g., engine room, switchgear room, thruster room, or other space).

c) verification that no changes have been made to the watertight integrity and fire subdivisions of compartments containing elements of the DP and associated systems

d) the uninterruptible power systems (UPS) are to be operated and confirmed to be functioning satisfactorily with spot-check. The uninterruptible power systems (UPS) are to be operated without the normal main power input for 30 minutes to confirm that the batteries can supply the output power and are in satisfactory condition. The schedule of batteries is to be examined to verify that the batteries have been maintained

e) a means of voice communication between the DP control position (navigation bridge), and the thruster room(s) is to be tested and confirmed to be functioning satisfactorily

f) a means of voice communication between the DP control position (Navigation Bridge), the engine control position and any operational control centers associated with DP is to be tested and confirmed to be functioning satisfactorily.

g) a means of voice communication between the DP control position (Navigation Bridge), the engine control position and any operational control centers associated with DP is to be tested and confirmed to be functioning satisfactorily.

Based on test results and inspections additional testing may be required.

6.2 Class renewal survey

6.2.1 *(1/1/2022)*

~~In general, the class renewal survey consists of the checks detailed in [6.2.3] to [6.2.6]. However, a specific program of the class renewal survey prepared by the Owner and taking into account the maintenance procedures of the Manufacturers of the system is to be submitted to the Society prior to the survey.~~

The complete DP system is to be tested in all operational modes

The survey is to include simulation of different failure conditions to verify switching of modes, back-up systems and the alarm system.

6.2.2 *(1/1/2022)*

~~The Owner is to confirm that any modification to the software is fully documented and properly recorded~~In addition to the requirements of the annual survey listed in [6.1], complete performance tests are to be carried out to the Surveyor's satisfaction. The schedule of these tests is to be developed to check the level of redundancy established in the FMEA.

6.2.3 *(1/1/2022)*

~~Prime movers of thrust units, electrical installations and electric power generators are to be surveyed and tested to the same extent as required in Ch 3, Sec 5, [3] for similar equipment for the class renewal survey of machinery~~The full power tests of thrusters and generators are to be performed. Different methods may be proposed by the Owner in advance during the annual surveys and Renewal Survey to satisfaction of Surveyor.

6.2.4 *(1/1/2022)*

~~During the bottom survey in dry condition which is to be carried out concurrently with the class renewal survey (see Ch 3, Sec 5, [2.1]), the thrust units are to be generally examined. Other checks are to be carried out, such as taking clearances, examination of the orientation device or variable pitch system, if any, verifying tightness devices, examination of results of lube oil analysis for detection of possible deterioration of internal gears and bearings. Dismantling of internal parts may be required if the above examinations are not satisfactory.~~The different modes of thruster control from the DP control center(s) are to be tested:

- manual control
- independent joystick control, if installed
- DP control.

6.2.5 *(1/1/2022)*

~~Sensors and position reference systems are to be tested to check their accuracy. Failure of sensors is to be simulated in order to check the related alarm system and switching logic. Switch over to the different reference systems is to be checked.~~The automatic DP system is to be tested by performing automatic DP operation. During this testing the following are to be verified:

- verification of views and the information displayed on them
- position keeping and position moves, both longitudinal and sideways. See also [6.2.6] and [6.2.7]
- heading keeping and changes. See also [6.2.6] and [6.2.7]
- selection and deselecting of reference systems when more than one system is installed
- selection and deselecting of wind sensors, heading reference sensors, vertical reference sensors and other sensors when installed
- selection and deselecting of thrusters
- alarm for loss of position and heading out of limit is to be demonstrated
- verification of all operational modes as applicable to the installation, e.g.: thruster allocation modes, different rotation centers, tracking modes, different combinations of surge/yaw/sway control, etc.

6.2.6 *(1/1/2022)*

~~An operational test of the installation is to be performed, including:~~All position reference systems are to be tested to verify:

- ~~test of each thrust unit at different loads, pitches and speeds, and check of monitoring devices~~correct operation and adequate accuracy of all installed sensors. This is to be done as part of the test in [6.2.5]. Each position reference systems is to be tested as single input to the DP control system, and in different combinations
- ~~test of the thrust controls in the different available modes (automatic, semi-automatic, manual), and the switch over between the different modes~~when more than one sensor is installed: switch-over between reference systems as input to controller is to be carried out to assure that warnings, alarms and information to operator are satisfactory. This is to be done as part of the test in [6.2.5]
- ~~test of the different alarms and safety systems, using simulated conditions as necessary~~failure of reference systems is to be simulated to check the alarm system.
- ~~test of power supply failure and verification of intended functioning in such cases~~
- ~~final test to verify the capacity of the system to keep the ship in the intended position and maintain the heading, with related alarm and monitoring devices. The accuracy of the system is to be checked and compared with previous results for evaluation of drift~~
- ~~test of the power management system.~~

6.2.7 *(1/1/2022)*

All heading reference sensors, wind sensors, vertical reference sensors and other peripheral equipment are to be tested in order to verify:

- correct operation and adequate accuracy of all installed sensors. This is to be done as part of the test in [6.2.5]
- when more than one sensor is installed: switch-over between sensors as input to controller is to be carried out to assure that warnings, alarms and information to operator are satisfactory. This is to be done as part of the test in [6.2.5]
- failure of sensors is to be simulated to check the alarm system.

6.2.8 *(1/1/2022)*

Overload prevention functionality is to be tested.

6.2.9 *(1/1/2022)*

Correct functioning of the consequence analysis facility is to be verified as far as possible.

6.2.10 *(1/1/2022)*

Change-over to the back-up DP control system is to be verified. Normal working condition of the back-up DP-control system is to be verified by performing tests as required in [6.2.5], [6.2.6], [6.2.7], [6.2.8].

6.2.11 *(1/1/2022)*

Single failure testing in the thruster control mode selection system is to be performed in order to verify alarms and the availability of manual control (individual thruster lever control) after failure:

- loop failures
- power failures in mode change systems dependent on power
- controller failure when based upon controllers
- communication/network failures when based on communication networks.

6.2.12 *(1/1/2022)*

Single failures in the thruster control systems including signal wire breaks of thruster command and feedback signals are to be tested in order to verify safe response on the thrust output. Equivalent testing may also be required for rudders controlled by the DP-control system.

6.2.13 *(1/1/2022)*

The loop monitoring alarm for the individual thruster emergency stops is to be verified.

6.2.14 *(1/1/2022)*

In addition for class notations **DP2** and **DP3** the redundancy in the main DP control systems is to be verified. As a minimum the following tests are to be tested:

- power failures, by disconnection of all outputs from each UPS and battery systems serving the DP control system, one UPS/battery system at a time
- communication/network failures when based on communication networks
- operator station failure
- automatic dynamic positioning controller failure.

6.2.15 *(1/1/2022)*

The alarms, indicators and safety functions of generators, thrusters and propulsion systems are to be performed.

Based on test results and inspections additional testing may be required.

6.2.16 *(1/1/2022)*

Consequence analysis and blackout prevention are to be tested (if applicable).

7 DP PLUS

7.1 Annual survey

7.1.1 *(1/1/2022)*

Annual survey is to to be performed with the ship in automatic DP mode. as long as practicable and safe.

7.1.2 *(1/1/2022)*

The dynamic positioning system is to be operated for a reasonable duration to demonstrate that the dynamic positioning system has been maintained properly and is in good working order.

7.1.3 *(1/1/2022)*

The operational testing is to be carried out to the Surveyor's satisfaction and the tests are to demonstrate the level of redundancy established by the DP FMEA document.

7.1.4 *(1/1/2022)*

The Owner or his representative is to declare to the attending Surveyor that no significant alterations have been made without the prior approval of the Society.

7.1.5 *(1/1/2022)*

Ascertainment and test as per paragraph [6] for **DP2** or **DP3** as applicable.

7.1.6 *(1/1/2022)*

DFS notation is to be verified in order the confirm that the dual feeding operation of thruster doesn't cause unsafe conditions in case of fault.

7.1.7 *(1/1/2022)*

DP2 and **DP3** ships whose **DFS** notation is assigned are to be tested to:

- confirm the reliability of protections devices
- demonstrate the ride-through capability in case of voltage-dip.

7.1.8 *(1/1/2022)*

FFP notation is to be verified to confirm the fire and flooding segregation of machinery spaces.

7.1.9 *(1/1/2022)*

DP2 ships whose **DFS** notation is assigned are to be tested to:

- confirm the segregation of auxiliaries' active components within a defined redundancy group
- confirm the segregation of auxiliaries' passive components within a defined redundancy group.

7.1.10 *(1/1/2022)*

DP3 ships whose **DFS** notation is assigned are to be tested to:

- confirm the segregation of auxiliaries' active components within a defined DP zone
- confirm the segregation of auxiliaries' passive components within a defined DP zone.

7.1.11 *(1/1/2022)*

PRD notation is to be verified in order to confirm the detection and protection capability of the main switchboard and auxiliary systems reliability of generators.

7.1.12 *(1/1/2022)*

DP2 and **DP3** ships whose **PRD** notation is assigned are to be tested to:

- confirm of the three operation modes of the main switchboard
- confirm the functionality of safety devices and relevant redundancy feeding section
- confirm the reliability of the network communication system
- confirm the reliability of Advanced Generator System
- confirm the operation of standby generator (within 20 sec.).

Based on test results and inspections additional testing may be required.

7.2 Class renewal survey

7.2.1 *(1/1/2022)*

The complete DP system is to be tested in all operational modes.

7.2.2 *(1/1/2022)*

In addition to the requirements of the annual survey listed in [7.1] the following tests are to be performed to demonstrate the performance established in the FMEA:

a) **DP2** and **DP3** ships whose **DFS** notation is assigned are to be tested to:
   - confirm the reliability of protections devices, a short-circuit test is to to be performed (with a derated current).

b) **DP2** ships whose **DFS** notation is assigned are to be tested to:
   - confirm the segregation of auxiliaries' active components within each redundancy group
   - confirm the segregation of auxiliaries' passive components within each redundancy group.

c) **DP3** ships whose **DFS** notation is assigned are to be tested to:
   - confirm the segregation of auxiliaries' active components within each DP zone
   - confirm the segregation of auxiliaries' passive components within each DP zone.

d) **DP2** and **DP3** ships whose **PRD** notation is assigned are to be tested to:
   - confirm the total blackout resolution (within 60 sec.).

Based on test results and inspections additional testing may be required.

~~7~~ 8 VCS

~~7~~8.1 Annual survey

~~7~~8.1.1 The Owner or his representative is to declare to the attending Surveyor that no significant modifications have been made without the prior approval of the Society.

SECTION 1 APPLICATION

1 General

1.1 Structural requirements

1.1.1 *(1/1/2022)*

Part B contains the requirements for determination of the minimum hull scantlings, applicable to all types of seagoing monohull displacement ships of normal form, speed and proportions, made in welded steel construction, except for bulk carriers and oil tankers, for which the requirements in the "Common Structural Rules for Bulk Carriers and Oil Tankers" apply. These requirements are to be integrated with those specified in Part E, for any individual ship type, and in Part F, as applicable, depending on the additional class notations assigned to the ships.

For ships with the notations **bulk carrier ESP CSR** and **oil tanker ESP CSR,** the above-mentioned Common Structural Rules apply as appropriate with the addition of the following requirements:

- Sec 4 - as regards the calculation programs
- Ch 3, Sec 1, Ch 3, Sec 2, Ch 3, App 1 and Ch 3, App 2 - for the requirements concerning Intact Stability
- Ch 5, Sec 1, [2.1.4] - for the direct calculations of hull girder wave induced loads in the case of ships with scantling length greater than 350 m
- Ch 5, Sec 6, [2.2] and [2.3] - for the calculation of impact pressures in tanks in the case of resonance
- Ch 9, Sec 7, [1.2] - for the materials of the hatch covers
- Ch 10, Sec 1 and App 1 - for the requirements concerning rudders.
- Ch 10, Sec 4, as applicable - for the requirements concerning ship equipment.
- Ch 10, App 2 - for the requirements concerning mooring lines for ships with EN > 2000.
- Ch 10, App 3 - for the requirements concerning direct mooring analyses.
- Ch 11, Sec 2, [4] - for the requirements concerning the loading instruments
- Ch 12, Sec 3, [1], [2] and [3] - for the requirements concerning testing.

1.1.2 The requirements of Part B, Part E and Part F apply also to those steel ships in which parts of the hull, e.g. superstructures or movable decks, are built in aluminium alloys.

1.1.3 Ships whose hull materials are different than those given in [1.1.2] and ships with novel features or unusual hull design are to be individually considered by the Society, on the basis of the principles and criteria adopted in the Rules.

1.1.4 The strength of ships constructed and maintained according to the Rules is sufficient for the draught corresponding to the assigned freeboard. The scantling draught considered when applying the Rules is to be not less than that corresponding to the assigned freeboard.

1.1.5 Where scantlings are obtained from direct calculation procedures which are different from those specified in Chapter 7, adequate supporting documentation is to be submitted to the Society, as detailed in Sec 3.

1.2 Limits of application to lifting appliances

1.2.1 The fixed parts of lifting appliances, considered as an integral part of the hull, are the structures permanently connected by welding to the ship's hull (for instance crane pedestals, masts, king posts, derrick heel seatings, etc., excluding cranes, derrick booms, ropes, rigging accessories, and, generally, any dismountable parts). The shrouds of masts embedded in the ship's structure are considered as fixed parts.

1.2.2 The fixed parts of lifting appliances and their connections to the ship's structure are covered by the Rules, even when the certification (especially the issuance of the Cargo Gear Register) of lifting appliances is not required.

2 Rule application

2.1 Ship parts

2.1.1 General

For the purpose of application of the Rules, the ship is considered as divided into the following three parts:

- fore part
- central part
- aft part.

2.1.2 Fore part

The fore part includes the structures located forward of the collision bulkhead, i.e.:

- the fore peak structures
- the stems.

In addition, it includes:

- the reinforcements of the flat bottom forward area
- the reinforcements of the bow flare area.

2.1.3 Central part

The central part includes the structures located between the collision bulkhead and the after peak bulkhead.

Where the flat bottom forward area or the bow flare area extend aft of the collision bulkhead, they are considered as belonging to the fore part.

SECTION 3 DOCUMENTATION TO BE SUBMITTED

1 Documentation to be submitted for all ships

1.1 Ships built under the Society's supervision

1.1.1 Plans and documents to be submitted for approval

The plans and documents to be submitted to the Society for approval are listed in Tab 1. This list is intended as guidance for the complete set of information to be submitted, rather than an actual list of titles.

The above plans and documents are to be supplemented by further documentation which depends on the service notation and, possibly, the additional class notation (see Pt A, Ch 1, Sec 2) assigned to the ship, as specified in [2].

Structural plans are to show details of connections of the various parts and, in general, are to specify the materials used, including their manufacturing processes, welded procedures and heat treatments. See also Ch 12, Sec 1, [1.6].

1.1.2 Plans and documents to be submitted for information

In addition to those in [1.1.1], the following plans and documents are to be submitted to the Society for information:

- general arrangement
- capacity plan, indicating the volume and position of the centre of gravity of all compartments and tanks
- lines plan
- hydrostatic curves
- lightweight distribution
- towing and mooring arrangement plan, containing the information specified in Ch 10, Sec 4, [3.1]
- list of dangerous goods intended to be carried, if any.

In addition, when direct calculation analyses are carried out by the Designer according to the rule requirements, they are to be submitted to the Society.

1.1.3 Number of copies

The number of copies to be submitted for each plan or document is to be agreed with the Society on a case by case basis depending on the specific conditions under which plan approval and supervision during construction are organised. However, it is generally equal to:

- 3 for plans and documents submitted for approval
- 2 for plans and documents submitted for information.

2 Further documentation to be submitted for ships with certain service notations or additional class notations

2.1 General

2.1.1 Depending on the service notation and, possibly, the additional class notation (see Pt A, Ch 1, Sec 2) assigned to the ship, other plans or documents may be required to be submitted to the Society, in addition to those in [1.1]. They are listed in [2.2] and [2.3] for the service notations and additional class notations which require this additional documentation.

However, the additional documentation relevant to a service notation or an additional class notation may be required also for ships to which it is not assigned, when this is deemed necessary by the Society on the basis, inter alia, of the ship service, the structural arrangements, the type of cargo carried and its containment.

2.2 Service notations

2.2.1 The plans or documents to be submitted to the Society are listed in Tab 2.

Table 2 : Plans and documents to be submitted depending on service notations *(1/1/2022)*

Service notations	Plans or documents
ro-ro passenger ship **ro-ro cargo ship**	Plans of the bow or stern ramps, elevators for cargo handling and movable decks, if any, including: • structural arrangements of ramps, elevators and movable decks with their masses • arrangements of securing and locking devices • connection of ramps, lifting and/or hoisting appliances to the hull structures, with indication of design loads (amplitude and direction) • wire ropes and hoisting devices in working and stowed position • hydraulic jacks • loose gear (blocks, shackles, etc.) indicating the safe working loads and the testing loads • test conditions Operating and maintenance manual (see Ch 9, Sec 5 and Ch 9, Sec 6) of bow and stern doors and ramps Plan of arrangement of motor vehicles, railway cars and/or other types of vehicles which are intended to be carried Characteristics of motor vehicles, railways cars and/or other types of vehicles which are intended to be carried: (as applicable) axle load, axle spacing, number of wheels per axle, wheel spacing, size of tyre print Plan of dangerous areas, in the case of ships intended for the carriage of motor vehicles with petrol in their tanks
container ship	Container arrangement in holds, on decks and on hatch covers, indicating size and gross mass of containers Container lashing arrangement indicating securing and load bearings arrangements Drawings of load bearing structures and cell guides, indicating the design loads and including the connections to the hull structures and the associated structural reinforcements
livestock carrier	Livestock arrangement Distribution of fodder and consumable liquid on the various decks and platforms
oil tanker ESP **FLS tanker**	Arrangement of pressure/vacuum valves in cargo tanks Cargo temperatures
Tanker	Cargo temperatures
chemical tanker ESP	List of cargoes intended to be carried, with their density Types of cargo to be carried in each tank Cargo temperatures Arrangement of pressure/vacuum valves in cargo tanks For ships with independent tanks, connection of the cargo tanks to the hull structure
liquefied gas carrier	Arrangement of pressure/vacuum valves in cargo tanks Heat transfer analysis Distribution of steel qualities For ships with independent tanks: • cargo tank structure • connection of the cargo tanks to the hull structure • anti-floating and anti-collision arrangements
dredger	Transverse sections through hoppers, wells, pump rooms and dredging machinery spaces Structural arrangement of hoppers and supporting structures Closing arrangements, if any Connection of dredging machinery with the hull structure
hopper dredger **hopper unit**	Transverse sections through hoppers, wells, pump rooms and dredging machinery spaces Structural arrangement of hoppers and supporting structures including: • location, mass, fore and aft extent of the movable dredging equipment, for each loading condition • calculations of the horizontal forces acting on the suction pipe and on the gallows Closing arrangements, if any Connection of dredging machinery with the hull structure

Service notations	Plans or documents
split hopper dredger **split hopper unit**	Transverse sections through hoppers, wells, pump rooms and dredging machinery spaces Structural arrangement of hoppers and supporting structures, including: • location, mass, fore and aft extent of the movable dredging equipment, for each loading condition • calculations of the horizontal forces acting on the suction pipe and on the gallows Closing arrangements, if any Connection of dredging machinery with the hull structure Superstructure hinges and connections to the ship's structure, including mass and location of the superstructure centre of gravity Structure of hydraulic jack spaces Deck hinges, including location of centre of buoyancy and of centre of gravity of each half-hull, mass of equipped half-hull, half mass of spoil or water, supplies for each half-hull and mass of superstructures supported by each half-hull Hydraulic jacks and connections to ship's structure including operating pressure and maximum pressure of the hydraulic jacks (cylinder and rod sides) and corresponding forces Longitudinal chocks of bottom and deck Transverse chocks Hydraulic installation of jacks, with explanatory note
tug **salvage tug** **tug escort**	Structural arrangement of the winch and its remote control of the quick-release device for opening under load Structural arrangement of the hook and its remote control of the quick-release device for opening under load Connection of the towing system (winch and hook) with the hull structures
tug, **salvage tug**, **tug escort** with additional service feature **barge combined** **barge** with additional service feature **tug combined**	Structural arrangement of the fore part of the tug, showing details of reinforcements in way of the connecting point Structural arrangement of the aft part of the barge, showing details of reinforcements in way of the connecting point Details of the connection system
supply vessel and **offshore support vessel**.	General plan showing the location of storage and cargo tanks with adjacent cofferdams and indicating the nature and density of cargoes intended to be carried Plan of gas-dangerous spaces Connection of the cargo tanks with the hull structure Stowage of deck cargoes and lashing arrangement with location of lashing points and indication of design loads Structural reinforcements in way of load transmitting elements, such as winches, rollers, lifting appliances
supply vessel and **offshore support vessel** with additional service feature **anchor handling** or **anchor handling stab**	General arrangement of the fittings and equipment for anchor handling operations Structural drawings of the guides/rollers used for anchor handling operations Structural drawings of hull supporting structures in way of guides/rollers used for anchor handling operations Only for ships with service feature anchor handling stab: stability operational manual for anchor handling operations, as detailed in Pt E, Ch 15, Sec 2, [3.4.3]
oil recovery ship	General plan showing the location of tanks intended for the retention of oily residues and systems for their treatment Plan of the system for treatment of oily residues and specification of all relevant apparatuses Supporting structures of the system for treatment of oily residues Operating manual
fishing vessel	Minimum design temperature of refrigerated spaces Structural reinforcements in way of load transmitting elements, such as masts, gantries, trawl gallows and winches, including the maximum brake load of the winches

SECTION 1 MATERIALS

1 General

1.1 Characteristics of materials

1.1.1 The characteristics of the materials to be used in the construction of ships are to comply with the applicable requirements of Part D.

1.1.2 Materials with different characteristics may be accepted, provided their specification (manufacture, chemical composition, mechanical properties, welding, etc.) is submitted to the Society for approval.

1.2 Testing of materials

1.2.1 Materials are to be tested in compliance with the applicable requirements of Part D.

1.3 Manufacturing processes

1.3.1 The requirements of this Section presume that welding and other cold or hot manufacturing processes are carried out in compliance with current sound working practice and the applicable requirements of Part D. In particular:

- parent material and welding processes are to be approved within the limits stated for the specified type of material for which they are intended
- specific preheating may be required before welding
- welding or other cold or hot manufacturing processes may need to be followed by an adequate heat treatment.

2 Steels for hull structure

2.1 Application

2.1.1 Tab 1 gives the mechanical characteristics of steels currently used in the construction of ships.

2.1.2 Higher strength steels other than those indicated in Tab 1 are considered by the Society on a case by case basis.

2.1.3 When steels with a minimum guaranteed yield stress R_{eH} other than 235 N/mm² are used on a ship, hull scantlings are to be determined by taking into account the material factor k defined in [2.3].

2.1.4 Characteristics of steels with specified through thickness properties are given in Pt D, Ch 2, Sec 1, [9].

2.2 Information to be kept on board

2.2.1 A plan is to be kept on board indicating the steel types and grades adopted for the hull structures. Where steels other than those indicated in Tab 1 are used, their mechanical and chemical properties, as well as any workmanship requirements or recommendations, are to be available on board together with the above plan.

2.2.2 It is also recommended that a plan is kept on board indicating the hull structures built in normal strength steel of grades D or E.

Table 1 : Mechanical properties of hull steels *(1/1/2022)*

Steel grades	Minimum yield stress R_{eH}, in N/mm²	Ultimate minimum tensile strength R_m, in N/mm²
A-B-D-E t ≤ 100mm	235	400 - 520
AH32-DH32-EH32 t ≤ 100mm FH32 t ≤ 50mm	315	440 - 5~~9~~70
AH36-DH36-EH36 t ≤ 100mm FH36 t ≤ 50mm	355	490 - 6~~2~~30
AH40-DH40-EH40 FH40 t ≤ 50mm	390	510 - 6~~5~~60
EH47	460	570 - 720
Note 1: Reference in Part D: Pt D, Ch 2, Sec 1, [2]		

2.3 Material factor k

2.3.1 General *(1/7/2017)*

Unless otherwise specified, the material factor k has the values defined in Tab 2, as a function of the minimum guaranteed yield stress R_{eH}.

For intermediate values of R_{eH}, k may be obtained by linear interpolation.

Steels with a yield stress lower than 235 N/mm² or greater than 460 N/mm² are considered by the Society on a case by case basis.

Table 2 : Material factor k *(1/7/2017)*

R_{eH}, in N/mm²	k
235	1
315	0,78
355	0,72
390	0,68 **(1)**
460	0,62
(1) 0,66 provided that a fatigue assessment of the structure is performed to verify compliance with Pt B, Ch 7, Sec 4	

SECTION 2 HULL GIRDER LOADS

Symbols

For symbols not defined in this Section, refer to the list at the beginning of this Chapter.

C : Wave parameter:

$$C = 10{,}75 - \left(\frac{300 - L}{100}\right)^{1{,}5} \quad \text{for} \quad 90 \le L < 300\,\text{m}$$

$$C = 10{,}75 \quad \text{for} \quad 300 \le L \le 350\,\text{m}$$

$$C = 10{,}75 - \left(\frac{L - 350}{150}\right)^{1{,}5} \quad \text{for} \quad L > 350\,\text{m}$$

1 General

1.1 Application

1.1.1 The requirements of this Section apply to ships having the following characteristics:

- $L < 500$ m
- $L / B > 5$
- $B / D < 2{,}5$
- $C_B \ge 0{,}6$

Ships not having one or more of these characteristics, ships intended for the carriage of heated cargoes and ships of unusual type or design will be considered by the Society on a case by case basis.

1.2 Sign conventions of vertical bending moments and shear forces

1.2.1 The sign conventions of bending moments and shear forces at any ship transverse section are as shown in Fig 1, namely:

- the vertical bending moment M is positive when it induces tensile stresses in the strength deck (hogging bending moment); it is negative in the opposite case (sagging bending moment)
- the vertical shear force Q is positive in the case of downward resulting forces preceding and upward resulting forces following the ship transverse section under consideration; it is negative in the opposite case.

2 Still water loads

2.1 General

2.1.1 Still water load calculation

For all ships, the longitudinal distributions of still water bending moment and shear force are to be calculated, for each of the loading conditions in [2.1.2], on the basis of realistic data related to the amount of cargo, ballast, fuel, lubricating oil and fresh water. Except for docking condition afloat, departure and arrival conditions are to be considered.

Where the amount and disposition of consumables at any intermediate stage of the voyage are considered more severe, calculations for such intermediate conditions are to be performed in addition to those for departure and arrival conditions. Also, where any ballasting and/or deballasting is intended during the voyage, calculations of the intermediate condition just before and just after ballasting and/or deballasting any ballast tank are to be considered and where approved included in the loading manual for guidance.

The actual hull lines and lightweight distribution are to be taken into account in the calculations. The lightweight distribution may be replaced, if the actual values are not available, by a statistical distribution of weights accepted by the Society.

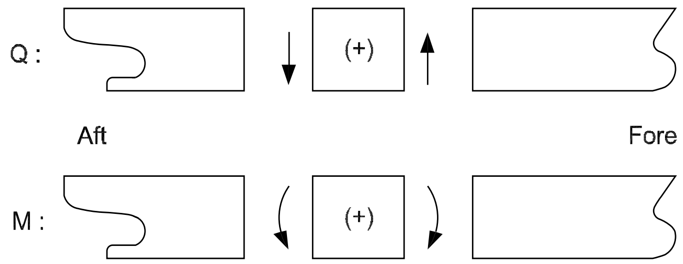
The designer is to supply the data necessary to verify the calculations of still water loads.

For ships with the service notation **container ship**, the torque due to non-uniform distribution of cargo, consumable liquids and ballast is also to be considered, as specified in Pt E, Ch 2, Sec 2.

2.1.2 Loading conditions *(1/1/2022)*

Still water loads are to be calculated for all the design loading conditions (cargo and ballast) subdivided into departure and arrival conditions, on which the approval of hull structural scantlings is based.

Figure 1 : Sign conventions for shear forces Q and bending moments M



For all ships, the following loading conditions are to be considered:

a) homogeneous loading conditions at maximum draught

b) ballast conditions. Ballast loading conditions involving partially filled peak and/or other ballast tanks at departure, arrival or during intermediate conditions are not permitted to be used as design conditions unless:

   - the allowable stress limits (defined in Ch 6, Sec 2, [3]) are satisfied for all filling levels between empty and full, and
   - for ships with the service notation **bulk carrier ESP**, the requirements in Pt E, Ch 4, Sec 3, [4.4] and in Pt E, Ch 4, Sec 3, [5.1], as applicable, are complied with for all filling levels between empty and full.

   To demonstrate compliance with all filling levels between empty and full, it is acceptable if, in each condition at departure, arrival and, where required in [2.1.1], any intermediate condition, the tanks intended to be partially filled are assumed to be:

   - empty
   - full
   - partially filled at the intended level.

   Where multiple tanks are intended to be partially filled, all combinations of empty, full or partially filled at intended level for those tanks are to be investigated.

   However, for ships with the service notation **ore carrier ESP** or **combination carrier/OOC ESP**, with large wing water ballast tanks in the cargo area, where empty or full ballast water filling levels of one or maximum two pairs of these tanks lead to the ship's trim exceeding one of the following conditions:

   - trim by stern equal to 3,0% of the ship's length
   - trim by bow equal to 1,5% of the ship's length
   - any trim that cannot maintain propeller immersion (I/D) of at least 25%, where:
     I : distance, in m, between the propeller centreline and the waterline, see Fig 2
     D : propeller diameter, in m, see Fig 2,

   It is sufficient to demonstrate compliance with maximum, minimum and intended partial filling levels of these one or maximum two pairs of ballast tanks such that the ship's condition does not exceed any of these trim limits. Filling levels of all other wing ballast tanks are to be considered between empty and full.

   The maximum and minimum filling levels of the above-mentioned pairs of side ballast tanks are to be indicated in the loading manual.

   App 2 contains the guidance for partially filled ballast tanks in ballast loading conditions.

c) cargo loading conditions. For cargo loading conditions involving partially filled peak and/or other ballast tanks, the requirements specified in b) apply to the peak tanks only

d) sequential ballast water exchange: the requirements specified in b) or c) are not applicable to ballast water exchange using the sequential method

e) special loadings (e.g. light load conditions at less than the maximum draught, deck cargo conditions, etc., where applicable)

f) short voyage or harbour conditions, where applicable

g) loading and unloading transitory conditions, where applicable

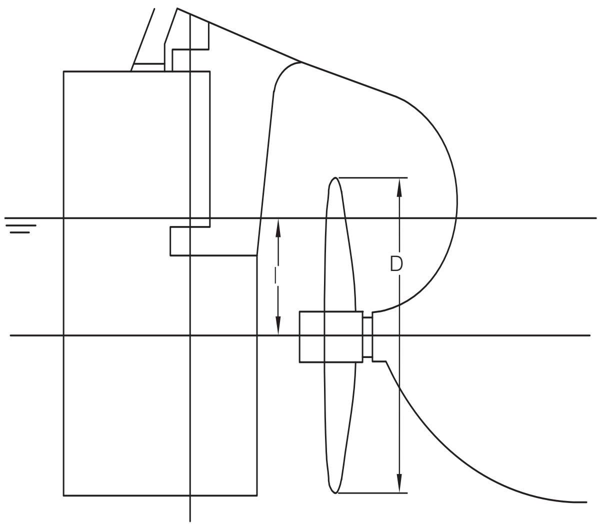
h) docking condition afloat

i) ballast exchange at sea, if applicable.

For ships with the service notation **general cargo ship** completed by the additional service feature **nonhomload**, the loading conditions to be considered are to include the cases where the selected holds are empty at draught T, according to the indications specified in the ship notation.

Part E specifies other loading conditions which are to be considered depending on the ship type.

Figure 2 : Propeller immersion and diameter



APPENDIX 2 GUIDELINES FOR BALLAST LOADING CONDITIONS OF CARGO VESSELS INVOLVING PARTIALLY FILLED BALLAST TANKS

1 General guidance note

1.1 Introduction

1.1.1 *(1/1/2022)*

This Appendix is intended to provide guidance and interpretation of "Partially filled ballast tanks in ballast loading conditions" in Sec 2, [2.1.2], b).

1.1.2 *(1/1/2022)*

Case A and B are generally applicable for ballast loading conditions for any cargo vessel which might have one Ballast Water (BW) Tank (or one pair of BW Tanks) partially filled.

1.1.3 *(1/1/2022)*

Where applicable, similar considerations are to be given to other cargo vessels covered by Sec 2 where ballast loading conditions involving partially filled ballast tanks may cause concerns for the longitudinal strength of the vessels.

1.1.4 *(1/1/2022)*

This Appendix does not apply to CSR Bulk Carriers and Oil Tankers or to container ships to which Pt E, Ch 2, App 1 is applicable.

1.1.5 *(1/1/2022)*

In the Figures, the conditions only intended for strength verification (not operational) are marked with a star (*).

2 Case A and B

2.1 Case A

2.1.1 *(1/1/2022)*

Fig. 1 and Fig. 2 shows Case A, with a cargo vessel where partial filling of BW Tank no. 6 (P/S) is permitted and may take place at any time during the ballast voyage. Intermediate condition(s) should be specified as shown in the Figures, however filling/partial filling of BW Tank no. 6 (P/S) may be done at any step to keep acceptable trim and propeller immersion during the ballast voyage.

To obtain full operational flexibility regarding the filling level of BW Tank no. 6 (P/S), loading conditions A2 (full at departure)* and A8 (empty at arrival)* is to be added for strength verification. Additional conditions (full and empty BW Tank no. 6 (P/S)) related to the intermediate conditions A3-A6 are not necessary as A2* and A8* will be the most critical one.

2.2 Case B

2.2.1 *(1/1/2022)*

Fig. 3 and Fig. 4 shows Case B, with a cargo vessel where partial filling of BW Tank no. 6 (P/S) to a given level ($f_{6\text{-int}\%}$) will be done after a specified % consumables is reached, see conditions B2 and B3. Before this % consumables (shown as 50% in this Figure) is reached, BW Tank no. 6 (P/S) is to be kept empty. When reaching a given level of consumables (shown as 20% in Fig. 2), BW Tank no. 6 (P/S) is to be kept full, see conditions B5 and B6. Two additional intermediate conditions (B4* and B7*) are to be added for longitudinal strength verification.

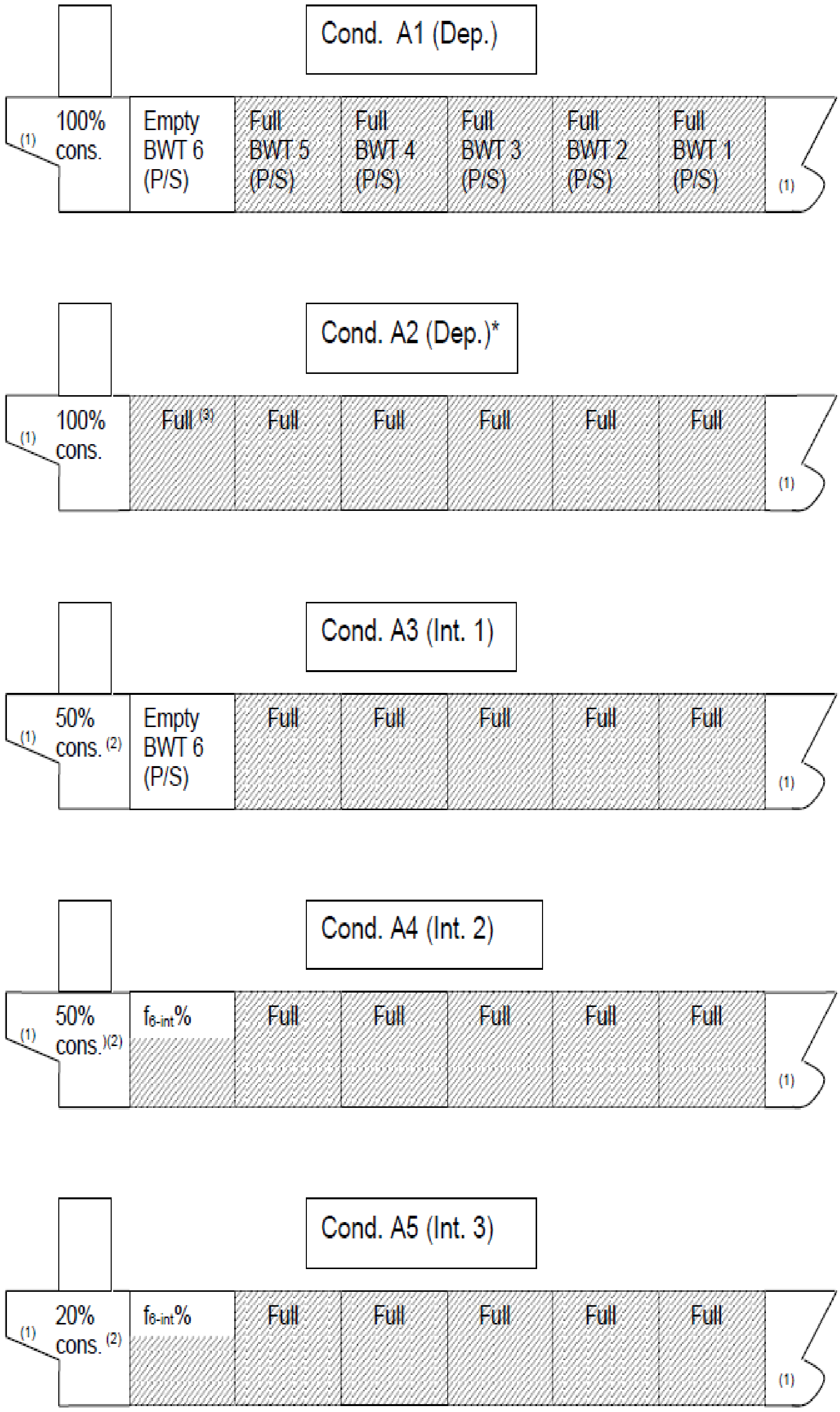
In order to categorize a vessel according to Case B, clear operational guidance for partial filling of ballast tanks, in association with the consumption level as shown in Fig. 3 and Fig. 4, is to be given in the loading manual. If such operational guidance is not given, Case A is to be applied.

2.3 Limitation of consumables

2.3.1 *(1/1/2022)*

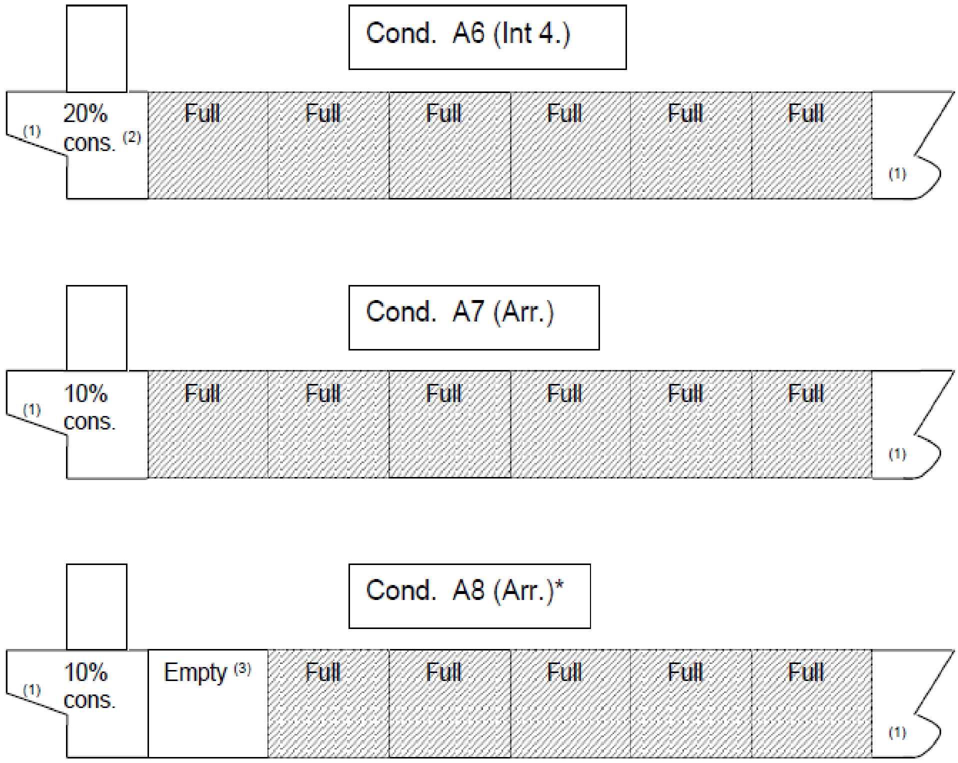
Case A has no limitation of consumables, whereas Case B has limitation of consumables.

Figure 1 : Case A *(1/1/2022)*



Case A, Partial filling of ballast tank no. 6 (P/S) is permitted at any stage during voyage. The intermediate conditions are specified, however other partial filling of BW Tank no. 6 (P/S) may be applied to keep acceptable trim and propeller immersion during the ballast voyage. Conditions only intended for strength verification (not operational) are marked: *

Figure 2 : Case A (continued) *(1/1/2022)*



Case A, Partial filling of ballast tank no. 6 (P/S) is permitted at any stage during voyage. The intermediate conditions are specified, however other partial filling of BW Tank no. 6 (P/S) may be applied to keep acceptable trim and propeller immersion during the ballast voyage. Conditions only intended for strength verification (not operational) are marked: *

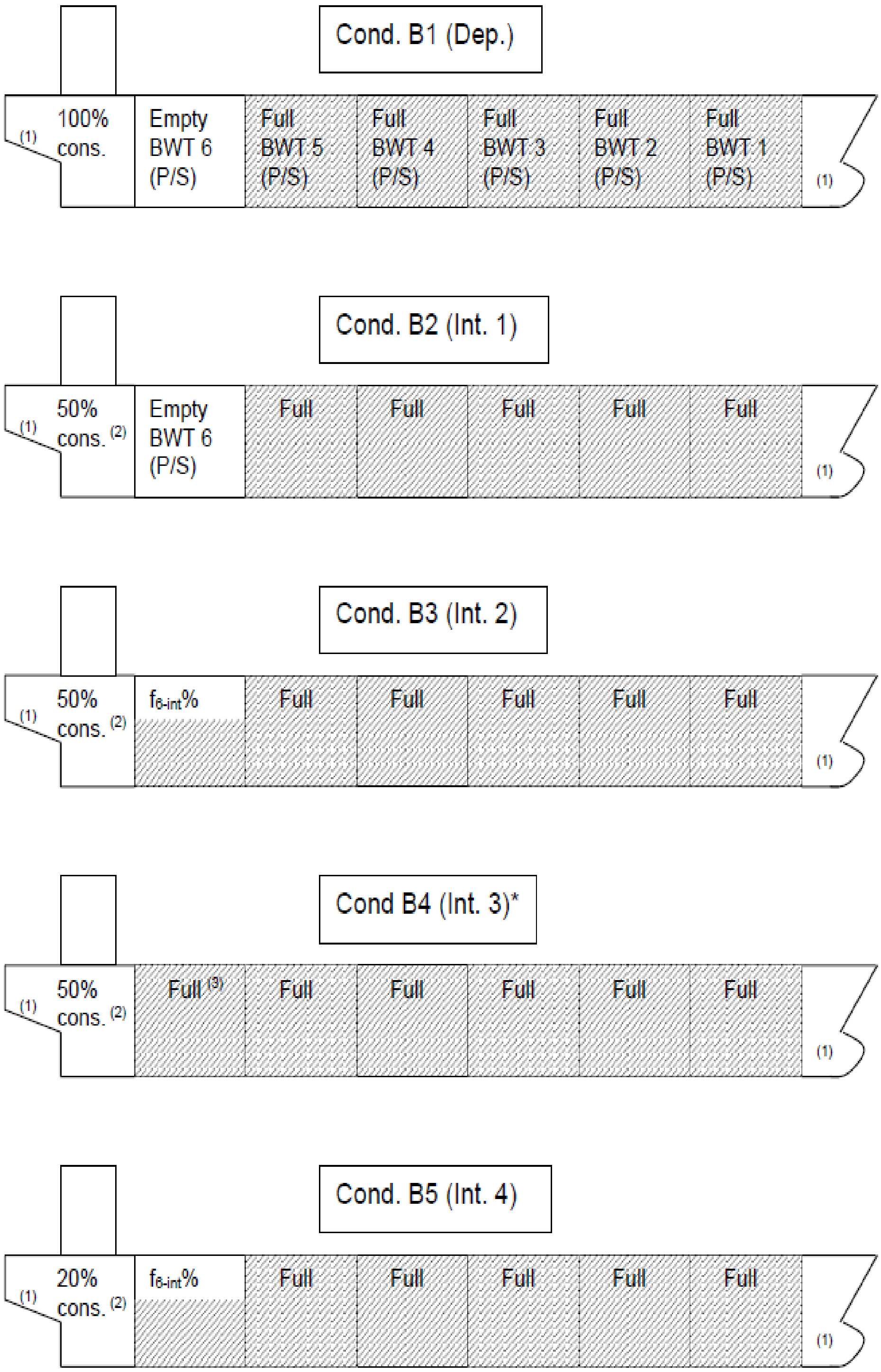
Notes:

(1) For peak tanks intended to be partially filled, all combinations of full or partially filled at intended level for those tanks are to be investigated.

(2) The intermediate condition(s) to be specified incl. % consumables

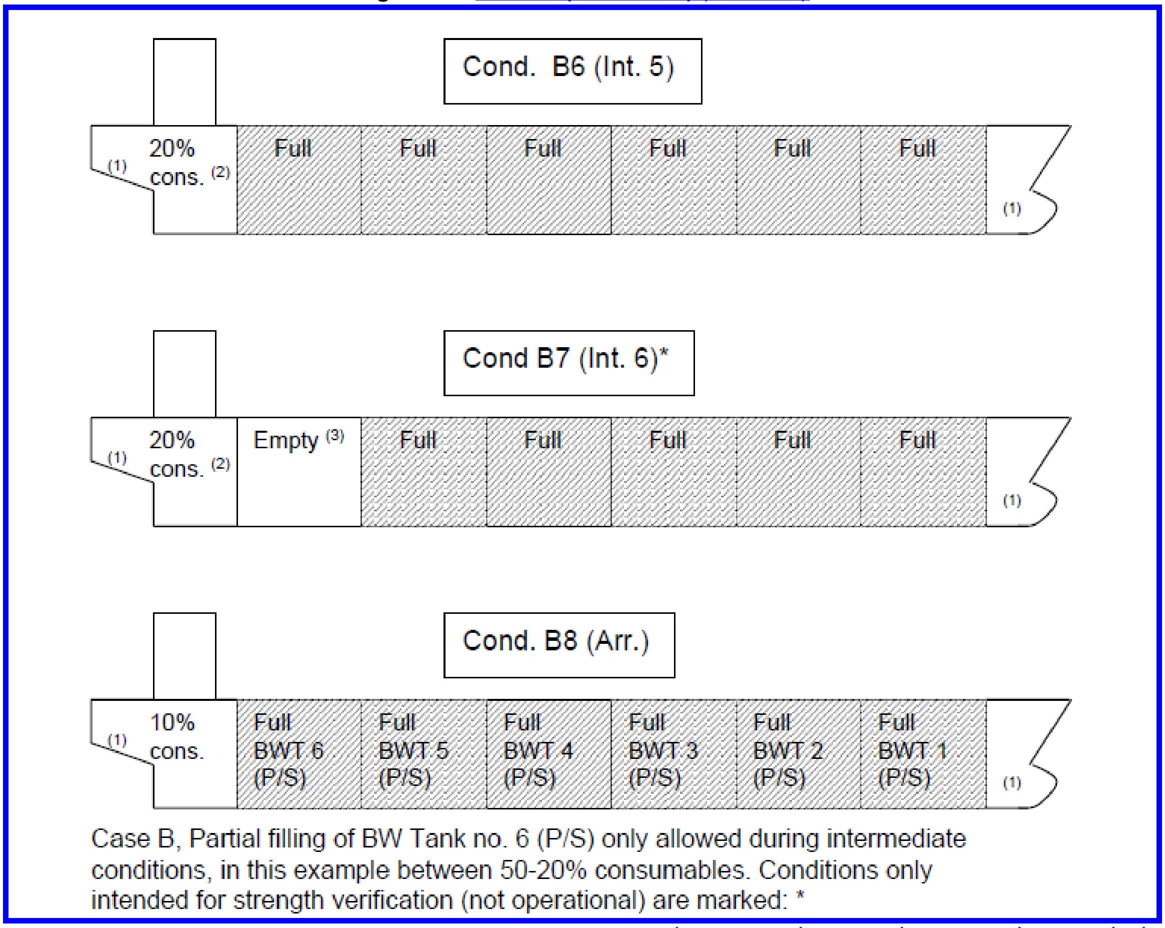
(3) For bulk carriers carrying ore and with large wing water ballast tanks full/empty may be replaced with maximum/minimum filling levels according to trim limitations given in Sec 2, [2.1.2], b).

Figure 3 : Case B *(1/1/2022)*



Case B, Partial filling of BW Tank no. 6 (P/S) only allowed during intermediate conditions, in this example between 50-20% consumables. Conditions only intended for strength verification (not operational) are marked: *

Figure 4 : Case B (continued) *(1/1/2022)*



Notes:

(1) For peak tanks intended to be partially filled, all combinations of full or partially filled at intended level for those tanks are to be investigated.

(2) The intermediate condition(s) to be specified incl. % consumables

(3) For bulk carriers carrying ore and with large wing water ballast tanks full/empty may be replaced with maximum/minimum filling levels according to trim limitations given in Sec 2, [2.1.2], b).

SECTION 4 SUPERSTRUCTURES AND DECKHOUSES

Symbols

x, y, z : X, Y and Z co-ordinates, in m, of the calculation point with respect to the reference co-ordinate system defined in Ch 1, Sec 2, [4]

s : Spacing, in m, of ordinary stiffeners

k : Material factor, defined in:

- Ch 4, Sec 1, [2.3], for steel
- Ch 4, Sec 1, [4.4], for aluminium alloys

t_c : Corrosion addition, in mm, defined in Ch 4, Sec 2, Tab 2.

1 General

1.1 Application

1.1.1 The requirements of this Section apply for the scantling of plating and associated structures of front, side and aft bulkheads and decks of superstructures and deckhouses, which may or may not contribute to the longitudinal strength.

1.1.2 The requirements of this Section comply with the applicable regulations of the 1966 International Convention on Load Lines, with regard to the strength of enclosed superstructures.

1.2 Net scantlings

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

The gross scantlings are obtained as specified in Ch 4, Sec 2.

1.3 Definitions

1.3.1 Superstructures and deckhouses contributing to the longitudinal strength

Superstructures and deckhouses contributing to the longitudinal strength are defined in Ch 6, Sec 1, [2.2].

1.3.2 Tiers of superstructures and deckhouses

The lowest tier is normally that which is directly situated above the freeboard deck.

Where the freeboard exceeds one standard superstructure height, defined in Ch 1, Sec 2, Tab 2 for "all other superstructures", the lowest tier may be considered as an upper tier when calculating the scantlings of superstructures and deckhouses.

The second tier is that located immediately above the lowest tier, and so on.

1.4 Connections of superstructures and deckhouses with the hull structure

1.4.1 Superstructure and deckhouse frames are to be fitted as far as practicable as extensions of those underlying and are to be effectively connected to both the latter and the deck beams above.

Ends of superstructures and deckhouses are to be efficiently supported by bulkheads, diaphragms, webs or pillars.

Where hatchways are fitted close to the ends of superstructures, additional strengthening may be required.

1.4.2 Connection to the deck of corners of superstructures and deckhouses is considered by the Society on a case by case basis. Where necessary, doublers or reinforced welding may be required.

1.4.3 As a rule, the frames of sides of superstructures and deckhouses are to have the same spacing as the beams of the supporting deck.

Web frames are to be arranged to support the sides and ends of superstructures and deckhouses.

1.4.4 The side plating at ends of superstructures is to be tapered into the bulwark or sheerstrake of the strength deck.

Where a raised deck is fitted, this arrangement is to extend over at least 3 frame spacings.

1.5 Structural arrangement of superstructures and deckhouses

1.5.1 Strengthening in way of superstructures and deckhouses

Web frames, transverse partial bulkheads or other equivalent strengthening are to be fitted inside deckhouses of at least 0,5B in breadth extending more than 0,15L in length within 0,4L amidships. These transverse strengthening reinforcements are to be spaced approximately 9 m apart and are to be arranged, where practicable, in line with the transverse bulkheads below.

Web frames are also to be arranged in way of large openings, boats davits and other areas subjected to point loads.

Web frames, pillars, partial bulkheads and similar strengthening are to be arranged, in conjunction with deck transverses, at ends of superstructures and deckhouses.

Table 1 : Lateral pressure for superstructures and deckhouses - Coefficient a

Type of bulkhead	Location	a	a maximum
Unprotected front	Lowest tier	$2+\frac{L}{120}$	4,5
	Second tier	$1+\frac{L}{120}$	3,5
	Third tier	$0,5+\frac{L}{150}$	2,5
	Fourth tier	$0,9\left(0,5+\frac{L}{150}\right)$	2,25
	Fifth tier and above	$0,8\left(0,5+\frac{L}{150}\right)$	2,0
Protected front	Lowest, second and third tiers	$0,5+\frac{L}{150}$	2,5
	Fourth tier	$0,9\left(0,5+\frac{L}{150}\right)$	2,25
	Fifth tier and above	$0,8\left(0,5+\frac{L}{150}\right)$	2,0
Side	Lowest, second and third tiers	$0,5+\frac{L}{150}$	2,5
	Fourth tier	$0,9\left(0,5+\frac{L}{150}\right)$	2,25
	Fifth tier and above	$0,8\left(0,5+\frac{L}{150}\right)$	2,0
Aft end	All tiers, when: x/L ≤ 0,5	$0,7+\frac{L}{1000}-0,8\frac{x}{L}$	$1-0,8\frac{x}{L}$
	All tiers, when: x/L > 0,5	$0,5+\frac{L}{1000}-0,4\frac{x}{L}$	$0,8-0,4\frac{x}{L}$

Table 2 : Lateral pressure for superstructures and deckhouses - Coefficient b

Location of bulkhead **(1)**	b
$\frac{x}{L}\le 0,45$	$1+\left(\frac{\frac{x}{L}-0,45}{C_B+0,2}\right)^2$
$\frac{x}{L}>0,45$	$1+1,5\left(\frac{\frac{x}{L}-0,45}{C_B+0,2}\right)^2$
(1) For deckhouse sides, the deckhouse is to be subdivided into parts of approximately equal length, not exceeding 0,15L each, and x is to be taken as the co-ordinate of the centre of each part considered. **Note 1:** C_B : Block coefficient, with $0,6 \le C_B \le 0,8$	

Table 3 : Lateral pressure for superstructures and deckhouses - Coefficient f *(1/7/2020)*

Rule Length L of ship, in m	f
L < 150	$\frac{L}{10}e^{-L/300}-\left[1-\left(\frac{L}{150}\right)^2\right]$
150 ≤ L < 300	$\frac{L}{10}e^{-L/300}$
L ≥ 300	11,03

Table 4 : Lateral minimum pressure for superstructures and deckhouses *(1/7/2020)*

Type of bulkhead	Location	p_{min}, in kN/m²
Unprotected front	Lowest tier	30 ≤ 25,0 + 0,10L ≤ 50
	Second and third tiers	15 ≤ 12,5 + 0,05L ≤ 25
	Fourth and fifth tiers	Linear interpolation
	Sixth tier and above	12,5
Protected front, side and aft end	Lowest, second and third tiers	15 ≤ 12,5 + 0,05L ≤ 25
	Fourth and fifth tiers	Linear interpolation
	Sixth tier and above	2,5

3 Plating

3.1 Front, side and aft bulkheads

3.1.1 Plating contributing to the longitudinal strength

The net thickness of side plate panels contributing to the longitudinal strength is to be determined in accordance with the applicable requirements of Ch 7, Sec 1 or Ch 8, Sec 3, as applicable, considering the lateral pressure defined in [2.1.2].

3.1.2 Plating not contributing to the longitudinal strength

The net thickness of plating of front, side and aft bulkheads not contributing to the longitudinal strength is to be not less than the value obtained, in mm, from the following formula:

$$t = 0,95s\sqrt{kp}-t_c$$

without being less than the values indicated in Tab 5, where p is the lateral pressure, in kN/m², defined in [2.2].

For plating which forms tank boundaries, the net thickness is to be determined in accordance with [3.1.1], considering the hull girder stress equal to 0.

3.2 Decks

3.2.1 The net thickness of plate panels of decks which may or may not contribute to the longitudinal strength is to be determined in accordance with the applicable requirements of Ch 7, Sec 1 or Ch 8, Sec 3, as applicable.

Table 5 : Superstructures and deckhouses Minimum thicknesses *(1/1/2022)*

Location	Minimum thickness, in mm
Lowest tier	$(5 + 0{,}01\ L)\ k^{1/2} - t_C$
Second tier and above	$(4 + 0{,}01\ L)\ k^{1/2} - t_C$
Note 1: L is to be taken not less than 100m and not greater than 300m. **Note 2:** For aluminum superstructures, it is possible to evaluate the minimum thickness on a case-by-case basis taking into account the type and tier level of the superstructure, the position of the superstructure (front, lateral, aft), the spacing of the ordinary stiffeners, the navigation and service notations of the ship.	

3.2.2 For decks sheathed with wood, the net thickness obtained from [3.2.1] may be reduced by 10 percent.

4 Ordinary stiffeners

4.1 Front, side and aft bulkheads

4.1.1 Ordinary stiffeners of plating contributing to the longitudinal strength

The net scantlings of ordinary stiffeners of plating contributing to the longitudinal strength are to be determined in accordance with the applicable requirements of Ch 7, Sec 2 or Ch 8, Sec 4, as applicable.

4.1.2 Ordinary stiffeners of plating not contributing to the longitudinal strength

The net section modulus w of ordinary stiffeners of plating not contributing to the longitudinal strength is to be not less than the value obtained, in cm³, from the following formula:

$$w = 0{,}35\varphi k s \ell^2 p(1 - \alpha t_c) - \beta t_c$$

where:

ℓ : Span of the ordinary stiffener, in m, equal to the 'tweendeck height and to be taken not less than 2 m

p : Lateral pressure, in kN/m², defined in [2.2]

φ : Coefficient depending on the stiffener end connections, and taken equal to:

- 1 for lower tier stiffeners
- value defined in Tab 6 for stiffeners of upper tiers

α, β : Parameters defined in Ch 4, Sec 2, Tab 1.

The section modulus of side ordinary stiffeners need not be greater than that of the side ordinary stiffeners of the tier situated directly below taking account of spacing and span.

For ordinary stiffeners of plating forming tank boundaries, the net scantlings are to be determined in accordance with [4.1.1], considering the hull girder stress equal to 0.

Table 6 : Stiffeners of superstructures and deckhouses - Coefficient φ for end connections

Coefficient φ	Upper end welded to deck	Bracketed upper end	Sniped upper end
Lower end welded to deck	1,00	0,85	1,15
Bracketed lower end	0,85	0,85	1,00
Sniped lower end	1,15	1,00	1,15

4.1.3 Minimum section modulus of stiffeners *(1/7/2020)*

The minimum net section modulus, in cm³, of stiffeners used for deckhouse and superstructure is to in any case not be less than:

$$w_{min} = 2{,}4\varphi k s \ell^2$$

4.2 Decks

4.2.1 The net scantlings of ordinary stiffeners of decks which may or may not contribute to the longitudinal strength are to be determined in accordance with the applicable requirements of Ch 7, Sec 2.

5 Primary supporting members

5.1 Front, side and aft bulkheads

5.1.1 Primary supporting members of plating contributing to the longitudinal strength

The net scantlings of side primary supporting members of plating contributing to the longitudinal strength are to be determined in accordance with the applicable requirements of Ch 7, Sec 3 or Ch 8, Sec 5, as applicable.

5.1.2 Primary supporting members of plating not contributing to the longitudinal strength

The net scantlings of side primary supporting members of plating not contributing to the longitudinal strength are to be determined in accordance with the applicable requirements of Ch 7, Sec 3 or Ch 8, Sec 5, as applicable, using the lateral pressure defined in [2.2].

5.2 Decks

5.2.1 The net scantlings of primary supporting members of decks which may or may not contribute to the longitudinal strength are to be determined in accordance with the applicable requirements of Ch 7, Sec 3.

SECTION 4 EQUIPMENT

Symbols

EN : Equipment Number defined in [2.1],

σ_{ALL} : allowable stress, in N/mm², used for the yielding check in [4.9.7], [4.10.7], [4.11.2] and [4.11.3], to be taken as the lesser of:

- $\sigma_{ALL} = 0,67\ R_{eH}$
- $\sigma_{ALL} = 0,40\ R_m$

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

R_m : tensile strength, in N/mm², of the material, defined in Ch 4, Sec 1, [2].

1 General

1.1 General

1.1.1 The requirements in [2] to [4] apply to temporary mooring of a ship within or near harbour, or in a sheltered area, when the ship is awaiting a berth, the tide, etc.

Therefore, the equipment complying with the requirements in [2] to [4] is not intended for holding a ship off fully exposed coasts in rough weather or for stopping a ship which is moving or drifting.

1.1.2 The equipment complying with the requirements in [2] to [4] is intended for holding a ship in good holding ground, where the conditions are such as to avoid dragging of the anchor. In poor holding ground the holding power of the anchors is to be significantly reduced.

1.1.3 It is assumed that under normal circumstances a ship will use one anchor only.

1.2 Definitions

1.2.1 Nominal capacity condition *(1/1/2022)*

Nominal capacity condition is the theoretical condition where the maximum possible deck cargoes are included in the ship arrangement in their respective positions. For container ships the nominal capacity condition represents the theoretical condition where the maximum possible number of containers is included in the ship arrangement in their respective positions.

1.2.2 Ship Design Minimum Breaking Load (MBL_{SD}) *(1/1/2022)*

Ship Design Minimum Breaking Load is the minimum breaking load of new, dry mooring lines or tow line for which shipboard fittings and supporting hull structures are designed in order to meet mooring restraint requirements or the towing requirements of other towing service.

1.2.3 Line Design Break Force (LDBF) *(1/1/2022)*

Line Design Break Force is the minimum force that a new, dry, spliced, mooring line will break at. This is for all synthetic cordage materials.

2 Equipment number

2.1 Equipment number

2.1.1 General

All ships are to be provided with equipment in anchors and chain cables (or ropes according to [3.3.5]), to be obtained from Tab 1, based on their Equipment Number EN.

In general, stockless anchors are to be adopted.

For ships with EN greater than 16000, the determination of the equipment will be considered by the Society on a case by case basis.

For ships having the navigation notation **coastal area** or **sheltered area**, the equipment in anchors and chain cables may be reduced. The reduction consists of entering Tab 1 one line higher for ships having the navigation notation **coastal area** and two lines higher for ships having the navigation notation **sheltered area**, based on their Equipment Number EN.

For ships of special design or ships engaged in special services or on special voyages, the Society may consider equipment other than that in Tab 1.

2.1.2 Equipment Number for ships with perpendicular superstructure front bulkhead *(1/1/2022)*

The Equipment Number EN is to be obtained from the following formula:

~~$EN = \Delta^{2/3} + 2\ h\ B + 0,1\ A$~~

$EN = \Delta^{2/3} + 2(h\ B + S_{fun}) + 0,1\ A$

where:

Δ : moulded displacement of the ship, in t, to the summer load waterline,

h : effective height, in m, from the summer load waterline to the top of the uppermost house, to be obtained in accordance with the following formula:

$h = a + \Sigma h_n$

~~For the lowest tier, h is to be measured at centreline from the upper deck or from a notional deck line where there is local discontinuity in the upper deck (see Fig 1 for an example).~~

When calculating h, sheer and trim are to be ~~disregarded~~ignored (i.e. h is the sum of freeboard amidships plus the height (at centreline) of each tier of houses having a breadth greater than B/4),

a : vertical distance at side hull, in m,~~freeboard amidships~~ from the summer load waterline amidships to the upper deck~~, in m~~,

h_n : height, in m, at the centreline of tier “n” of superstructures or deckhouses having a breadth greater than B/4. Where a house having a breadth greater than B/4 is above a house with a breadth of B/4 or less, the upper house is to be included and the lower ignored.~~,~~

For the lowest tier h_1 is to be measured at centreline from the upper deck or from a notional deck line where there is local discontinuity in the upper deck, (see Fig 1 for an example),

S_{fun} : effective front projected area of the funnel, in m², defined as:

$S_{fun} = A_{FS} - S_{shield}$

A_{FS} : front projected area of the funnel, in m², calculated between the upper deck at centreline, or notional deck line where there is local discontinuity in the upper deck, and the effective height h_F.

A_{FS} is taken equal to zero if the funnel breadth is less than or equal to B/4 at all elevations along the funnel height.

h_F : effective height of the funnel, in m, measured from the upper deck at centreline, or notional deck line where there is local discontinuity in the upper deck, and the top of the funnel.

The top of the funnel may be taken at the level where the funnel breadth reaches B/4.

S_{shield} : is the section of front projected area A_{FS}, in m², which is shielded by all deck houses having breadth greater than B/4. If there are more than one shielded section, the individual shielded sections i.e $S_{shield1}$, $S_{shield 2}$ etc as shown in Fig 2 to be added together. To determine S_{shield}, the deckhouse breadth is assumed B for all deck houses having breadth greater than B/4 as shown for $S_{shield1}$, $S_{shield2}$ in Fig 2.

A : side projected area, in m², ~~in profile view,~~ of the ~~parts of the~~ hull, superstructures, ~~and~~ houses and funnels above the summer load waterline which are within the length L_E and also have a breadth greater than B/4 (see Note 1).~~,~~

The side projected area of the funnel is considered in A when A_{FS} is greater than zero. In this case, the side projected area of the funnel should be calculated between the upper deck, or notional deck line where there is local discontinuity in the upper deck, and the effective height h_F.

L_E : equipment length, in m, equal to L without being taken neither less than 96% nor greater than 97% of the ~~total~~extreme length ~~of~~on the summer load waterline (measured from the forward end of the waterline).

Fixed screens or bulwarks 1,5 m or more in height are to be regarded as parts of houses when determining h and A. In particular, the hatched area shown in Fig ~~6~~7 is to be included.

The height of hatch coamings and that of any deck cargo, such as containers, may be disregarded when determining h and A.

When several funnels are fitted on the ship, the above parameters are taken as follows:

h_F : effective height of the funnel, in m, measured from the upper deck, or notional deck line where there is local discontinuity in the upper deck, and the top of the highest funnel. The top of the highest funnel may be taken at the level where the sum of each funnel breadth reaches B/4.

A_{FS} : sum of the front projected area of each funnel, in m², calculated between the upper deck, or notional deck line where there is local discontinuity in the upper deck, and the effective height h_F.

A_{FS} is to be taken equal to zero if the sum of each funnel breadth is less than or equal to B/4 at all elevations along the funnels height.

A : side projected area, in m², of the hull, superstructures, houses and funnels above the summer load waterline which are within the equipment length of the ship. The total side projected area of the funnels is to be considered in the side projected area of the ship, A, when A_{FS} is greater than zero. The shielding effect of funnels in transverse direction may be considered in the total side projected area, i.e., when the side projected areas of two or more funnels fully or partially overlap, the overlapped area needs only to be counted once.

Note 1: For selection of mooring and towing lines (see [3.5]), deck cargoes as given by the loading manual is to be taken into account for the determination of side-projected area A when calculating the equipment number EN.

Figure 1 : ~~Effective height in case of local discontinuity in the upper deck~~ ~~*(1/7/2018)*~~

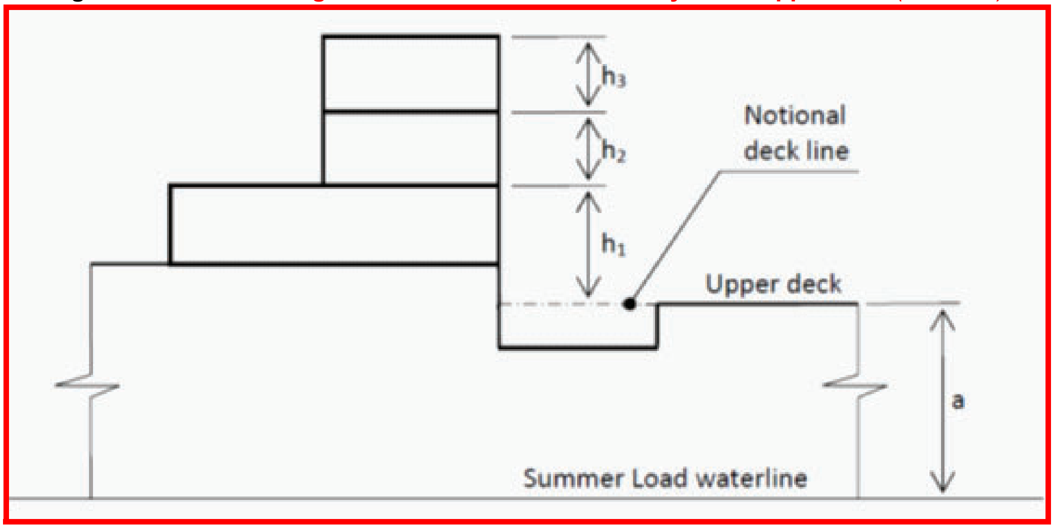


Figure 1 : Effective height in case of local discontinuity in the upper deck *(1/1/2022)*

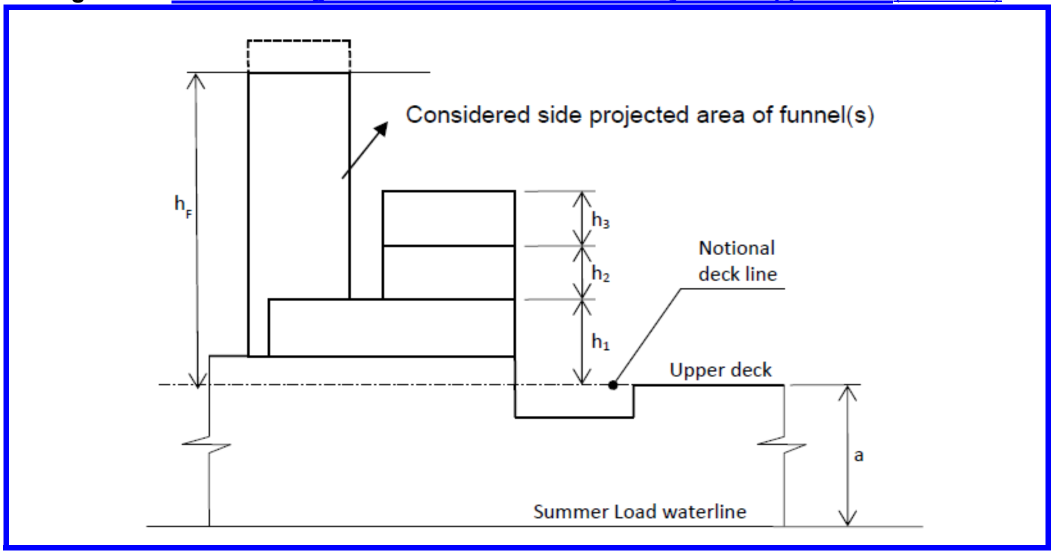
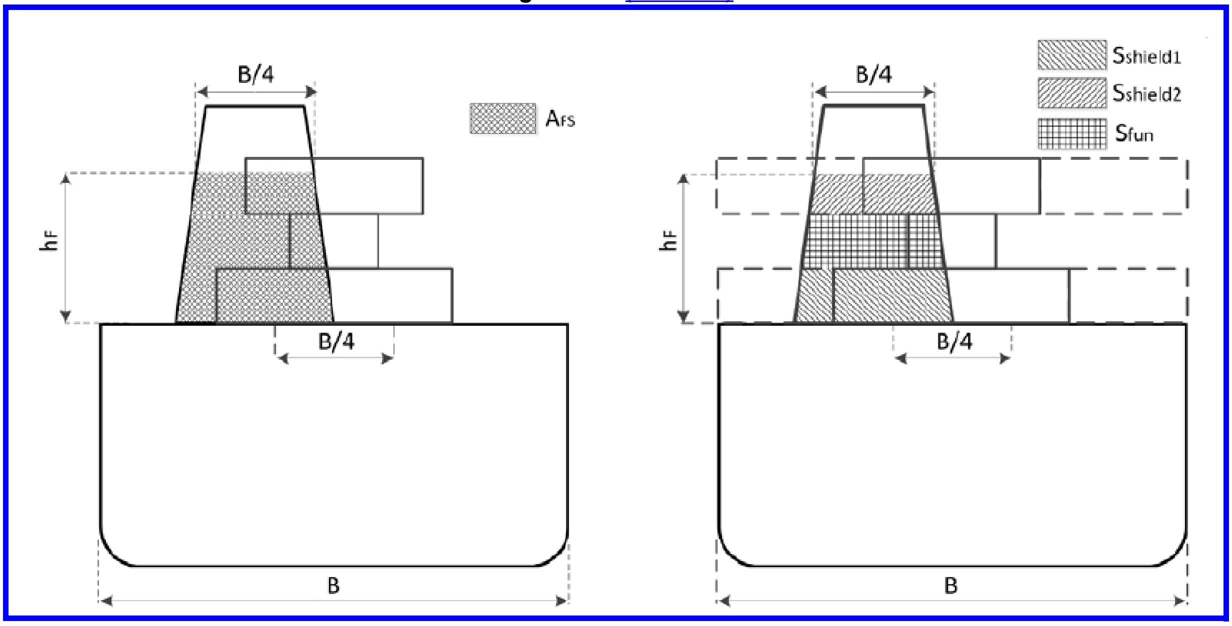


Figure 2 : *(1/1/2022)*



...OMISSIS...

Equipment number EN A < EN ≤ B		Stockless anchors		Stud link chain cables for anchors			
		N	Mass per anchor, in kg	Total length, in m	Diameter, in mm		
A	B				Q1	Q2	Q3
4600	4800	2	14100	715,0	120,0	105,0	92,0
4800	5000	2	14700	742,5	122,0	107,0	95,0
5000	5200	2	15400	742,5	124,0	111,0	97,0
5200	5500	2	16100	742,5	127,0	111,0	97,0
5500	5800	2	16900	742,5	130,0	114,0	100,0
5800	6100	2	17800	742,5	132,0	117,0	102,0
6100	6500	2	18800	742,5		120,0	107,0
6500	6900	2	20000	770,0		124,0	111,0
6900	7400	2	21500	770,0		127,0	114,0
7400	7900	2	23000	770,0		132,0	117,0
7900	8400	2	24500	770,0		137,0	122,0
8400	8900	2	26000	770,0		142,0	127,0
8900	9400	2	27500	770,0		147,0	132,0
9400	10000	2	29000	770,0		152,0	132,0
10000	10700	2	31000	770,0			137,0
10700	11500	2	33000	770,0			142,0
11500	12400	2	35500	770,0			147,0
12400	13400	2	38500	770,0			152,0
13400	14600	2	42000	770,0			157,0
14600	16000	2	46000	770,0			162,0

2.1.3 Equipment Number for ships with inclined superstructure front bulkhead *(1/1/2022)*

For ships with navigation notation other than unrestricted navigation and having superstructures with the front bulkhead with an angle of inclination aft, the Equipment Number EN is to be obtained from the following formula:

$EN = \Delta^{2/3} + 2\,(a\,B + \Sigma b_N\,h_N\,\sin\theta_N + S_{fun}) + 0{,}1\,A$

where:

Δ, a, h_N, A and S_{fun}: as defined in [2.1.2],

θ_N : angle of inclination aft of each front bulkhead, shown in Fig ~~7~~8,

b_N : greatest breadth, in m, of each tier n of superstructures or deckhouses having a breadth greater than B/4.

Fixed screens or bulwarks 1,5 m or more in height are to be regarded as parts of houses when determining h and A. In particular, the hatched area shown in Fig ~~7~~8 is to be included.

3 Equipment

3.1 Shipboard fittings and supporting hull structures

3.1.1 Application *(1/7/2018)*

Ships are to be provided with arrangements, equipment and fittings of sufficient safe working load to enable the safe conduct of all towing and mooring operations associated with the normal operations of the ship.

The requirements of [3.1] apply to ships of 500 gross tonnage and upwards; in particular they apply to bollards, bitts, fairleads, stand rollers, chocks used for normal mooring of the ship and similar components used for normal towing of the ship. For emergency towing arrangements, the requirements in [4] are to be applied. Normal towing means towing operations necessary for manoeuvring in ports and sheltered waters associated with the normal operations of the ship.

For ships, not subject to Regulation 3-4 of Chapter II-1 of SOLAS Convention, but intended to be fitted with equipment for towing by another ship or a tug, the requirements designated as 'other towing' are to be applied to design and construction of those shipboard fittings and supporting hull structures.

Requirements of [3.1] is not applicable to design and construction of shipboard fittings and supporting hull structures used for special towing services defined as:

- Escort towing: Towing service, in particular for laden oil tankers or LNG carriers, required in specific estuaries. Its main purpose is to control the ship in case of failures of the propulsion or steering system. It should be referred to local escort requirements and guidance given by, e.g., the Oil Companies International Marine Forum (OCIMF); for the requirements of shipboard fittings and supporting hull structures of ships with service notation **escort tug** , see Pt E, Ch 14, [2] and [4].
- Canal transit towing: Towing service for ships transiting canals, e.g. the Panama Canal. It should be referred to local canal transit requirements.
- Emergency towing for tankers: Towing services to assist tankers in case of emergency. For emergency towing arrangements of ships which are to comply with Regulation 3-4 of Chapter II-1 of SOLAS Convention, the requirements in [4] are to be applied.

The supporting hull structures are constituted by that part of the ship's structure on/in which the shipboard fitting is placed and which is directly submitted to the forces exerted on the shipboard fitting. The supporting hull structures of capstans, winches, etc used for normal or other towing and mooring operations are also covered by [3.1].

Other components such as capstans, winches, etc are not covered by this item. Any weld or bolt or equivalent device connecting the shipboard fitting to the supporting structure is part of the shipboard fitting and if selected from an industry standards subject to that standard applicable to this shipboard fitting.

3.1.2 Net scantlings

The net minimum scantlings of the supporting hull structure are to comply with the requirements in [3.1.9] and [3.1.15]. The net thicknesses, t_{net}, are the member thicknesses necessary to obtain the above required minimum net scantlings. The required gross thicknesses are obtained by adding the total corrosion additions, t_c, given in [3.1.3], to t_{net}.

3.1.3 Corrosion addition *(1/1/2022)*

The total corrosion addition, t_c, in mm, ~~for both sides of the hull supporting structure is to be in accordance with Ch 4, Sec 2~~is not to be less than the following values:~~.~~

a) Ships covered by Common Structural Rules for Bulk Carriers and Oil Tankers:

   t_c:, total corrosion addition to be as defined in these rules.

b) Other ships:

   - For the supporting hull structure, according to Ch 4, Sec 2 for the surrounding structure (e.g. deck structures, bulwark structures)
   - For pedestals and foundations on deck which are not part of a fitting according to an accepted industry standard, 2.0 mm
   - For shipboard fittings not selected from an accepted industry standard, 2.0 mm.

~~For pedestal and foundations on deck which are not part of a fitting according to an accepted industry standard and for ship-board fittings not selected from an accepted industry standard the total corrosion addition is to be taken equal to 2.0 mm.~~

3.1.4 Wear allowance *(1/7/2018)*

In addition to the corrosion addition given in [3.1.3] the wear allowance, tw, for shipboard fittings not selected from an accepted industry standard is not to be less than 1.0 mm, added to surfaces which are intended to regularly contact the line.

3.1.5 Towing shipboard fittings selection *(1/1/2022)*

Towing shipboard fittings may be selected from an industry standard accepted by the Society and at least based on the following loads:

a) for normal towing operations, the intended maximum towing load (e.g. static bollard pull) as indicated on the towing and mooring arrangements plan,

b) for other towing service, the Ship Design Minimum Breaking Load~~minimum breaking strength~~ of the tow-line according to Tab 3 for the ship's corresponding EN (see Notes in [3.1.8]),

c) for fittings intended to be used for both, normal and other towing operations, the greater of the loads according to (a) and (b).

Towing bitts (double bollards) may be chosen for the towing line attached with eye splice if the industry standard distinguishes between different methods to attach the line, i.e. figure-of-eight or eye splice attachment.

When the shipboard fitting is not selected from an accepted industry standard, the strength of the fitting and of its attachment to the ship is to be in accordance with [3.1.~~99~~8] and [3.1.~~99~~9]. Towing bitts (double bollards) are required to resist the loads caused by the towing line attached with eye splice. For strength assessment beam theory or finite element analysis using net scantlings is to be applied, as appropriate. Corrosion additions are to be as defined in [3.1.3]. A wear down allowance is to be included as defined in [3.1.4].

3.1.6 Towing shipboard fittings location *(1/7/2018)*

Shipboard fittings for towing are to be located on stiffeners and/or girders which are part of the deck construction so as to facilitate efficient distribution of the towing loads. Other equivalent arrangements (e.g. chocks in bulwarks) may be accepted provided the strength is confirmed adequate for the intended service.

3.1.7 Arrangement of supporting hull structures for towing fittings *(1/7/2018)*

The arrangement of the reinforced members beneath towing shipboard fittings is to be such as to withstand any variation of direction (laterally and vertically) of the towing forces upon the shipboard fittings (see Fig ~~2~~3). Proper alignment of fitting and supporting hull structure is to be ensured.

Figure 4 : Sample arrangement of supporting hull structure *(1/7/2018)*

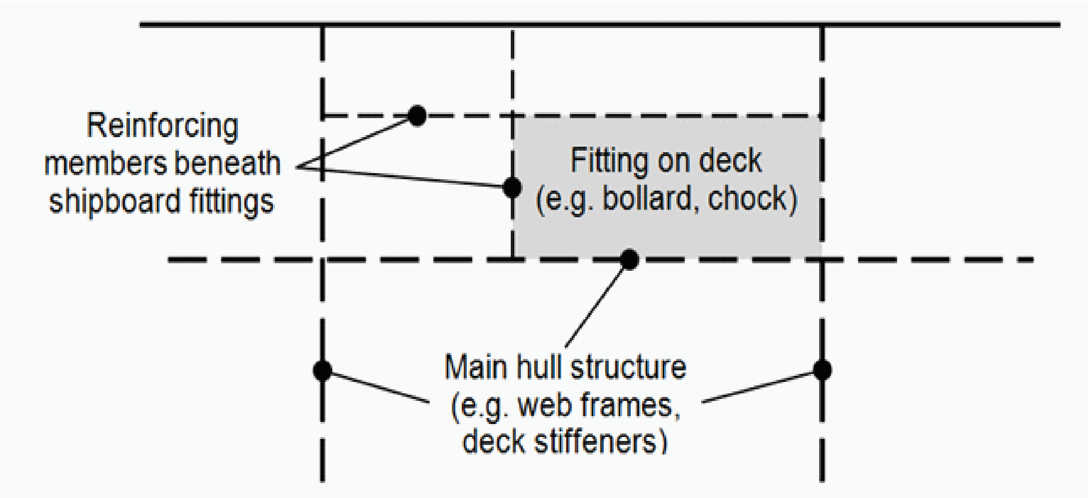
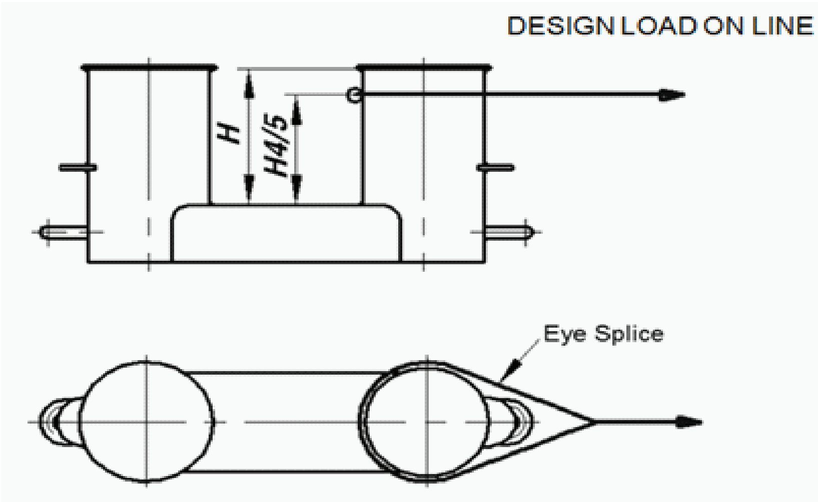


Figure 5 : Attachment point of the towing line *(1/7/2018)*



3.1.8 Towing load model *(1/1/2022)*

The minimum design load a~~-~~pplied to supporting hull structures for shipboard fittings is to be:

a) for normal towing operations, 1,25 times the intended maximum towing load (e.g. static bollard pull) as indicated on the towing and mooring arrangement plan.

b) for other towing service, the Ship Design Minimum Breaking Load~~nominal breaking strength of the towline~~ according to Table 3 for the ship's corresponding EN (see Note 1 and see Note 2).

c) for fittings intended to be used for both, normal and other towing operations, the greater of the design loads according to a) and b).

This force is to be considered as acting on the shipboard fittings at the attachment point of the towing line or mooring line or at a change in its direction, as applicable. For bollards and bitts the attachment point of the towing line is to be taken not less than 4/5 of the tube height above the base, as shown in Fig ~~3~~4.

The design load is to be applied to fittings in all directions that may occur by taking into account the arrangement shown on the towing and mooring arrangements plan. Where the towing line takes a turn at a fitting the total design load applied to the fitting is equal to the resultant of the design loads acting on the line (see Fig ~~4~~5). However, in no case does the design load applied to the fitting need to be greater than twice the design load on the line.

When a safe towing load TOW greater than that determined according to [3.1.10] is requested by the applicant, then the design load is to be in-creased in accordance with the appropriate TOW/design load relationship given by [3.1.8] and [3.1.10].

Note 1: Side projected area including that of deck cargoes as given by the ship nominal capacity condition~~loading manual~~ is to be taken into account for selection of towing lines and the loads applied to shipboards fittings and supporting hull structures. The nominal capacity condition is defined in [1.2]

Note 2: The increase of the Line Design Break Force~~minimum break-ing strength~~ for synthetic ropes according to [3.5.7] needs not to be taken into account for the loads applied to shipboard fittings and supporting hull structures.

3.1.9 Allowable stresses for towing fittings *(1/1/2022)*

The allowable stresses for towing fittings are given as follows:

a) For strength assessment of supporting hull structures for towing fittings withby means of beam theory or grillage analysis:

- nNormal stress: 1,0 $R_{eH}$the minimum yield stress of the supporting hull structure material
- sShear stress: 0,6 R_{eH}0,6 times the minimum yield stress of the supporting hull structure material.

Normal stress is the sum of bending stress and axial stress with the corresponding shearing stress acting perpendicular to the normal stress. No stress concentration facotrs being taken into account.

b) For strength assessment withby means of finite element analysis:

- equivalentVon Mises stress: 1,0 $R_{eH}$the minimum yield stress of the supporting hull structure material.

For strength calculations by means of finite elements, the geometry is to be idealized as realistically as possible. The ratio of element length to width is not to exceed 3. Girders are to be modelled using shell or plane stress elements. Symmetric girder flanges may be modelled by beam or truss elements. The element height of girder webs must not exceed one third of the web height. In way of small openings in girder webs the web thickness is to be reduced to a mean thickness over the web height. Large openings are to be modelled. Stiffeners may be modelled by using shell, plane stress, or beam elements. Stresses are to be read from the centre of the individual element. For shell elements the stresses are to be evaluated at the mid plane of the element.

For strength assessment by means of finite element analysis the mesh is to be fine enough to represent the geometry as realistically as possible. The aspect ratios of elements are not to exceed 3. Girders are to be modelled using shell or plane stress elements. Symmetric girder flanges may be modelled by beam or truss elements. The element height of girder webs must not exceed one-third of the web height. In way of small openings in girder webs the web thickness is to be reduced to a mean thickness over the web height. Large openings are to be modelled. Stiffeners may be modelled by using shell, plane stress, or beam elements. The mesh size of stiffeners is to be fine enough to obtain proper bending stress. If flat bars are modeled using shell or plane stress elements, dummy rod elements are to be modelled at the free edge of the flat bars and the stresses of the dummy elements are to be evaluated. Stresses are to be read from the centre of the individual element. For shell elements the stresses are to be evaluated at the mid plane of the element.

R_{eH} is the specified minimum yield stress of the material.

3.1.10 Safe Towing Load (TOW) *(1/1/2022)*

The safe towing load (TOW) is the safe load limit of shipboard fittings used for towing purpose, to be taken as follows:

a) TOW used for normal towing operations is not to exceed 80% of the design load as per [3.1.8] a)

b) TOW used for other towing operations is not to exceed 80% of the design load as per [3.1.8] b)

c) For fittings used for both normal and other towing operations, the greater of the safe towing loads according to a) and b) is to be used

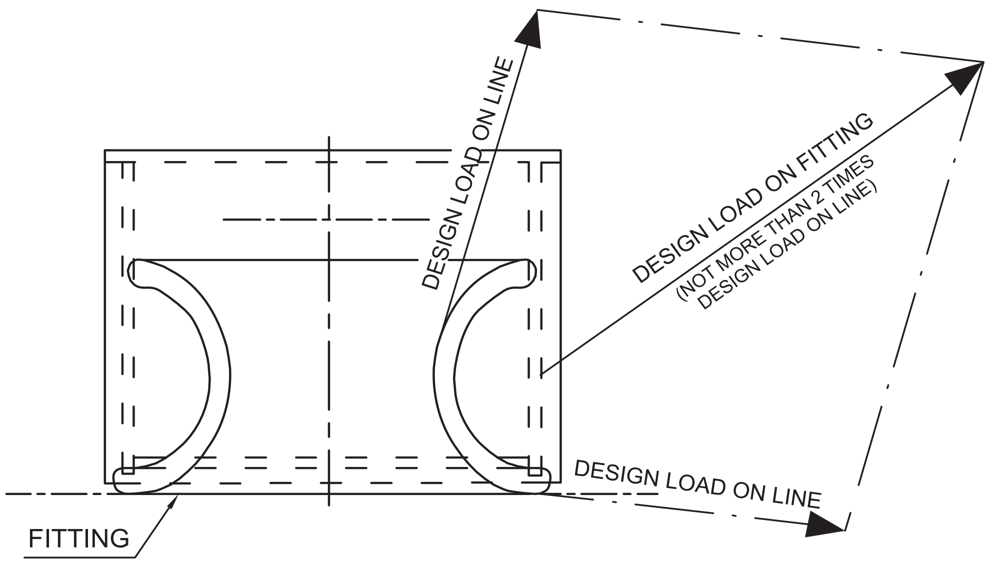
d) For fittings intended to be used for both, towing and mooring, the requirements in [3.1.11] to [3.1.16] applies to mooring TOW, in t, of each shipboard fitting is to be marked (by weld bead or equivalent) on the deck fittings used for towing. For fit tings intended to be used for both, towing and mooring, SWL, in t, according to [3.1.16] is to be marked in addition to TOW.

e) TOW, in t, of each shipboard fitting is to be marked (by weld bead or equivalent) on the deck fittings used for towing. For fittings intended to be used for both, towing and mooring, SWL, in t, according to [3.1.16] is to be marked in addition to TOW.

The above requirements on TOW apply for the use with no more than one line. If not otherwise chosen, for towing bitts (double bollards) TOW is the load limit for a towing line attached with eye-splice.

The towing and mooring arrangements plan mentioned in [3.1.17] is to define the method of use of towing lines.

Figure 6



3.1.11 Mooring shipboard fittings selection *(1/1/2022)*

The mooring shipboard fittings may be selected from an industry standard accepted by the Society and at least based on the Ship Design Minimum Breaking Load~~minimum breaking strength of the mooring line~~ according to Table 3 for the ship's corresponding EN (see Notes in [3.1.14]). When the shipboard fitting is not selected from an accepted industry standard, the strength of the fitting and of its attachment to the ship is to be in accordance with [3.1.14] and [3.1.15]. Mooring bitts (double bollards) are required to resist the loads caused by the mooring line attached in figure-of-eight fashion (see Note 1). For strength assessment beam theory or finite element analy-sis using net scantlings is to be applied, as appropriate. Corrosion additions are to be as defined in [3.1.3]. A wear down allow-ance is to be included as defined in [3.1.4].

Note 1: With the line attached to a mooring bitt in the usual way (figure-of-eight fashion), either of the two posts of the mooring bitt can be subjected to a force twice as large as that acting on the mooring line. Disregarding this effect, depending on the applied industry standard and fitting size, overload may occur.

3.1.12 Mooring shipboard fittings location *(1/7/2018)*

Shipboard fittings, winches and capstans for mooring are to be located on stiffeners and/or girders which are part of the deck construction so as to facilitate efficient distribution of the mooring load. Other arrangements may be accepted (for chocks in bulwarks, etc) provided the strength is confirmed adequate for the service.

3.1.13 Arrangement of supporting hull structures for mooring fittings *(1/7/2018)*

The arrangement of the reinforced members beneath mooring shipboard fittings, winches and capstans is to be such as to withstand any variation of direction (laterally and vertically) of the mooring forces acting upon the shipboard fittings (see Fig ~~2~~3). Proper alignment of fitting and supporting hull structure is to be ensured.

3.1.14 Mooring load model *(1/1/2022)*

a) The minimum design load applied to supporting hull structures for shipboard fittings is to be 1,15 times the Ship Design Minimum Breaking Load~~minimum breaking strength of the mooring line~~ according to Tab 4 and App 2 for the ship's corresponding EN (see Notes 1 and 2).

b) The minimum design load applied to supporting hull structures for winches is to be 1,25 times the intended maximum brake holding load, where the maximum brake holding load is to be assumed not less than 80% of the Ship Design Minimum Breaking Load~~minimum breaking strength of the mooring line~~ according to Tab 4 and App 2 (see Note 1 and 2). For supporting hull structures of capstans, 1.25 times the maximum hauling-in force is to be taken as the minimum design load.

c) This force is to be considered as acting on the shipboard fittings at the attachment point of the mooring line or at a change in its direction, as applicable. For bollards and bitts the attachment point of the mooring line is to be taken not less than 4/5 of the tube height above the base. However, if fins are fitted to the bollard tubes to keep the mooring line as low as possible, the attachment point of the mooring line may be taken at the location of the fins (see Fig ~~5~~6).

d) The design load is to be applied to mooring fittings in all directions that may to fittings in all directions that may occur by taking into account the arrangement shown on the towing and mooring arrangements plan. Where the mooring line takes a turn at a fitting the total design load applied to the fitting is equal to the resultant of the design loads acting on the line (see Fig ~~4~~5). However, in no case does the design load applied to the fitting need to be greater than twice the design load on the line.

e) The method of application of the design load to the fittings and supporting hull structures is to be taken into account such that the total load need not be more than twice the design load specified above, i.e. no more than one turn of one line.

f) When a safe working load SWL greater than that determined according to [3.1.16] is requested by the applicant, then the design load is to be increased in accordance with the appropriate SWL/design load relationship given by [3.1.14] and [3.1.16].

Note 1: Side projected area including that of deck cargoes as given by the ship nominal capacity condition~~the loading~~ manual is to be taken into account for selection of mooring lines and the loads applied to shipboards fittings and supporting hull structures. The nominal capacity condition is defined in [1.2].

Note 2: The increase of the Line Design Break Force~~minimum break ing strength~~ for synthetic ropes according to [3.5.7] needs not to be taken into account for the loads applied to shipboard fittings and supporting hull structure.

3.1.15 Allowable stresses for mooring fittings *(1/1/2022)*

The allowable stresses for towing fittings are given as fol-lows:

a) for strength assessment of supporting hull structures for mooring fittings ~~with~~ by means of beam theory or grillage analysis:

- ~~n~~Normal stress: $1{,}0\ R_{eH}$~~the minimum yield stress of the supporting hull structure material~~
- ~~s~~Shear stress: $0{,}6\ R_{eH}$~~0,6 times the minimum yield stress of the supporting hull structure material.~~

Normal stress is the sum of bending stress and axial stress~~with the corresponding shearing stress acting perpendicular to the normal stress~~. No stress concentration factors being taken into account;

b) for strength assessment ~~with~~by means of finite element analysis:

- Von Mises~~equivalent~~ stress: $1{,}0\ R_{eH}$~~the minimum yield stress of the supporting hull structure material.~~

~~For strength calculations by means of finite elements, the geometry is to be idealized as realistically as possible. The ratio of element length to width is not to exceed 3. Girders are to be modelled using shell or plane stress elements. Symmetric girder flanges may be modelled by beam or truss elements. The element height of girder webs must not exceed one third of the web height. In way of small openings in girder webs the web thickness is to be reduced to a~~

~~mean thickness over the web height. Large openings are to be modelled. Stiffeners may be modelled by using shell, plane stress, or beam elements. Stresses are to be read from the centre of the individual element. For shell elements the stresses are to be evaluated at the mid plane of the element.~~

For strength assessment by means of finite element analysis the mesh is to be fine enough to represent the geometry as realistically as possible. The aspect ratios of elements are not to exceed 3. Girders are to be modelled using shell or plane stress elements. Symmetric girder flanges may be modelled by beam or truss elements. The element height of girder webs must not exceed one-third of the web height. In way of small openings in girder webs the web thickness is to be reduced to a mean thickness over the web height. Large openings are to be modelled. Stiffeners may be modelled by using shell, plane stress, or beam elements. The mesh size of stiffeners is to be fine enough to obtain proper bending stress. If flat bars are modeled using shell or plane stress elements, dummy rod elements are to be modelled at the free edge of the flat bars and the stresses of the dummy elements are to be evaluated. Stresses are to be read from the centre of the individual element. For shell elements the stresses are to be evaluated at the mid plane of the element.

R_{eH} is the specified minimum yield stress of the material.

3.1.16 Safe Working Load (SWL) *(1/1/2022)*

The Safe Working Load (SWL) is the safe load limit of shipboard fittings used for mooring purpose

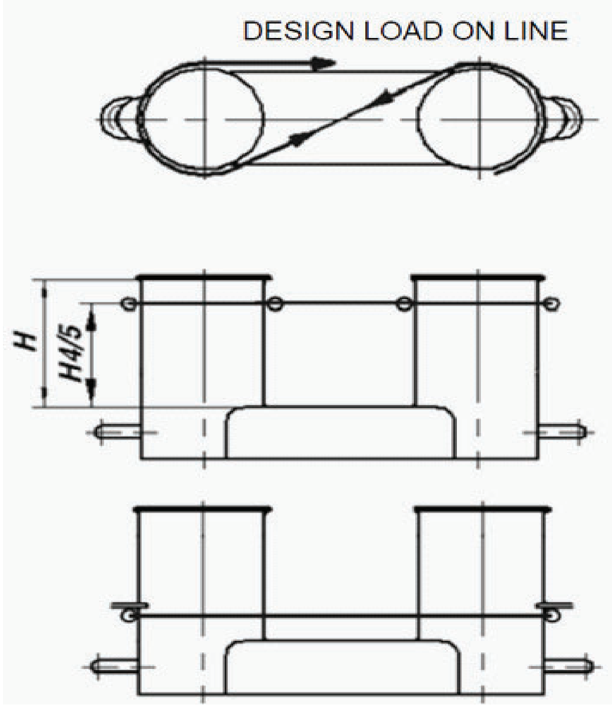
Unless a greater SWL is requested by the applicant according to [3.1.14], the SWL is not to exceed the Ship Design Minimum Breaking Load~~minimum breaking strength of the mooring line~~ according to Tab 4 and App 2 (see notes in [3.1.14]).

The SWL, in t, of each shipboard fitting is to be marked (by weld bead or equivalent) on the deck fittings used for towing. For fittings intended to be used for both, towing and mooring, TOW, in t, according to [3.1.10] is to be marked in addition to SWL.

The above requirements on SWL apply for the use with no more than one mooring line.

The towing and mooring arrangement plan mentioned in [3.1.17] is to define the method of use of mooring lines.

Figure 7 : Attachment point of the mooring line *(1/7/2018)*



3.1.17 Towing and mooring arrangement plan *(1/1/2022)*

The SWL and TOW for the intended use for each shipboard fitting is to be noted in the towing and mooring arrangement plan available on board for the guidance of the Master. It is to be noted that TOW is the load limit for the towing purpose and SWL that for mooring purpose. If not otherwise chosen, for towing bitts it is to be noted that TOW is the load limit for a towing line attached with eye-splice.

Information provided on the plan is to include in respect of each shipboard fitting:

- location on the ship;
- fitting type;
- SWL/TOW;
- purpose (mooring/normal (harbour) towing/other towing); and
- manner of applying towing or mooring line load including limiting fleet angle~~s~~ i.e. angle of change in direction of a line at the fitting.

Furthermore, information provided on the plan is to include:

- the arrangement of mooring lines showing the number of lines (N),
- the Ship Design Minimum Breaking Load~~minimum breaking strength of each mooring line~~ (MBL_{SD}).

The acceptable environmental conditions (refer for minimum conditions to~~as given in~~ App 2 for the recommended Ship Design Minimum Breaking Load~~minimum breaking strength of mooring lines~~ for ships with Equipment Number EN > 2000:

- 30 second mean wind speed from any direction, see App 2, [1.4.2], The total length of chain cable, required in Tab 1, is to be divided in approximately equal parts between the two anchors ready for use.

Where different arrangements are provided, they are- considered by the Society on a case-by-case basis.

3.3.5 Wire ropes *(1/7/2018)*

As an alternative to the stud link or short link chain cables mentioned, wire ropes may be used in the following cases:

- wire ropes for both the anchors, for ship length less than 40 m,
- wire ropes for both the anchors, for ships with restricted navigation notations and/or having special anchoring design and operational characteristics, to be considered on a case-by-case basis taking into account the operational and safety aspects; in any case, the weight of the anchors is to be 1,25 times the value required according to Tab 1.

The wire ropes above are to have a total length equal to 1,5 times the corresponding required length of stud link chain cables, obtained from Tab 1, and a minimum breaking load equal to that given for the corresponding stud link chain cable (see [3.3.2]).

Unless incompatible with the anchor operation, to be evaluated on a case-by-case basis, a short length of chain cable is to be fitted between the wire rope and the anchor, having a length equal to 12,5m or the distance from the anchor in the stowed position to the winch, whichever is the lesser.

All surfaces being in contact with the wire need to be rounded with a radius of not less than 10 times the wire rope diameter (including stem).

3.4 Attachment pieces

3.4.1 General

Where the lengths of chain cable are joined to each other by means of shackles of the ordinary Dee type, the anchor may be attached directly to the end link of the first length of chain cable by a Dee type end shackle.

A detachable open link in two parts riveted together may be used in lieu of the ordinary Dee type end shackle; in such case the open end link with increased diameter, defined in [3.4.2], is to be omitted.

Where the various lengths of chain cable are joined by means of lugless shackles and therefore no special end and increased diameter links are provided, the anchor may be attached to the first length of chain cable by a special pear-shaped lugless end shackle or by fitting an attachment piece.

3.4.2 Scantlings

The diameters of the attachment pieces, in mm, are to be not less than the values indicated in Tab 2.

Attachment pieces may incorporate the following items between the increased diameter stud link and the open end link:

- swivel, having diameter = 1,2 d
- increased stud link, having diameter = 1,1 d

Where different compositions are provided, they will be considered by the Society on a case-by-case basis.

Table 2 : Diameters of attachment pieces

Attachment piece	Diameter, in mm
End shackle	1,4 d
Open end link	1,2 d
Increased stud link	1,1 d
Common stud link	d
Lugless shackle	d
Note 1: d : diameter, in mm, of the common link.	

3.4.3 Material

Attachment pieces, joining shackles and end shackles are to be of such material and design as to provide strength equivalent to that of the attached chain cable, and are to be tested in accordance with the applicable requirements of Pt D, Ch 4, Sec 1.

3.4.4 Spare attachment pieces

A spare pear-shaped lugless end shackle or a spare attachment piece is to be provided for use when the spare anchor is fitted in place.

3.5 Towlines and mooring lines

3.5.1 General *(1/1/2022)*

The requirements of [3.5] apply for the determination of the characteristics of towlines and mooring lines. The equipment number EN is to be calculated in compliance with [2]. Deck cargoes at the ship nominal capacity conditionas given by the loading manual is to be included for the determination of side-projected area A.

[3.5.3] and [3.5.4] specify the minimum number and minimum strength of mooring lines. As an alternative to [3.5.3] and [3.5.4], the direct mooring analysis in line with the procedure given in App 3 may be carried out.

The designer is to consider verifying the adequacy of mooring lines based on assessments carried out for the individual mooring arrangement, expected shore-side mooring facilities and design environmental conditions for the berth.

3.5.2 Towlines *(1/1/2022)*

The towlines having the characteristics defined in Tab 3 are intended as those belonging to the ship to be towed by a tug or another ship.

The designer should consider verifying the adequacy of towing lines based on assessment carried out for the individual towing arrangement.

3.5.3 Mooring lines for ships with EN ≤ 2000 *(1/7/2018)*

Mooring lines for ships having an Equipment Number EN of less than or equal to 2000 are given in Tab 4.

For ships having the ratio A/EN > 0,9 additional mooring lines are required in addition to the number of mooring lines defined in Tab 4.

The number of these additional mooring lines is defined in Tab 6.

3.5.4 Mooring lines for ships with EN > 2000 *(1/7/2018)*

The minimum strength and number of mooring lines for ships with an Equipment Number EN > 2000 are given in App 2.

3.5.5 Materials *(1/7/2018)*

Towlines and mooring lines may be of wire, natural or synthetic fibre or a mixture of wire and fibre. For synthetic fibre ropes it is recommended to use lines with reduced risk of recoil (snap-back) to mitigate the risk of injuries or fatalities in the case of breaking mooring lines.

The breaking loads defined in Tab 3, Tab 4 and App 2 refer to steel wires or natural fibre ropes.

Steel wires and fibre ropes are to be tested in accordance with the applicable requirements in Pt D, Ch 4, Sec 1.

3.5.6 Length of mooring lines *(1/7/2018)*

The length of mooring lines for ships with EN of less than or equal to 2000 may be taken from Tab 4. For ships with EN > 2000 the length of mooring lines may be taken as 200 m.

The lengths of individual mooring lines may be reduced by up to 7% of the above given lengths but the total length of mooring lines is not to be less than would have resulted had all lines been of equal length.

3.5.7 Equivalence between the breaking loads of synthetic and natural fibre ropes *(1/1/2022)*

Generally, fibre ropes are to be made of polyamide or other equivalent synthetic fibres (e.g. polyester, polypropylene).

The equivalence between the breaking loads of synthetic fibre ropes B_{LS} and of natural fibre ropes B_{LN} is to be obtained, in kN, from the following formula:

$B_{LS} = 7,4\ \delta\ B_{LN}^{8/9}$ without being less than $1,2\ B_{LN}$

where:

δ : elongation to breaking of the synthetic fibre rope~~, to be assumed not less than 30%~~.

For other synthetic ropes different from those mentioned above (e.g. aramid fiber, Ultra High Molecular Weight Poly-Ethylene) the breaking load is to be taken equal to $1,1\ B_{LN}$.

3.5.8 Length of mooring lines for supply vessels

For ships with the service notation **supply vessel**, the length of mooring lines may be reduced. The reduced length ℓ is to be not less than that obtained, in m, from the following formula:

$\ell = L + 20$

Table 3 : Towlines *(1/1/2022)*

Equipment number EN A< EN ≤ B		Towline **(1)**	
A	B	Minimum length, in m	Ship Design Minimum Breaking load, in kN
50	70	180	98
70	90	180	98
90	110	180	98
110	130	180	98
130	150	180	98
150	175	180	98
175	205	180	112
205	240	180	129
240	280	180	150
280	320	180	174
320	360	180	207
360	400	180	224
400	450	180	250
450	500	180	277
500	550	190	306
550	600	190	338
600	660	190	371
660	720	190	406
720	780	190	441
780	840	190	480
840	910	190	518

(1) The towline is not compulsory. It is recommended for ships having length not greater than 180 m.

Equipment number EN A< EN ≤ B		Towline **(1)**	
A	B	Minimum length, in m	Ship Design Minimum Breaking load, in kN
910	980	190	550
980	1060	200	603
1060	1140	200	647
1140	1220	200	692
1220	1300	200	739
1300	1390	200	786
1390	1480	200	836
1480	1570	220	889
1570	1670	220	942
1670	1790	220	1024
1790	1930	220	1109
1930	2080	220	1168
2080	2230	240	1259
2230	2380	240	1356
2380	2530	240	1453
2530	2700	260	1471
2700	2870	260	1471
2870	3040	260	1471
3040	3210	280	1471
3210	3400	280	1471
3400	3600	280	1471
3600	-	300	1471

(1) The towline is not compulsory. It is recommended for ships having length not greater than 180 m.

Table 4 : Mooring lines for ships with EN ≤ 2000 *(1/1/2022)*

Equipment number EN A< EN ≤ B		Mooring lines		
A	B	N **(1)**	Lenght of each line, in m	Ship Design Minimum Breaking load, in kN
50	70	3	80	37
70	90	3	100	40
90	110	3	110	42
110	130	3	110	48
130	150	3	120	53
150	175	3	120	59
175	205	3	120	64
205	240	3	120	69
240	280	4	120	75
280	320	4	140	80
320	360	4	140	85
360	400	4	140	96
400	450	4	140	107
450	500	4	140	117
500	550	4	160	134
550	600	4	160	143
600	660	4	160	160

(1) See [3.5.3] and [3.5.4]

Equipment number EN A< EN ≤ B		Mooring lines		
A	B	N **(1)**	Lenght of each line, in m	Ship Design Minimum Breaking load, in kN
660	720	4	160	171
720	780	4	170	187
780	840	4	170	202
840	910	4	170	218
910	980	4	170	235
980	1060	4	180	250
1060	1140	4	180	272
1140	1220	4	180	293
1220	1300	4	180	309
1300	1390	4	180	336
1390	1480	4	180	352
1480	1570	5	190	352
1570	1670	5	190	362
1670	1790	5	190	384
1790	1930	5	190	411
1930	2000	5	190	437
(1) See [3.5.3] and [3.5.4]				

Table 5 : Steel wire composition

Breaking load B_L ,in kN	Steel wire components		
	Number of threads	Ultimate tensile strength of threads, in N/mm²	Composition of wire
B_L < 216	72	1420 ÷ 1570	6 strands with 7-fibre core
216 ≤ B_L ≤ 490	144	1570 ÷ 1770	6 strands with 7-fibre core
B_L > 490	216 or 222	1770 ÷ 1960	6 strands with 1-fibre core

3.6 Hawse pipes

3.6.1 Hawse pipes are to be built according to sound marine practice.

Their position and slope are to be so arranged as to create an easy lead for the chain cables and efficient housing for the anchors, where the latter are of the retractable type, avoiding damage to the hull during these operations.

For this purpose chafing lips of suitable form with ample lay-up and radius adequate to the size of the chain cable are to be provided at the shell and deck. The shell plating in way of the hawse pipes is to be reinforced as necessary.

Table 6 : Additional mooring lines

A/EN	Number of additional mooring lines
0,9 < A/EN ≤ 1,1	1
1,1 < A/EN ≤ 1,2	2
1,2 < A/EN	3
Note 1: A and EN are defined in [2.1.2].	

3.6.2 In order to obtain an easy lead of the chain cables, the hawse pipes may be provided with rollers. These rollers are to have a nominal diameter not less than 10 times the size of the chain cable where they are provided with full imprints, and not less than 12 times its size where provided with partial imprints only.

3.6.3 All mooring units and accessories, such as thimble, riding and trip stoppers are to be securely fastened to the Surveyor’s satisfaction.

3.7 Windlass

3.7.1 General *(1/7/2018)*

The windlass, which is generally single, is to be power driven and suitable for the size of chain cable and the mass of the anchors. Windlass is also to comply with requirements given in Pt C, Ch 1, Sec 15.

In mechanically propelled ships of less than 200 t gross tonnage, a hand-operated windlass may be fitted. In such case it is to be so designed as to be capable of weighing the anchors in a reasonably short time.

The windlass is to be fitted in a suitable position in order to ensure an easy lead of the chain cables to and through the hawse pipes. The deck in way of the windlass is to be suitably reinforced.

3.7.2 Windlass brake *(1/7/2018)*

A windlass brake is to be provided having sufficient capacity to stop the anchor and chain cable when paying out the latter with safety, in the event of failure of the power supply to the prime mover. Windlasses not actuated by steam are also to be provided with a non-return device.

Where a chain cable stopper is fitted, a windlass with brakes applied and the cable lifter declutched is to be able to withstand a pull of 45% of the breaking load of the chain without any permanent deformation of the stressed parts or brake slip.

Where a chain stopper is not fitted a windlass with brakes applied and the cable lifter declutched is to be able to withstand a pull of 80% of the breaking load of the chain without any permanent deformation of the stressed parts or brake slip.

3.7.3 Chain stoppers *(1/7/2018)*

Where a chain stopper is fitted, it is to be able to withstand a pull of 80% of the breaking load of the the chain and the windlass is to be able to withstand a pull of 45% of the breaking load of the chain without any permanent deformation of the stressed part or brake slip.

Where a chain cable stopper is fitted, a windlass with brakes applied and the cable lifter declutched is to be able to withstand a pull of 45% of the breaking load of the chain without any permanent deformation of the stressed parts or brake slip.

3.7.4 Strength criteria for windlass subject to anchor and chain loads

The stresses on the parts of the windlass, its frame and stopper are to be less than the yield stress of the material used.

For the calculation of the above stresses, special attention is to be paid to:

- stress concentrations in keyways and other stress raisers,
- dynamic effects due to sudden starting or stopping of the prime mover or anchor chain,
- calculation methods and approximation.

3.7.5 Green sea loads

For ships of length 80 m or more, where the height of the exposed deck in way of the item is less than 0,1L or 22 m above the summer load waterline, whichever is the lesser, the securing devices of windlasses located within the forward quarter length of the ship are to resist green sea forces.

The green sea pressure and associated areas are to be taken equal to (see Fig ~~8~~9):

- 200 kN/m^2 normal to the shaft axis and away from the forward perpendicular, over the projected area in this direction,
- 150 kN/m^2 parallel to the shaft axis and acting both inboard and outboard separately, over the multiple of f times the projected area in this direction,

where:

f : 1+ B/H, but not greater than 2,5

B : width of windlass measured parallel to the shaft axis,

H : overall height of windlass.

Where mooring winches are integral with the anchor windlass, they are to be considered as part of the windlass.

3.7.6 Forces in the securing devices of windlasses due to green sea loads

Forces in the bolts, chocks and stoppers securing the windlass to the deck are to be calculated by considering the green sea loads specified in [3.7.5].

The windlass is supported by N bolt groups, each containing one or more bolts (see also Fig ~~9~~10).

The axial force R_i in bolt group (or bolt) i, positive in tension, is to be obtained, in kN, from the following formulae:

$R_{xi} = P_x h_{xi} A_i / I_x$

$R_{yi} = P_y h_{yi} A_i / I_y$

and $R_i = R_{xi} + R_{yi} - R_{si}$

where:

P_x : force, in kN, acting normal to the shaft axis

P_y : force, in kN, acting parallel to the shaft axis, either inboard or outboard, whichever gives the greater force in bolt group i

H : shaft height, in cm, above the windlass mounting

x_i , y_i : x and y co-ordinates, in cm, of bolt group i from the centroid of all N bolt groups, positive in the direction opposite to that of the applied force

A_i : cross-sectional area, in cm^2, of all bolts in group i

I_x : $\Sigma A_i x_i^2$ for N bolt groups

I_y : $\Sigma A_i y_i^2$ for N bolt groups

R_{si} : static reaction, in kN, at bolt group i, due to weight of windlass.

Shear forces F_{xi} , F_{yi} applied to the bolt group i, and the resultant combined force F_i are to be obtained, in kN, from the following formulae:

$F_{xi} = (P_x - \alpha g M) / N$

$F_{yi} = (P_y - \alpha g M) / N$

and

$F_i = (F_{xi}^2 + F_{yi}^2)^{0,5}$

where:

α : coefficient of friction, to be taken equal to 0,5

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3.9 ~~Hull s~~Supporting hull structures of anchor windlass and chain stopper

3.9.1 General *(1/1/2022)*

The ~~hull~~ supporting hull structure of anchor windlass and chain stopper is to be sufficient to accommodate the ~~operating~~design sea loads.

3.9.2 ~~Operating~~Design loads *(1/1/2022)*

The ~~operating~~design loads are to be taken not less than:

- for chain stoppers, 80% of the chain cable breaking load,
- for windlasses where no chain stopper is fitted or the chain stopper is attached to the windlass, 80% of the chain cable breaking load,
- for windlasses, where chain stoppers are fitted but not attached to the windlass, 45% of the chain cable breaking load.

The ~~operating~~design loads are to be applied in the direction of the chain cable.

3.9.3 Sea loads *(1/7/2018)*

The sea loads are to be taken as defined in [3.7.5].

3.9.4 Allowable stresses *(1/1/2022)*

The ~~allowable~~ stresses acting on the~~for hull~~ supporting hull structures of windlass and chain stopper, based on the net ~~scantling~~thickness obtained by deducting the corrosion addition, t_c, given in [3.9.5], are not to be ~~taken~~greater ~~as~~than the following permissible values:

- ~~normal stress: the minimum yield stress of the supporting hull structure material~~
- ~~shear stress: 0,6 times the minimum yield stress of the supporting hull structure material.~~

a) For strength assessment by means of beam theory or grillage analysis:

- Normal stress: 1,0 R_{eH}
- Shear stress: 0,6 R_{eH}

The normal stress is the sum of bending stress and axial stress. The shear stress to be considered corresponds to the shear stress acting perpendicular to the normal stress. No stress concentration factors are to be taken into account.

b) For strength assessment by means of finite element analysis:

- Von Mises stress: 1.0 R_{eH}

For strength assessment by means of finite element analysis the mesh is to be fine enough to represent the geometry as realistically as possible. The aspect ratios of elements are not to exceed 3. Girders are to be modelled using shell or plane stress elements. Symmetric girder flanges may be modelled by beam or truss elements. The element height of girder webs must not exceed one-third of the web height. In way of small openings in girder webs, the web thickness is to be reduced to a mean thickness over the web height. Large openings are to be modelled. Stiffeners may be modelled using shell, plane stress, or beam elements. The mesh size of stiffeners is to be fine enough to obtain proper bending stress. If flat bars are modeled using shell or plane stress elements, dummy rod elements are to be modelled at the free edge of the flat bars and the stresses of the dummy elements are to be evaluated. Stresses are to be read from the centre of the individual element. For shell elements the stresses are to be evaluated at the mid plane of the element.

Where R_{eH} is the specified minimum yield stress of the material.

3.9.5 Corrosion addition *(1/1/2022)*

The total corrosion addition, t_c, is not to be less than the following values:

a) Ships covered by Common Structural Rules for Bulk Carriers and Oil Tankers:

t_c: total corrosion addition as defined in these rules.

b) Other ships:

For the supporting hull structure, the total corrosion addition, t_c, is defined according to Ch 4, Sec 2 for all considered structural members used in the model (e.g. deck structures).

3.10 Chain locker

3.10.1 The capacity of the chain locker is to be adequate to stow all chain cable equipment and provide an easy direct lead to the windlass.

3.10.2 Where two chains are used, the chain lockers are to be divided into two compartments, each capable of housing the full length of one line.

3.10.3 The inboard ends of chain cables are to be secured to suitably reinforced attachments in the structure by means of end shackles, whether or not associated with attachment pieces.

Generally, such attachments are to be able to withstand a force not less than 15% of the breaking load of the chain cable.

In an emergency, the attachments are to be easily released from outside the chain locker.

3.10.4 Where the chain locker is arranged aft of the collision bulkhead, its boundary bulkheads are to be watertight and a drainage system is to be provided.

3.11 Fairleads and bollards

3.11.1 Fairleads and bollards of suitable size and design are to be fitted for towing, mooring and warping operations.

4 Emergency towing arrangements

4.1 Definitions

4.1.1 Deadweight

Deadweight is the difference, in t, between the displacement of a ship in water of a specific gravity of 1,025 t/m^3 at the load waterline corresponding to the assigned summer freeboard and the lightweight of the ship.

4.2 General and application

4.2.1

This Article applies to ships which are to comply with Regulation 3-4 of Chapter II-1 of SOLAS Convention. It concerns the equipment arrangements for towing ships out of danger in emergencies such as complete mechanical breakdowns, loss of power or loss of steering capability.

4.2.2 An emergency towing arrangement is to be fitted at both ends on board of ships of 20000 t deadweight and above with one of the following service notations:

- **combination carrier ESP**,
- **oil tanker ESP**,
- **FLS tanker**,
- **chemical tanker ESP**,
- **liquefied gas carrier**.

4.3 Documentation

4.3.1 Documentation for approval

In addition to the documents in Ch 1, Sec 3, the following documentation is to be submitted to the Society for approval:

- general layout of the bow and stern towing arrangements and associated equipment,
- operation manual for the bow and stern towing arrangements,
- construction drawings of the bow and stern strongpoints (towing brackets or chain cable stoppers) and fairleads (towing chocks), together with material specifications and relevant calculations,
- drawings of the local ship structures supporting the loads applied by strongpoints, fairleads and roller pedestals.

4.3.2 Documentation for information

The following documentation is to be submitted to the Society for information (see Ch 1, Sec 3):

- specifications of chafing gears, towing pennants, pick-up gears and roller fairleads,
- height, in m, of the lightest seagoing ballast freeboard measured at stern towing fairlead,
- deadweight, in t, of the ship at summer load line.

4.4 General

4.4.1 Scope

The emergency towing arrangements are to be so designed as to facilitate salvage and emergency towing operations on the concerned ship, primarily to reduce the risk of pollution.

4.4.2 Main characteristics

The emergency towing arrangements are, at all times, to be capable of rapid deployment in the absence of main power on the ship to be towed and easy connection to the towing ship. At least one of the emergency towing arrangements is to be pre-rigged for rapid deployment.

To demonstrate such rapid and easy deployment, the emergency towing arrangements are to comply with the requirements in [4.12].

Emergency towing arrangements at both ends are to be of adequate strength taking into account the size and deadweight of the ship and the expected forces during bad weather conditions.

To this end, the emergency towing arrangements are to comply with the requirements in [4.6] to [4.11].

4.4.3 Typical layout

Fig 1~~0~~1 shows an emergency towing arrangement which may be used as reference.

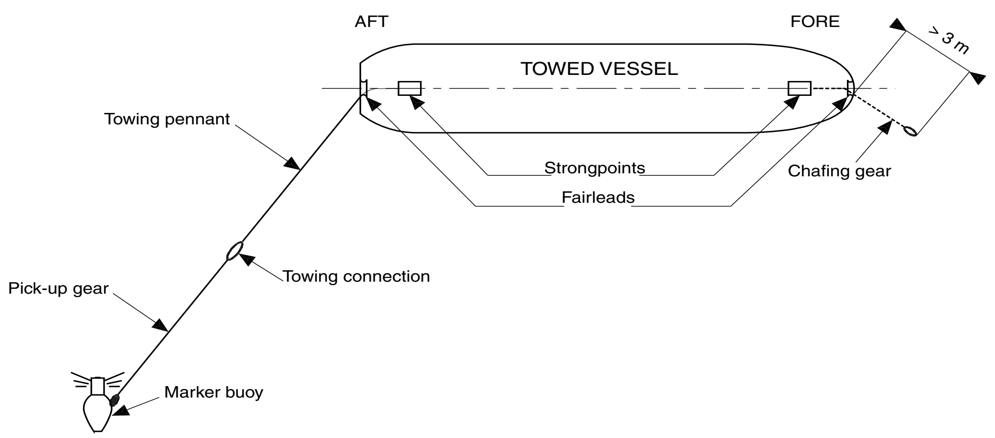
4.4.4 List of major components

The major components of the towing arrangements, their position on board and the requirements of this Article which they are to comply with are defined in Tab 7.

4.4.5 Inspection and maintenance

All the emergency towing arrangement components are to be inspected by ship personnel at regular intervals and maintained in good working order.

Figure 12 : Typical emergency towing arrangement



$MBS_{PC} = \varphi \, MBS_P$

where:

MBS_P : minimum breaking strength, in kN, defined in [4.7.3],

φ : coefficient to be taken equal to:

$$\varphi = \frac{2\sqrt{\rho}}{2\sqrt{\rho} - 1}$$

φ may be taken equal to 1,0 if tests carried out under a test load equal to twice the safe working load defined in [4.6.1] demonstrate that the strength of the towing pennants is satisfactory,

ρ : bending ratio (ratio between the minimum bearing surface diameter of the fairlead and the towing pennant diameter), to be taken not less than 7.

4.7.5 Towing pennant termination

For towing connection, the towing pennant is to have a hard eye-formed termination allowing connection to a standard shackle.

Socketed or ferrule-secured eye terminations of the towing pennant are to be type tested in order to demonstrate that their minimum breaking strength is not less than twice the safe working load defined in [4.6.1].

4.8 Chafing gear

4.8.1 General

Different solutions for the design of chafing gear may be used.

If a chafing chain is to be used, it is to have the characteristics defined in the following requirements.

4.8.2 Type

Chafing chains are to be stud link chains.

Chafing chains are to be designed, manufactured, tested and certified in accordance with the requirements in Pt D, Ch 4, Sec 1.

Chafing chains are to be manufactured by works approved by the Society in accordance with the requirements in Pt D, Ch 4, Sec 1.

4.8.3 Material

The materials used for the manufacture of the chafing chain and associated accessories are to comply with the requirements in Pt D, Ch 4, Sec 1.

The common link is to be of grade Q2 or Q3.

4.8.4 Chafing chain length

The chafing chain is to be long enough to ensure that the towing pennant, or the towline, remains outside the fairlead during the towing operation. A chain extending from the strongpoint to a point at least 3m beyond the fairlead complies with this requirement.

4.8.5 Minimum breaking strength

The minimum breaking strength of the stud link chafing chain and the associated links is to be not less than twice the safe working load defined in [4.6.1].

4.8.6 Diameter of the common links

The nominal diameter of the common links for chafing chains is to be not less than the values indicated in Tab 9.

Table 9 : Nominal diameter of common links for chafing chains

Safe working load, in kN; refer to [4.6.1]	Nominal diameter, in mm	
	Grade Q2	Grade Q3
1000	62	52
2000	90	76

4.8.7 Chafing chain ends

One end of the chafing chain is to be suitable for connection to the strongpoint. Where a chain stopper is used, the inboard end of the chafing chain is to be efficiently secured in order to prevent any inadvertent loss of the chafing chain when operating the stopping device. Where the chafing chain is connected to a towing bracket, the corresponding chain end may be constructed as shown in Fig 1~~1~~2, but the inner dimension of the pear link may be taken as 5,30d (instead of 5,75d).

The other end of the chafing chain is to be fitted with a standard pear-shaped open link allowing connection to a standard bow shackle. A typical arrangement of this chain end is shown in Fig 1~~1~~2. Arrangements different than that shown in Fig 1~~1~~2 are considered by the Society on a case-by-case basis.

4.8.8 Storing

The chafing chain is to be stored and stowed in such a way that it can be rapidly connected to the strongpoint.

4.9 Fairleads

4.9.1 General

Fairleads are normally to be of a closed type (such as Panama chocks).

Fairleads are to have an opening large enough to pass the largest portion of the chafing gear, towing pennant or towline. The corners of the opening are to be suitably rounded.

Where the fairleads are designed to pass chafing chains, the openings are to be not less than 600mm in width and 450mm in height.

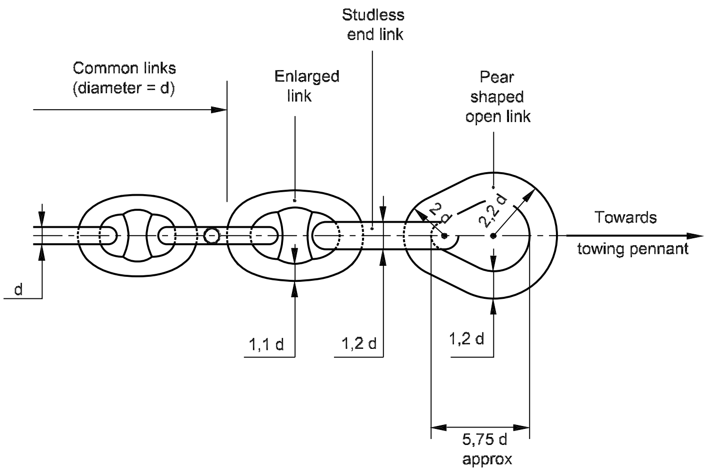
4.9.2 Material

Fairleads are to be made of fabricated steel plates or other ductile materials such as weldable forged or cast steel complying with the applicable requirements of Part D, Chapter 2.

4.9.3 Operating condition

The bow and stern fairleads are to give adequate support for the towing pennant during towing operation, which means bending 90° to port and and starboard side and 30° vertical downwards.

Figure 13 : Typical outboard chafing chain end



4.9.4 Positioning

The bow and stern fairleads are to be located so as to facilitate towing from either side of the bow or stern and minimise the stress on the towing system.

The bow and stern fairleads are to be located as close as possible to the deck and, in any case, in such a position that the chafing chain is approximately parallel to the deck when it is under strain between the strongpoint and the fairlead.

Furthermore, the bow and stern fairleads are normally to be located on the ship's centreline. Where it is practically impossible to fit the towing fairleads exactly on the ship’s centreline, it may be acceptable to have them slightly shifted from the centreline.

4.9.5 Bending ratio

The bending ratio (ratio between the towing pennant bearing surface diameter and the towing pennant diameter) is to be not less than 7.

4.9.6 Fairlead lips

The lips of the fairlead are to be suitably faired in order to prevent the chafing chain from fouling on the lower lip when deployed or during towing.

4.9.7 Yielding check

The equivalent Von Mises stress σ_E, in N/mm^2, induced in the fairlead by a load equal to the safe working load defined in [4.6.1], is to comply with the following formula:

$\sigma_E \, \sigma \leq_{ALL}$

Areas subjected to stress concentrations are considered by the Society on a case-by-case basis.

Where the fairleads are analysed through fine mesh finite element models, the allowable stress may be taken as 1,1 σ_{ALL}.

4.9.8 Alternative to the yielding check

The above yielding check may be waived provided that fairleads are tested with a test load equal to twice the safe working load defined in [4.6.1] and this test is witnessed by a Surveyor of the Society. In this case, the Designer is responsible for ensuring that the fairlead scantlings are sufficient to withstand such a test load.

Unless otherwise agreed by the Society, components subjected to this test load are considered as prototype items and are to be discarded.

4.10 Strongpoint

4.10.1 General

The strongpoint (inboard end fastening of the towing gear) is to be a chain cable stopper or a towing bracket or other fitting of equivalent strength and ease of connection. *The strongpoint can be designed integral with the fairlead.*

The strongpoint is to be type approved according to [4.13] and is to be clearly marked with its SWL.

4.10.2 Materials

The strongpoint is to be made of fabricated steel or other ductile materials such as forged or cast steel complying with the applicable requirements of Part D, Chapter 2.

Use of spheroidal graphite cast iron (SG iron) may be accepted for the main framing of the strongpoint provided that:

- the part concerned is not intended to be a component part of a welded assembly,
- the SG iron is of ferritic structure with an elongation not less than 12%,
- the yield stress at 0,2% is measured and certified,
- the internal structure of the component is inspected by suitable non-destructive means.

The material used for the stopping device (pawl or hinged bar) of chain stoppers and for the connecting pin of towing brackets is to have mechanical properties not less than those of grade Q3 chain cables, defined in Pt D, Ch 4, Sec 1.

4.10.3 Typical strongpoint arrangement

Typical arrangements of chain stoppers and towing brackets are shown in Fig 1~~2~~3, which may be used as reference.

Chain stoppers may be of the hinged bar type or pawl (tongue) type or of other equivalent design.

4.10.4 Position and operating condition

The operating conditions and the positions of the strongpoints are to comply with those defined in [4.9.3] and [4.9.4], respectively, for the fairleads.

4.10.5 Stopping device

The stopping device (chain engaging pawl or bar) is to be arranged, when in closed position, to prevent the chain stopper from working in the open position, in order to avoid chain cable release and allow it to pay out.

Stopping devices are to be easy and safe to operate and, in the open position, are to be properly secured.

4.10.6 Connecting pin of the towing bracket

The scantlings of the connecting pin of the towing bracket are to be not less than those of a pin of a grade Q3 end shackle, as shown in Fig 1~~2~~3, provided that clearance between the two side lugs of the bracket does not exceed 2,0d, where d is the chain diameter specified in [4.8.6] (see also Fig 1~~1~~2).

4.10.7 Yielding check

The equivalent Von Mises stress σ_E , in N/mm^2, induced in the strongpoint by a load equal to the safe working load defined in [4.6.1], is to comply with the following formula:

$\sigma_E \le \sigma_{ALL}$

Areas subjected to stress concentrations are considered by the Society on a case-by-case basis.

Where the strongpoints are analysed through fine mesh finite element models, the allowable stress may be taken as 1,1 σ_{ALL}.

4.10.8 Alternative to the yielding check

The above yielding check may be waived provided that strongpoints are tested with a test load equal to twice the safe working load defined in [4.6.1] and this test is witnessed by a Surveyor. In this case, the Designer is responsible for ensuring that the fairlead scantlings are sufficient to withstand such a test load.

Unless otherwise agreed by the Society, components subjected to this test load are considered as prototype items and are to be discarded.

4.10.9 Bolted connection

Where a chain stopper or a towing bracket is bolted to a seating welded to the deck, the bolts are to be relieved from shear force by means of efficient thrust chocks capable of withstanding a horizontal force equal to 1,3 times the safe working load defined in [4.6.1] within the allowable stress defined in [4.10.7].

The steel quality of bolts is to be not less than grade 8.8 as defined by ISO standard No. 898/1.

Bolts are to be pre-stressed in compliance with appropriate standards and their tightening is to be suitably checked.

4.11 Hull structures in way of fairleads or strongpoints

4.11.1 Materials and welding

The materials used for the reinforcement of the hull structure in way of the fairleads or the strongpoints are to comply with the applicable requirements of Part D.

Main welds of the strongpoints with the hull structure are to be 100% inspected by adequate non-destructive tests.

4.11.2 Yielding check of bulwark and stays

The equivalent Von Mises stress σ_E , in N/mm^2, induced in the bulwark plating and stays in way of the fairleads by a load equal to the safe working load defined in [4.6.1], for the operating condition of the fairleads defined in [4.9.3], is to comply with the following formula:

$\sigma_E \le \sigma_{ALL}$

4.11.3 Yielding check of deck structures

The equivalent Von Mises stress σ_E , in N/mm^2, induced in the deck structures in way of chain stoppers or towing brackets, including deck seatings and deck connections, by a horizontal load equal to 1,3 times the safe working load defined in [4.6.1], is to comply with the following formula:

$\sigma_E \le \sigma_{ALL}$

4.11.4 Minimum gross thickness of deck plating

The gross thickness of the deck is to be not less than:

- 12 mm for a safe working load, defined in [4.6.1], equal to 1000 kN,
- 15 mm for a safe working load, defined in [4.6.1], equal to 2000 kN.

4.12 Rapid deployment of towing arrangement

4.12.1 General

To facilitate approval of towing arrangements and to ensure rapid deployment, emergency towing arrangements are to comply with the requirements of this item.

4.12.2 Marking

All components, including control devices, of the emergency towing arrangements are to be clearly marked to facilitate safe and effective use even in darkness and poor visibility.

4.12.3 Pre-rigged

The pre-rigged emergency towing arrangement is to be capable of being deployed in a controlled manner in harbour conditions in not more than 15 minutes.

The pick-up gear for the pre-rigged towing pennant is to be designed at least for manual operation by one person taking into account the absence of power and the potential for adverse environmental conditions that may prevail during such emergency towing operations.

The pick-up gear is to be protected against the weather and other adverse conditions that may prevail.

APPENDIX 2 MOORING LINES FOR SHIPS WITH EN > 2000

1 General

1.1 Application

1.1.1 *(1/7/2018)*

The requirements of this Appendix apply for the determination of the minimum strength and number of mooring lines for ships with an Equipment number EN > 2000. The length of mooring lines is given in Ch 10, Sec 4, [3.5.6].

1.2 Definitions

1.2.1 Breast line *(1/7/2018)*

Breast line is a mooring line that is deployed perpendicular to the ship, restraining the ship in the off-berth direction (see Fig 1).

1.2.2 Spring line *(1/7/2018)*

Spring line is a mooring line that is deployed almost parallel to the ship, restraining the ship in the fore or aft direction (see Fig 1).

1.2.3 Head/Stern line *(1/7/2018)*

Head/Stern line is a mooring line that is oriented between longitudinal and transverse direction, restraining the ship in the off-berth and in fore or aft direction. The amount of restraint in fore or aft and off-berth direction depends on the line angle relative to these directions (see Fig 1).

1.3 Calculation of side projected area A_1

1.3.1 *(1/1/2022)*

The strength of mooring lines and the number of head, stern, and breast lines (see Note) for ships with an Equipment Number EN > 2000 are based on the side-projected area A1. Side projected area A1 is to be calculated similar to the side-projected area A according to Ch 10, Sec 4, [2.1] but considering the following conditions:

- ~~for oil tankers, chemical tankers, bulk carriers and ore carriers t~~The ~~lightest~~ ballast draft is to be considered for the calculation of the side-projected area A1~~. For other ships the lightest draft of usual loading conditions is to be considered if the ratio of the freeboard in the lightest draft and the full load condition is equal to or above two. Usual loading conditions mean loading conditions as given by the trim and stability booklet that are to be expected to regularly occur during operation and, in particular, excluding light weight conditions, propeller inspection conditions, etc~~For ship types having small variation in the draft, like e.g. passenger and RO/RO vessels, the side projected area A1 may be calculated using the summer load waterline;
- wind shielding of the pier can be considered for the calculation of the side-projected area A1 unless the ship is intended to be regularly moored to jetty type piers. A height of the pier surface of 3 m over waterline may be assumed, i.e. the lower part of the side projected area with a height of 3 m above the waterline for the considered loading condition may be disregarded for the calculation of the side-projected area A_1;
- deck cargoes at the ship nominal capacity condition~~as given by the loading manual~~ is to be included for the determination of side-projected area A_1. For the condition with cargo on deck, the summer load waterline may be considered. Deck cargoes may not need to be considered if ballast~~a usual light~~ draft condition~~ without cargo on deck~~ generates a larger side-projected area A_1 than the full load condition with cargoes on deck. The larger of both side-projected areas is to be chosen as side-projected area A_1. The nominal capacity condition is defined in Ch 10, Sec 4, [1.2].

1.4 Environmental conditions

1.4.1 Current *(1/7/2018)*

The mooring lines characteristics, as given in this Appendix, are based on a maximum current speed of 1 m/s.

The current speed is considered representative of the maximum current speed acting on bow or stern (±10°) and at a depth of one-half of the mean draft. Furthermore, it is considered that ships are moored to solid piers that provide shielding against cross current.

1.4.2 Wind *(1/7/2018)*

The mooring lines characteristics, as given in this Appendix, are based on the maximum wind speed v_W, in m/s, given in the following.

- for ships with one of the service notations ro-ro cargo ships, passenger ship or ro-ro passenger ship:

  $v_W = 25 - 0{,}002\ (A_1 - 2000)$ for $2000\ m^2 \leq A_1 \leq 4000\ m^2$

  $v_W = 21$ for $A_1 \geq 4000\ m^2$

- for other ship types:

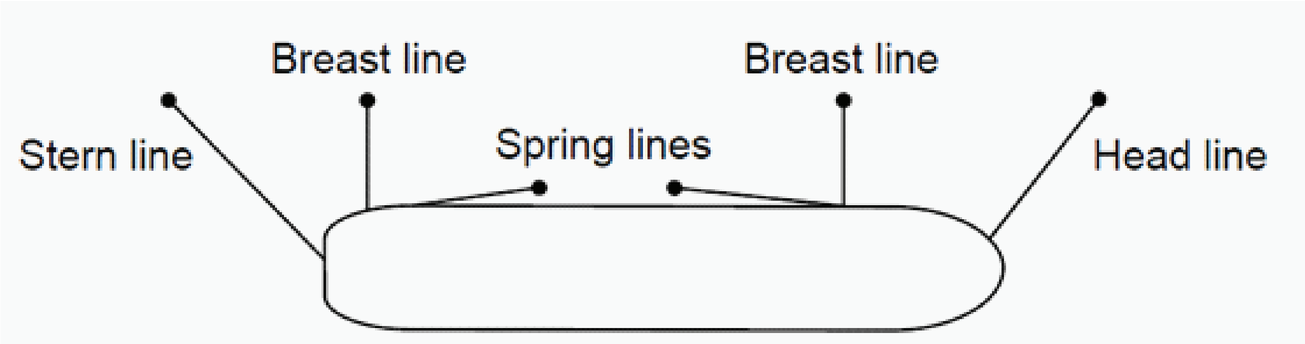
  $v_W = 25$

The wind speed is considered representative of a 30 second mean speed from any direction and at a height of 10 m above the ground.

1.4.3 Additional loads *(1/7/2018)*

Additional loads caused by, e.g., higher wind or current speeds, cross currents, additional wave loads or reduced shielding from non-solid piers may need to be considered by the Society on a case-by-case basis. Furthermore, it is to be observed that unbeneficial mooring layouts can considerably increase the loads on single mooring lines.

Figure 1 : Mooring lines *(1/7/2018)*



2 Mooring lines characteristics

2.1 ~~Minimum breaking strength~~Ship Design Minimum Breaking Load

2.1.1 *(1/1/2022)*

The Ship Design Minimum Breaking Load~~minimum breaking strength of the mooring lines~~, in kN, is to be obtained from the following formula:

$MBL_{SD} = 0,1A_1 + 350$

2.1.2 *(1/1/2022)*

The Ship Design Minimum Breaking Load~~minimum breaking strength~~ may be limited to 1275 kN. However, in this case the moorings are to be considered as not sufficient for environmental conditions given in [1.4]. For these ships, the acceptable wind speed v_W*, in m/s, can be estimated from the following formula:

$$v_w^* = v_w \sqrt{\frac{MBL^*}{MBL}}$$

$$v_w^* = v_w \sqrt{\frac{MBL_{SD}^*}{MBL_{SD}}}$$

where:

v_W : wind speed, in m/s, given in [1.4.2]

MBL_{SD} : Ship Design Minimum Breaking Load~~minimum breaking strength~~, in kN, according to the formulation given in [2.1.1]

MBL_{SD}* : Ship Design Minimum Breaking Load of the mooring lines intended to be supplied~~lowered breaking strength~~, not to be taken less than corresponding to an acceptable wind speed of 21 m/s:

$$MBL^* \geq \left(\frac{21}{v_w}\right)^2 MBL$$

$$MBL_{SD}^* \geq \left(\frac{21}{v_w}\right)^2 MBL_{SD}$$

2.1.3 *(1/1/2022)*

If lines are intended to be supplied for an acceptable wind speed v_W* higher than v_W given in [1.4.2], the Ship Design Minimum Breaking Load~~minimum breaking strength~~ is to be obtained from the following formula:

$$MBL^* \geq \left(\frac{v_w^*}{v_w}\right)^2 MBL$$

$$MBL_{SD}^* \geq \left(\frac{v_w^*}{v_w}\right)^2 MBL_{SD}$$

2.2 Number of mooring lines

2.2.1 *(1/7/2018)*

The total number of head, stern and breast lines, rounded to the nearest whole number, is to be taken as:

- For oil tankers, chemical tankers, bulk carriers and ore carriers:

  $n = 8,3\ 10^{-4}\ A_1 + 4$

- For other ship types:

  $n = 8,3\ 10^{-4}\ A_1 + 6$

2.2.2 *(1/1/2022)*

The number of head, stern and breast lines may be increased or decreased in conjunction with an adjustment to the Ship Design Minimum Breaking Load~~strength~~ of the lines. The adjusted Ship Design Minimum Breaking Load~~strength~~, MBL_{SD}**, is to be obtained from the following formulae:

for increased number of lines:

$MBL_{SD}^{**} = 1,2\ MBL_{SD}\ n/n^{**} \leq MBL_{SD}$ ~~for increased number of lines~~

for reduced number of lines:

$MBL_{SD}^{**} = MBL_{SD}\ n/n^{**}$ ~~for reduced number of lines~~

where:

MBL_{SD} : is MBL_{SD} or MBL_{SD}* defined in [2.1], as appropriate

n : number of lines for the considered ship type as calculated by the above formulas without rounding~~total number of head, stern and breast lines, defined in [2.2.1]~~

n** : increased or decreased total number of head, stern and breast lines

Vice versa, the Ship Design Minimum Breaking Load~~strength~~ of head, stern and breast lines may be increased or decreased in conjunction with an adjustment to the number of lines.

2.2.3 *(1/1/2022)*

The total number of spring lines is to be taken not less than:

- 2 spring lines for EN < 5000
- 4 spring lines for EN ≥ 5000

The Ship Design Minimum Breaking Load~~strength~~ of spring lines is to be the same as that of the head, stern and breast lines. If the number of head, stern and breast lines is increased in conjunction with an adjustment to the Ship Design Minimum Breaking Load~~strength~~ of the lines, the number of spring lines is to be taken as follows~~likewise increased~~, but rounded up to the nearest even number.

$$n_S^* = MBL_{SD}/MBL_{SD}^{**} \cdot n_S$$

where:

MBL_{SD}	:	is MBL_{SD} or MBL_{SD}^* defined in [2.1], as appropriate
n_S	:	number of spring lines as given above
n_S^*	:	increased number of spring lines

APPENDIX 3 DIRECT MOORING ANALYSES

1 General

1.1

1.1.1 *(1/1/2022)*

As an alternative to the prescriptive approach in Sec 4, [3.5.3] and [3.5.4], direct mooring analysis may be performed to determine the necessary mooring restraint, i.e. number and strength of mooring lines.

Direct analyses allow to optimize mooring equipment and arrangement for the individual ship and the port mooring facilities typical for the considered ship type and size.

2 Documentation

2.1

2.1.1 *(1/1/2022)*

The calculations are to be documented in a report. The report is to include all assumptions made in calculations for the finally chosen mooring equipment, including lines, and its arrangement, reflected in the mooring arrangement plan as required by Sec 4, [3.1.17].

3 Analysis methodology

3.1

3.1.1 *(1/1/2022)*

Three dimensional quasi-static calculations is to be performed to determine the acting mooring line forces. As a minimum, loads from wind and current is to be accounted for in the analysis. Geometrical and material non linearities of mooring lines and fenders or breasting dolphins are to be considered. An iterative calculation procedure is to be applied to arrive at a converged solution with forces acting on mooring lines and on fenders or breasting dolphins being in equilibrium with forces and moments applied to the ship.

4 Environmental conditions

4.1

4.1.1 *(1/1/2022)*

Mooring line forces are to be calculated for environmental conditions given in Sec 4, [3.5.4]. Additional loads, e.g. wave loads or cross currents, or increased wind and current loads are to be considered for certain ship types or for specific ports intended to be regularly called.

5 Steps to be taken in a direct mooring analysis

5.1

5.1.1 *(1/1/2022)*

Direct assessment of mooring forces and determination of the necessary number and strength of mooring lines comprise the following steps:

a) Determine port mooring facilities representative for the considered ship type and size

b) Determine shipboard mooring equipment and arrangement

c) Determine mooring line type(s) to be used

d) Determine mooring layout(s) to be assessed

e) Determine ship loading condition(s) to be assessed

f) Select or determine wind and current drag coefficients

g) Determine wind and current forces and moments

h) Compute forces acting on all mooring line

i) Determine necessary strength of mooring lines

j) If strength of mooring lines should be altered, modify steps b), c) and/or d) with or without changing the number of mooring lines and repeat steps h) and i).

6 Port mooring facilities

6.1

6.1.1 *(1/1/2022)*

Characteristics of port mooring facilities have strong influence on the resulting mooring line forces. Mooring analysis is to be performed for port mooring facilities representative for the considered ship type and size, i.e. type of berth, type and arrangement of hooks/bollards, type and arrangement of fenders or breasting dolphins and height of pier above waterline.

Fenders or breasting dolphins in many cases may not affect the critical mooring line loads. Hence, initially, generic fender or dolphin arrangements and infinitely stiff load deformation characteristics are to be considered. If no fender or dolphin loads occur for load cases yielding the critical mooring line loads, more specific fender or dolphin arrangements and characteristics are to be omitted.

If there are substantially different port mooring facilities typically encountered by the considered ship type, additional calculations are to be performed to consider these variations.

7 Shipboard mooring equipment and arrangement

7.1

7.1.1 (1/1/2022)

The mooring equipment and arrangement is to be chosen for the mooring analysis, i.e. location of mooring decks and location of mooring winches and fairleads. As a starting point, mooring equipment for the number of lines as determined by the prescriptive approach is to be chosen, (see App 2 [2.2]).

8 Mooring lines

8.1

8.1.1 (1/1/2022)

The mooring analysis is to apply the mooring line type(s) intended to be supplied with the vessel. The geometrical and material nonlinearities of the mooring lines are to be considered by the mooring analysis. Load-deflection characteristics of mooring lines are to be taken from data sheets of rope manufacturers. If given, characteristics of the broken-in ropes are to be applied.

To achieve a good distribution of mooring line forces, mooring line type and characteristics are to be at least same for lines in the same service, e.g. for head and stern lines, breast lines and spring lines. For very stiff mooring lines, e.g. made of steel or high modulus synthetic fibers, the use of elastic tails is to be considered to enhance the elasticity in the mooring system and taken into account for the mooring analysis.

9 Mooring layout

9.1

9.1.1 (1/1/2022)

For the assessment of forces acting on mooring lines, a realistic mooring layout is to be assumed, i.e. for each mooring line it is to be determined from which bollard or winch, along which path, through which fairlead it is led and to which shoreside hook or bollard it is connected. Inboard parts of the mooring lines (between fairlead and shipboard fixation point) contribute to the elongation behavior of the line and are to be included in the analysis.

The maximum number of lines connected to one shore mooring point are to be limited to not load the shore side mooring points unrealistically high. For multipurpose piers the number of lines per shore bollard are to be limited to three. For other types of berths, the number mooring lines per shore mooring point is also limited, e.g., by the available number of hooks. Reasonable assumptions are to be made based on typical berth types encountered by the considered ship type.

Alternative mooring layouts are to also be assessed, considering possible and reasonable options to moor the ship to the assumed port mooring facilities. Also, a different position of the ship relative to the shoreside mooring bollards/hooks is to be assessed to find the critical mooring line loads for the normal operation of the ship. Exemptions may be given to e.g. tankers, LNG carriers or ferries if typically moored in the same position relative to the shoreside mooring facilities.

10 Loading conditions

10.1

10.1.1 (1/1/2022)

Mooring line forces are to be calculated for loading conditions given in Sec 4, [3.5.4].

11 Wind and current drag coefficients

11.1

11.1.1 (1/1/2022)

To calculate the wind and current forces and moments acting on the ship, wind and current drag coefficients are needed for the considered ship type, size and loading condition. Drag coefficients are to be as specific as possible for the considered ship and loading conditions.

There are different sources for drag coefficients. Some Industry Guidelines provide drag coefficients for tankers and LNG carriers which are to be applied. Due to the similarity of hull forms and superstructures, these coefficients are also to be used for bulk carriers and ore carriers. For other ship types drag coefficients are to be taken from the literature, if available, or are to be determined by CFD calculations or model tests. CFD calculations are to be justified with suitable validation and sensitivity studies.

There are some effects that can influence the drag coefficients, i.e. blockage (limited under keel clearance, solid quay walls), ship draft and wind shielding by solid quays and buildings or cargo stored on quays (e.g. container stacks). Effects from blockage and ship draft can only be accounted for by appropriate coefficients. Drag coefficient is to be chosen or determined for realistic water depth to draft ratios and for the considered ship draft(s). Some Industry Guidelines provide current drag coefficients for ballast and loaded draft conditions and for different water depth to draft ratios. Wind shielding effects are typically not considered by the wind drag coefficients. The effect of wind shielding of solid quays is to be considered by an equivalent reduction of the lateral wind area of the ship. Shielding by buildings or cargo stored on quays is not to be considered as their presence is imponderable.

12 Calculation of wind and current forces and moments

12.1

12.1.1 (1/1/2022)

Wind and current forces and moments are to be calculated for the given environmental conditions with the geometrical particulars of the considered ship and the selected drag coefficients. Usually, the forces in longitudinal and transversal directions as well as the moment about the vertical ship axis (yaw) are calculated.

Wind forces and moments are to be calculated for all directions in intervals of preferably 15°, but not more than 30°. Current forces and moments are to be calculated for selected directions as per Sec 4, [3.5.4]. For ships regularly moored to non-solid piers or jetties, cross current is to be considered in addition.

13 Calculation of mooring line forces

13.1

13.1.1 *(1/1/2022)*

For all considered scenarios and all combinations of applied environmental conditions, the maximum mooring line force is to be determined for groups of lines in the same service.

In case of all lines are intended to be attached to winches, brake rendering is to be considered to better distribute line loads among all lines in a group of lines in the same service. Then, the average mooring line force of a group of lines is to be determined and taken as mooring line force used to determine the necessary strength of the mooring lines according to [14].

14 Strength of mooring lines

14.1

14.1.1 *(1/1/2022)*

The necessary strength of mooring lines, i.e., the Ship Design Minimum Breaking Load (MBL_{SD}), results from the calculated maximum mooring line force ($F_{L,\ max}$) divided by the Work Load Limit (WLL) factor of mooring lines. The WLL factor and the resulting MBL_{SD} for different mooring line materials are shown in Tab 1.

Table 1 :

Mooring line material	WLL factor	MBL_{SD}
Steel wire	0,55	$1,82 \cdot F_{L,\ max}$
Synthetic fibers	0,5	$2,0 \cdot F_{L,\ max}$

All lines supplied to the ship are to have the same characteristics and strength to avoid confusion of lines. However, for significantly different maximum calculated line loads, lines in different service are also to have different strength and characteristics, e.g. for head and stern lines other than for spring lines.

SECTION 10 PIPING SYSTEMS

1 General

1.1 Application

1.1.1

a) General requirements applying to all piping systems are contained in:
- [2] for their design and construction
- [3] for the welding of steel pipes
- [4] for the bending of pipes
- [5] for their arrangement and installation
- [21] for their certification, inspection and testing.

b) Specific requirements for ship piping systems and machinery piping systems are given in Articles [6] to [19].

1.2 Documentation to be submitted

1.2.1 Documents

The documents listed in Tab 1 are to be submitted.

1.2.2 Additional information

The information listed in Tab 2 is also to be submitted.

Table 1 : Documents to be submitted

No.	I/A **(1)**	Document **(2)**
1	A	Drawing showing the arrangement of the sea chests and ship side valves
2	A	Diagram of the bilge and ballast systems (in and outside machinery spaces)
3	A	Specification of the central priming system intended for bilge pumps, when provided
4	A	Diagram of the scuppers and sanitary discharge systems
5	A	Diagram of the air, sounding and overflow systems
6	A	Diagram of cooling systems (sea water and fresh water)
7	A	Diagram of fuel oil system
8	A	Drawings of the fuel oil tanks not forming part of the ship's structure
9	A	Diagram of the lubricating oil system
10	A	Diagram of the thermal oil system
11	A	Diagram of the hydraulic systems intended for essential services or located in machinery spaces
12	A	Diagram of steam system, including safety valve exhaust and drain pipes
13	 A I	For high temperature steam pipes: • stress calculation note • drawing showing the actual arrangement of the piping in three dimensions
14	A	Diagram of the boiler feed water and condensate system
15	A	Diagram of the compressed air system
16	A	Diagram of the hydraulic and pneumatic remote control systems
17	A	Diagram of the remote level gauging system
18	I	Diagram of the exhaust gas system
19	A	Diagram of drip trays and gutterway draining system
20	A	Diagram of the oxyacetylene welding system
21	A	Drawings and specification of valves and accessories, where required in [2.7]

(1) A = to be submitted for approval, in four copies;
I = to be submitted for information, in duplicate.
(2) Diagrams are also to include, where applicable, the (local and remote) control and monitoring systems and automation systems.

20 Exhaust gas treatment systems

20.1 Application

20.1.1 *(1/1/2018)*

This Article applies to:

- exhaust gas cleaning systems (scrubbers)
- selective catalytic reduction (SCR) systems.

20.1.2 Applicability of other Rules *(1/4/2021)*

Exhaust gas treatment systems are regarded as non-essential services, therefore:

- redundancy is not necessary, and
- testing of materials and components is to be in compliance with the requirements for equipment intended non essential services.

  However, equipment intended to ensure the ship safety or essential to ensure personnel safety (such as but not limited to valves connected to the outer shell, sea water piping, pipes conveying hazardous substances, exhaust gas by-pass valves), is anyway to be inspected and tested as requested for equipment intended for essential services.

20.2 Efficiency

20.2.1 *(1/1/2018)*

When the additional class notations "**EGCS-Sox**" or "**EGCS NOx**" are issued, the efficiency of the equipment is to be certified against the requirements of the latest IMO Guidelines published at the Building Contract date.

20.3 Exhaust ducting

20.3.1 *(1/1/2018)*

The parts of the Exhaust gas treatment systems containing exhaust gas are to be in compliance with [18].

When the exhaust gas treatment system may influence the operation of essential machinery, arrangements are to be made to ensure the continuity of the service concerned also in case of possible failures of the exhaust gas treatment system (e.g. exhaust gas bypasses are to be arranged, to enable continued operation of engine intended to drive single essential users in case of filters clogging by particulate matter).

20.4 Materials

20.4.1 *(1/1/2018)*

Materials used for equipment and piping systems are to be suitable with fluids conveyed, taking into account their chemical reactivity.

Aluminium and galvanized pipes are to be avoided for equipment and piping systems in contact with fluids containing sodium hydroxide or acids.

Copper is to be avoided for equipment and piping systems in contact with fluids containing ammonia.

20.5 Use of hazardous substances

20.5.1 *(1/1/2018)*

When hazardous substances are produced, or loaded and stored on board or anyway used in connection with exhaust gas treatment systems, the arrangements are to take into account the risks involved in such a production, loading, storage and use.

Substances containing products listed in the IMDG Code are to be regarded as hazardous substances, unless documented otherwise.

20.6 Use of reductants in SCR systems

20.6.1 Use of aqueous and anydrous ammonia *(1/1/2018)*

Aqueous and Anydrous ammonia are not to be used as a reductant in a SCR except where it can be demonstrated that it is not practicable to use a urea based reductant.

Use of Anydrous ammonia is to be agreed with the Flag Administration.

20.6.2 Use of urea based ammonia *(1/1/2022)*

Where urea based ammonia (e.g. AUS 40 - aqueous urea solution specified in ISO 18611-1:2014) is used, the storage tank is to be arranged so that any leakage will be contained and prevented from making contact with heated surfaces. All pipes or other tank penetrations are to be provided with manual closing valves attached to the tank. Tank and piping arrangements are to be approved.

The storage tank may be located within the engine room.

The storage tank is to be protected from excessively high or low temperatures applicable to the particular concentration of the solution. Depending on the operational area of the ship, this may necessitate the fitting of heating and/or cooling systems. The physical conditions recommended by applicable recognized standards (such as ISO 18611-3:2014) are to be taken into account to ensure that the contents of the aqueous urea tank are maintained to avoid any impairment of the urea solution during storage.

If a urea storage tank is installed in a closed compartment, the area is to be served by an effective mechanical ventilation system of extraction type providing not less than 6 air changes per hour which is independent from the ventilation system of accommodation, service spaces, or control stations. The ventilation system is to be capable of being controlled from outside the compartment. A warning notice requiring the use of such ventilation before entering the compartment shall be provided outside the compartment adjacent to each point of entry. These requirements also apply to closed compartments normally entered by persons:

- when they are adjacent to the urea integral tanks and there are possible leak points (e.g. manhole, fittings) from these tanks; or
- when the urea piping systems pass through these compartments, unless the piping system is made of steel or other equivalent material with melting point above 925 degrees C and with fully welded joints.

Alternatively, where a urea storage tank is located within an engine room a separate ventilation system is not required

APPENDIX 1 CHECK FOR SCANTLINGS OF CRANKSHAFTS FOR DIESEL ENGINES

1 General

1.1 Application

1.1.1

a) The requirements for the check of scantlings of crankshaft given in this Appendix apply to diesel engines as per Sec 2, [5.1.1] a) and b) capable of continuous operation of their maximum continuous power P as defined in Sec 2, [1.5.3], at the nominal maximum speed n.
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 these requirements.

b) The requirements of this Appendix apply only to solid forged and semi-built crankshafts of forged or cast steel, with one crankthrow between main bearings.

1.2 Documentation to be submitted

1.2.1

Required data for the check of the scantlings are indicated in the specific Society form as per item 1) of Sec 2, Tab 1.

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 journal diameter is equal to or larger than crankpin diameter, 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 (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 stresses

2.1 Calculation of alternating stresses due to bending moments and radial forces

2.1.1 Assumptions

The calculation is based on a statically determined system, composed of a single crankthrow 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 mid-points (distance L_3, see Fig 1).

The bending moments M_{BR}, M_{BT} are calculated in the relevant section based on triangular bending moment diagrams due to the radial component F_R and tangential component F_T of the connecting rod force, respectively (see Fig 1a)).

For crankthrows 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 1b)).

a) 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) 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. This reference section results from the web thickness W and the web width B (see Fig 2).

Mean stresses are disregarded.

b) Bending acting in outlet of crankpin oil bore

The two relevant bending moments are taken in the crankpin cross-section through the oil bore (see Fig 3).

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 disregarded.

γ_T [-] : stress concentration factor for torsion in the outlet of the crankpin oil bore (determination- see [3])

τ_N [N/mm²]: nominal alternating torsional stress related to crankpin diameter.

3 Evaluation of stress concentration factors

3.1 General

3.1.1 *(1/7/2018)*

The stress concentration factors are evaluated by means of the formulae according to items [3.2], [3.3] and [3.4] 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 noted 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 (SCF), the calculation method detailed in [9] may be undertaken.

All crank dimensions necessary for the calculation of stress concentration factors are shown in Fig 4 and Tab 1.

The stress concentration factor for bending (α_B, β_B) is defined as the ratio of the maximum equivalent stress (VON MISES) - occurring in the fillets under bending load - to the nominal bending stress related to the web cross-section (see Tab 4).

The stress concentration factor for compression (β_Q) in the journal fillet is defined as the ratio of the maximum equivalent stress (VON MISES) - occurring in the fillet due to the radial force - to the nominal compressive stress related to the web cross-section.

The stress concentration factor for torsion (α_T, β_T) is 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 (see Tab 4).

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 (see Tab 5).

When reliable measurements and/or calculations are available, which can allow direct assessment of stress concentration factors, the relevant documents and their method of analysis are to be submitted to the Society in order to demonstrate their equivalence to the present Rule evaluation. This is always to be performed when dimensions are outside of any of the validity ranges for the empirical formulae presented in [3.2] to [3.4].

Item [9] and [12] describes how FE analyses can be used for the calculation of the stress concentration factors. Care should be taken to avoid mixing equivalent (von Mises) stresses and principal stresses.

Figure 4 : Crank dimensions

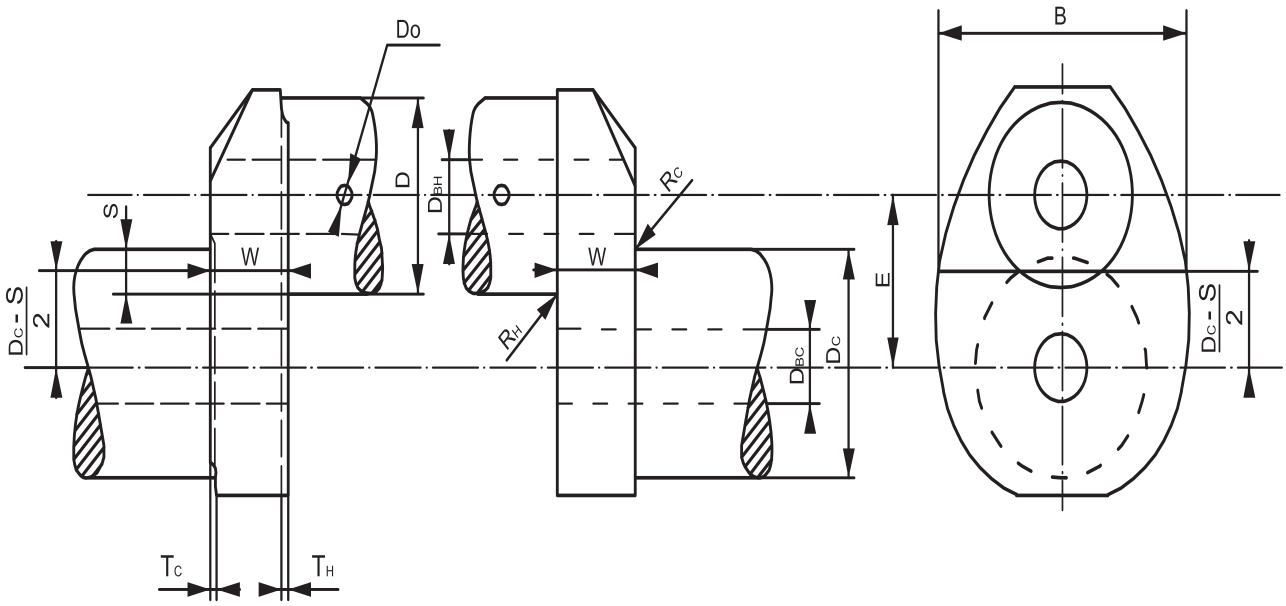


Table 1 : Actual dimensions

D	[mm]	crankpin diameter
D_{BH}	[mm]	diameter of axial bore in crankpin
D_O	[mm]	diameter of oil bore in crankpin
R_H	[mm]	fillet radius of crankpin
T_H	[mm]	recess of crankpin fillet
D_G	[mm]	journal diameter
D_{BG}	[mm]	diameter of axial bore in journal
R_G	[mm]	fillet radius of journal
T_G	[mm]	recess of journal fillet
E	[mm]	pin eccentricity
S	[mm] $S = \frac{D + D_G}{2} - E$	pin overlap
W (*)	[mm]	web thickness
B (*)	[mm]	web width
(*) In the case of 2-stroke semi-built crankshafts: • when $T_H > R_H$, the web thickness is to be considered as equal to : $W_{red} = W - (T_H - R_H)$ [refer to Fig 2] • web width B is to be taken in way of the crankpin fillet radius centre according to Fig 2		

The related dimensions in Tab 2 will be applied for the calculation of stress concentration factors in the crankpin fillet and in the journal fillet.

Table 2 : Related dimensions

Crankpin fillet	Journal fillet
$r = R_H / D$	$r = R_G / D$
s	= S/D
w	= W/D crankshafts with overlap W_{red}/D crankshafts without overlap
b	= B/D
d_o	= D_o/D
d_G	= D_{BG}/D
d_H	= D_{BH}/D
t_H	= T_H/D
t_G	= T_G/D

Stress concentration factors are valid for the ranges of related dimensions for which the investigations have been carried out. Ranges are as follows:

$S \leq 5$

$0,2 \leq w \leq 0,8$

$1,1 \leq b \leq 2,2$

$0,03 \leq r \leq 0,13$

$0 \leq d_G \leq 0,8$

$0 \leq d_H \leq 0,8$

$0 \leq d_o \leq 0,2$

Low range of s can be extended down to large negative values provided that:

- If calculated f (recess) < 1 then the factor f (recess) is not to be considered (f (recess) = 1)
- If s < - 0,5 then f (s,w) and f (r,s) are to be evaluated replacing the actual value of s by - 0,5.

3.2 Crankpin fillet

3.2.1 *(1/1/2022)*

The stress concentration factor for bending (α_B) is :

$$\alpha_B = 2,6914 \cdot f(s,w) \cdot f(w) \cdot f(b) \cdot f(r) \cdot f(d_G) \cdot f(d_H) \cdot f(recess)$$

where:

$$f(s,w) = -4,1883 + 29,2004 \cdot w - 77,5925 \cdot w^2 + 91,9454 \cdot w^3 - 40,0416 \cdot w^4 + (1-s) \cdot (9,5440 - 58,3480 \cdot w + 159,3415 \cdot w^2 - 192,5846 \cdot w^3 + 85,2916 \cdot w^4) + (1-s)^2 \cdot (-3,8399 + 25,0444 \cdot w - 70,5571 \cdot w^2 + 87,0328 \cdot w^3 - 39,1832 \cdot w^4)$$

$$f(w) = 2,1790 \cdot w^{0,7171}$$

$$f(b) = 0,6840 - 0,0077 \cdot b + 0,1473 \cdot b^2$$

$$f(r) = 0,2881 \cdot r^{(-0,5231)}$$

$$f(r) = 0,2081 \cdot r^{(-0,5231)}$$

$$f(d_G) = 0,9993 + 0,27 \cdot d_G - 1,0211 \cdot d^2_G + 0,5306 \cdot d^3_G$$

$$f(d_H) = 0,9978 + 0,3145 \cdot d_H - 1,5241 \cdot d^2_H + 2,4147 \cdot d^3_H$$

$$f(recess) = 1 + (t_H + t_G) \cdot (1,8 + 3,2 \cdot s)$$

The stress concentration factor for torsion (α_T) is :

$$\alpha_T = 0,8 \cdot f(r,s) \cdot f(b) \cdot f(w)$$

where:

$$f(r,s) = r^{(-0,322 + 0,1015 \cdot (1-s))}$$

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SECTION 3 SYSTEM DESIGN

1 Supply systems and characteristics of the supply

1.1 Supply systems

1.1.1 The following distribution systems may be used:

a) on d.c. installations:
- two-wire insulated
- two-wire with one pole earthed

b) on a.c. installations:
- three-phase three-wire with neutral insulated
- three-phase three-wire with neutral directly earthed or earthed through an impedance
- three-phase four-wire with neutral directly earthed or earthed through an impedance
- single-phase two-wire insulated
- single-phase two-wire with one phase earthed.

1.1.2 Distribution systems other than those listed in [1.1.1] (e.g. with hull return, three-phase four-wire insulated) will be considered by the Society on a case by case basis.

1.1.3 The hull return system of distribution is not to be used for power, heating or lighting in any ship of 1600 tons gross tonnage and upwards.

1.1.4 The requirement of [1.1.3] does not preclude under conditions approved by the Society the use of:

a) impressed current cathodic protective systems,

b) limited and locally earthed systems, or

c) insulation level monitoring devices provided the circulation current does not exceed 30 mA under the most unfavourable conditions.

Note 1: Limited and locally earthed systems such as starting and ignition systems of internal combustion engines are accepted provided that any possible resulting current does not flow directly through any dangerous spaces.

1.1.5 For the supply systems of ships carrying liquid developing combustible gases or vapours, see Pt E, Ch 7, Sec 5, Pt E, Ch 8, Sec 10 or Pt E, Ch 9, Sec 10.

1.1.6 For the supply systems in HV Installations, see Sec 13.

1.2 Maximum voltages

1.2.1 The maximum voltages for both alternating current and direct current low-voltage systems of supply for the ship's services are given in Tab 1.

Table 1 : Maximum voltages for various ship services

Use		Maximum voltage, in V
For permanently installed and connected to fixed wiring	Power equipment	1000
	Heating equipment (except in accommodation spaces)	500
	Cooking equipment	500
	Lighting	250
	Space heaters in accommodation spaces	250
	Control **(1)**, communication (including signal lamps) and instrumentation equipment	250
For permanently installed and connected by flexible cable	Power and heating equipment, where such connection is necessary because of the application (e.g. for moveable cranes or other hoisting gear)	1000
For socket-outlets supplying	Portable appliances which are not hand-held during operation (e.g. refrigerated containers) by flexible cables	1000
	Portable appliances and other consumers by flexible cables	250
	Equipment requiring extra precaution against electric shock where an isolating transformer is used to supply one appliance **(2)**	250
	Equipment requiring extra precaution against electric shock with or without a safety transformer **(2)**.	50

(1) For control equipment which is part of a power and heating installation (e.g. pressure or temperature switches for starting/stopping motors), the same maximum voltage as allowed for the power and heating equipment may be used provided that all components are constructed for such voltage. However, the control voltage to external equipment is not to exceed 500 V.
(2) Both conductors in such systems are to be insulated from earth.

2.3 Emergency source of electrical power

2.3.1 *A self-contained emergency source of electrical power shall be provided.*

2.3.2 *Provided that suitable measures are taken for safeguarding independent emergency operation under all circumstances, the emergency generator may be used, exceptionally, and for short periods, to supply non-emergency circuits.*

Exceptionally is understood to mean conditions, while the vessel is at sea, such as:

a) blackout situation

b) dead ship situation

c) routine use for testing

d) short-term parallel operation with the main source of electrical power for the purpose of load transfer.

Unless otherwise instructed by the Society, the emergency generator may be used during lay time in port for the supply of the ship mains, provided the requirements of [2.4] are complied with.

2.3.3 *The electrical power available shall be sufficient to supply all those services that are essential for safety in an emergency, due regard being paid to such services as may have to be operated simultaneously.*

2.3.4 *The emergency source of electrical power shall be capable, having regard to starting currents and the transitory nature of certain loads, of supplying simultaneously at least the services stated in* [3.7.3] *for the period specified, if they depend upon an electrical source for their operation.*

2.3.5 *The transitional source of emergency electrical power, where required, is to be of sufficient capacity to supply at least the services stated in* [3.7.7] *for half an hour, if they depend upon an electrical source for their operation.*

2.3.6 *An indicator shall be mounted in a suitable place on the main switchboard or in the machinery control room to indicate when the batteries constituting either the emergency source of electrical power or the transitional source of emergency electrical power referred to in* [2.3.13] *and* [2.3.14] *are being discharged.*

2.3.7 If the services which are to be supplied by the transitional source receive power from an accumulator battery by means of semiconductor convertors, means are to be provided for supplying such services also in the event of failure of the convertor (e.g. providing a bypass feeder or a duplication of convertor).

2.3.8

Where electrical power is necessary to restore propulsion, the capacity of the emergency source shall be sufficient to restore propulsion to the ship in conjunction to other machinery as appropriate, from a dead ship condition within 30 min. after blackout.

For the purpose of this requirement only, the dead ship condition and blackout are both understood to mean a condition under which the main propulsion plant, boilers and auxiliaries are not in operation and in restoring the propulsion, no stored energy for starting the propulsion plant, the main source of electrical power and other essential auxiliaries is to be assumed available. It is assumed that means are available to start the emergency generator at all times.

The emergency generator and other means needed to restore the propulsion are to have a capacity such that the necessary propulsion starting energy is available within 30 minutes of blackout/dead ship condition as defined above. Emergency generator stored starting energy is not to be directly used for starting the propulsion plant, the main source of electrical power and/or other essential auxiliaries (emergency generator excluded).

For steam ships, the 30 minute time limit given in SOLAS Convention can be interpreted as time from blackout/dead ship condition defined above to light-off the first boiler.

For passenger ships not engaged in international voyages and cargo ships of less than 500 gross tonnage or of 500 gross tonnage and upwards not engaged in international voyages, the 30 minute time limit does not apply.

2.3.9 *Provision shall be made for the periodic testing of the complete emergency system and shall include the testing of automatic starting arrangements,* where provided.

2.3.10 For starting arrangements for emergency generating sets, see Ch 1, Sec 2, [5.1].

2.3.11 *The emergency source of electrical power may be either a generator or an accumulator battery which shall comply with the requirements of* [2.3.12] *or* [2.3.13], *respectively.*

2.3.12 *Where the emergency source of electrical power is a generator, it shall be:*

a) *driven by a suitable prime mover with an independent supply of fuel, having a flashpoint (closed cup test) of not less than 43°C;*

b) *started automatically upon failure of the main source of electrical power supply* to the emergency switchboard *unless a transitional source of emergency electrical power in accordance with (c) below is provided; where the emergency generator is automatically started, it shall be automatically connected to the emergency switchboard; those services referred to in* [3.7.7] *shall then be connected automatically to the emergency generator; and*

c) *provided with a transitional source of emergency electrical power as specified in* [2.3.14] *unless an emergency generator is provided capable both of supplying the services mentioned in that paragraph and of being automatically started and supplying the required load as quickly as is safe and practicable subject to a maximum of 45 s.*

2.3.13 *Where the emergency source of electrical power is an accumulator battery it shall be capable of:*

a) *carrying the emergency electrical load without recharging while maintaining the voltage of the battery through-*

out the discharge period within 12% above or below its nominal voltage;

b) *automatically connecting to the emergency switchboard in the event of failure of the main source of electrical power; and*

c) *immediately supplying at least those services specified in* [3.7.7].

2.3.14 *The transitional source of emergency electrical power where required by* [2.3.12] (item c) *shall consist of an accumulator battery which shall operate without recharging while maintaining the voltage of the battery throughout the discharge period within 12% above or below its nominal voltage and be so arranged as to supply automatically in the event of failure of either the main or the emergency source of electrical power for half an hour at least the services in* [3.7.7] *if they depend upon an electrical source for their operation.*

2.3.15 For the emergency source of electrical power in passenger ships, see Pt E, Ch 11, Sec 5.

2.3.16 *(1/1/2022)*

When the emergency generator room ventilation system is fitted with closable ventilation louvers and ventilator closing appliances~~closing appliances (dampers or lovers)~~, the following requirements apply:

a) ventilation louvers and closing appliances may either be hand-operated or power-operated (hydraulic / pneumatic / electric) and are to be operable under a fire condition;

b) hand-operated ventilation louvers and closing appliances are to be kept open during normal operation of the vessel. Corresponding instruction plates are to be provided at the location where hand-operation is provided;

c) power-operated ventilation louvers and closing appliances are to be of a fail-to-open type~~,~~. Closed power-operated ventilation louvers and closing appliances are acceptable~~and may be kept closed~~ during normal operation of the vessel;

d) power-operated ventilation louvers and closing appliances are to open automatically whenever the emergency generator is starting / in operation;

e) it is to be possible to close ventilation openings by a manual operation from a clearly marked safe position outside the space, where the closing operation can be easily confirmed. The louver status (open / closed) shall be indicated at this position. Such closing shall not be possible from any other remote position.

2.4 Use of emergency generator in port

2.4.1 To prevent the generator or its prime mover from becoming overloaded when used in port, arrangements are to be provided to shed sufficient non-emergency loads to ensure its continued safe operation.

2.4.2 The prime mover is to be arranged with fuel oil filters and lubrication oil filters, monitoring equipment and protection devices as requested for the prime mover for main power generation and for unattended operation.

2.4.3 The fuel oil supply tank to the prime mover is to be provided with a low level alarm, arranged at a level ensuring sufficient fuel oil capacity for the emergency services for the period of time as required in [3.7].

2.4.4 The prime mover is to be designed and built for continuous operation and should be subjected to a planned maintenance scheme ensuring that it is always available and capable of fulfilling its role in the event of an emergency at sea.

2.4.5 Fire detectors are to be installed in the location where the emergency generator set and emergency switchboard are installed.

2.4.6 Means are to be provided to readily change over to emergency operation.

2.4.7 Control, monitoring and supply circuits for the purpose of the use of the emergency generator in port are to be so arranged and protected that any electrical fault will not influence the operation of the main and emergency services.

When necessary for safe operation, the emergency switchboard is to be fitted with switches to isolate the circuits.

2.4.8 Instructions are to be provided on board to ensure that, even when the vessel is underway, all control devices (e.g. valves, switches) are in a correct position for the independent emergency operation of the emergency generator set and emergency switchboard.

These instructions are also to contain information on the required fuel oil tank level, position of harbour/sea mode switch, if fitted, ventilation openings, etc.

3 Distribution

3.1 Earthed distribution systems

3.1.1 System earthing is to be effected by means independent of any earthing arrangements of the non-current-carrying parts.

3.1.2 Means of disconnection are to be fitted in the neutral earthing connection of each generator so that the generator may be disconnected for maintenance or insulation resistance measurements.

3.1.3 Generator neutrals may be connected in common, provided that the third harmonic content of the voltage wave form of each generator does not exceed 5%.

3.1.4 Where a switchboard is split into sections operated independently or where there are separate switchboards, neutral earthing is to be provided for each section or for each switchboard. Means are to be provided to ensure that the earth connection is not removed when generators are isolated.

3.1.5 Where for final sub-circuits it is necessary to locally connect a pole (or phase) of the sub-circuits to earth after the protective devices (e.g. in automation systems or to avoid electromagnetic disturbances), provision (e.g. d.c./d.c. convertors or transformers) is to be made such that

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The protective devices are to be placed as near as possible to the tapping from the supply.

The secondary side of current transformers is not to be protected.

7.13.2 Control circuits and control transformers are to be protected against overload and short-circuit by means of multipole circuit-breakers or fuses on each pole not connected to earth.

Overload protection may be omitted for transformers with a rated current of less than 2 A on the secondary side.

The short-circuit protection on the secondary side may be omitted if the transformer is designed to sustain permanent short-circuit current.

7.13.3 Where a fault in a pilot lamp would impair the operation of essential services, such lamps are to be protected separately from other circuits such as control circuits.

Note 1: Pilot lamps connected via short-circuit-proof transformers may be protected in common with control circuits.

7.13.4 Circuits whose failure could endanger operation, such as steering gear control feeder circuits, are to be protected only against short-circuit.

7.13.5 The protection is to be adequate for the minimum cross-section of the protected circuits.

7.14 Protection of transformers

7.14.1 The primary winding side of power transformers is to be protected against short-circuit and overload by means of multipole circuit-breakers or switches and fuses.

Overload protection on the primary side may be dispensed with where it is provided on the secondary side or when the total possible load cannot reach the rated power of the transformer.

7.14.2 The protection against short-circuit is to be such as to ensure the selectivity between the circuits supplied by the secondary side of the transformer and the feeder circuit of the transformer.

7.14.3 When transformers are arranged to operate in parallel, means are to be provided so as to trip the switch on the secondary winding side when the corresponding switch on the primary side is open.

8 System components

8.1 General

8.1.1 The components of the electrical system are to be dimensioned such as to withstand the currents that can pass through them during normal service without their rating being exceeded.

8.1.2 The components of the electrical system are to be designed and constructed so as to withstand for the admissible duration the thermal and electrodynamic stresses caused by possible overcurrents, including short-circuit.

9 Electrical cables

9.1 General

9.1.1 *All electrical cables and wiring external to equipment shall be at least of a flame-retardant type,* in accordance with IEC Publication 60332-1.

9.1.2 In addition to the provisions of [9.1.1], when cables are laid in bundles, cable types are to be chosen in compliance with IEC Publication 60332-3 Category A, or other means (see Sec 12) are to be provided such as not to impair their original flame-retarding properties.

9.1.3 Where necessary for specific applications such as radio frequency or digital communication systems, which require the use of particular types of cables, the Society may permit the use of cables which do not comply with the provisions of [9.1.1] and [9.1.2].

9.1.4

Cables which are required to have fire-resisting characteristics are to comply with the requirements stipulated in [9.6].

9.2 Choice of insulation

9.2.1 The maximum rated operating temperature of the insulating material is to be at least 10°C higher than the maximum ambient temperature liable to occur or to be produced in the space where the cable is installed.

9.2.2 The maximum rated conductor temperature for normal and short-circuit operation, for the type of insulating compounds normally used for shipboard cables, is not to exceed the values stated in Tab 4. Special consideration will be given to other insulating materials.

9.2.3 PVC insulated cables are not to be used either in refrigerated spaces, or on decks exposed to the weather of ships classed for unrestricted service.

9.2.4 Mineral insulated cables will be considered on a case by case basis.

9.3 Choice of protective covering

9.3.1 The conductor insulating materials are to be enclosed in an impervious sheath of material appropriate to the expected ambient conditions where cables are installed in the following locations:

- on decks exposed to the weather,
- in damp or wet spaces (e.g. in bathrooms),
- in refrigerated spaces,
- in machinery spaces and, in general,
- where condensation water or harmful vapour may be present.

9.3.2 Where cables are provided with armour or metallic braid (e.g. for cables installed in hazardous areas), an overall impervious sheath or other means to protect the metallic elements against corrosion is to be provided; see Sec 9, [1.5].

9.3.3 An impervious sheath is not required for single-core cables installed in tubes or ducts inside accommodation spaces, in circuits with maximum system voltage 250 V.

9.3.4 In choosing different types of protective coverings, due consideration is to be given to the mechanical action to which each cable may be subjected during installation and in service.

If the mechanical strength of the protective covering is considered insufficient, the cables are to be mechanically protected (e.g. by an armour or by installation inside pipes or conduits).

9.3.5 Single-core cables for a.c. circuits with rated current exceeding 20 A are to be either non-armoured or armoured with non-magnetic material.

9.4 Cables in refrigerated spaces

9.4.1 Cables installed in refrigerated spaces are to have a watertight or impervious sheath and are to be protected against mechanical damage. If an armour is applied on the sheath, the armour is to be protected against corrosion by a further moisture-resisting covering.

9.5 Cables in areas with a risk of explosion

9.5.1 For cables in areas with a risk of explosion, see [10].

9.6 Electrical services required to be operable under fire conditions and fire-resistant cables

9.6.1

Electrical services required to be operable under fire conditions are as follows:

- Control and power systems to power-operated fire doors and status indication for all fire doors
- Control and power systems to power-operated watertight doors and their status indication
- Emergency fire pump
- Emergency lighting
- Fire and general alarms
- Fire detection systems
- Fire-extinguishing systems and fire-extinguishing media release alarms
- Low location lighting
- Public address systems
- Remote emergency stop/shutdown arrangements for systems which may support the propagation of fire and/or explosion.

9.6.2 *(1/1/2022)*

Where cables for services specified in [9.6.1] including their power supplies pass through high fire risk areas (see Note 1), and in addition for passenger ships, main vertical fire zones, other than those which they serve, they are to be so arranged that a fire in any of these areas or zones does not affect the operation of the service in any other area or zone. This may be achieved by either of the following measures:

a) Cables being of a fire-resistant type complying with IEC 60331-1 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 installed and run continuous to keep the fire integrity within the high fire risk area (see Fig 3).

b) At least two loops/radial distributions run as widely apart as is practicable and so arranged that in the event of damage by fire at least one of the loops/radial distributions remains operational.

Systems that are, fail safe or duplicated with cable runs as widely separated as is practicable may be exempted.

Note 1:

a) For the purpose of application of this item [9.6], the definition of "high fire risk areas" is the following:

(1) Machinery spaces as defined by ~~Chapter 4~~Regulation 3.30 of SOLAS Chapter II-2, as amended by IMO resolutions up to MSC.421(98) (hereinafter the same), except spaces having little or no fire risk as defined by paragraph (10) of ~~Chap. II-2 /~~ Reg~~.~~ulation 9.2.2.3.2.2 of SOLAS Chapter II-2 (including the interpretations for tables 9.3, 9.4, 9.5, 9.6, 9.7 and 9.8 given in MSC/Circ.1120 as amended by MSC.1/Circ.1436 and MSC.1/Circ.1510)

(2) Spaces containing fuel treatment equipment and other highly flammable substances

(3) Galley and Pantries containing cooking appliances

(4) Laundry containing drying equipment

(5) Spaces as defined by paragraphs (8), (12), and (14) of ~~Chap. II-2 /~~ Reg. 9.2.2.3.2.2 of SOLAS Chapter II-2 for ships carrying more than 36 passengers~~;~~

b) Fire-resistant type cables are to be easily distinguishable.

c) For special cables, requirements in the following standards may be used:

(1) IEC60331-23: Procedures and requirements - Electric data cables

(2) IEC60331-25: Procedures and requirements - Optical fibre cables.

9.6.3 *(1/1/2016)*

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 [9.6.2] a), where they pass through other high fire risk areas.

9.7 Cables for submerged bilge pumps

9.7.1 Cables and their connections to such pumps are to be capable of operating under a head of water equal to their distance below the bulkhead deck. The cable is to be impervious-sheathed and armoured, is to be installed in continuous lengths from above the bulkhead to the motor terminals and is to enter the air bell from the bottom.

Table 11 : Correction factors for short-time loads

½ -hour service		1-hour service		
Sum of nominal cross-sectional areas of all conductors in the cable, in mm²		Sum of nominal cross-sectional areas of all conductors in the cable, in mm²		Correlation factor
Cables with metallic sheath and armoured cables	Cables with non-metallic sheath and non-armoured cables	Cables with metallic sheath and armoured cables	Cables with non-metallic sheath and non-armoured cables	
up to 20	up to 75	up to 80	up to 230	1,06
21-41	76-125	81-170	231-400	1,10
41-65	126-180	171-250	401-600	1,15
66-95	181-250	251-430	601-800	1,20
96-135	251-320	431-600	-	1,25
136-180	321-400	601-800	-	1,30
181-235	401-500	-	-	1,35
236-285	501-600	-	-	1,40
286-350	-	-	-	1,45

Table 12 : Correction factors for intermittent service

Sun of nominal cross selectionel areas of all conductors in the cable, in mm²		Correction factor
Cables with metallic sheath and armoured cables	Cables without metallic sheath and non-amoured cables	
	S ≤ 5	1,10
	5 < S ≤ 8	1,15
	8 < S ≤ 16	1,20
S ≤ 4	16 < S ≤ 825	1,25
4 < S ≤ 7	25 < S ≤ 42	1,30
7 < S ≤ 17	42 < S ≤ 72	1,35
17 < S ≤ 42	72 < S ≤ 140	1,40
42 < S ≤ 110	140 < S	1,45
110 < S	-	1,50

10 Electrical installations in hazardous areas

10.1 Electrical equipment

10.1.1 No electrical equipment is to be installed in hazardous areas unless the Society is satisfied that such equipment is:

- essential for operational purposes,
- of a type which will not ignite the mixture concerned,
- appropriate to the space concerned, and
- appropriately certified for safe usage in the dusts, vapours or gases likely to be encountered.

10.1.2 Where electrical equipment of a safe type is permitted in hazardous areas it is to be selected with due consideration to the following:

a) risk of explosive dust concentration; see Sec 2, [6.2]:
   - degree of protection of the enclosure
   - maximum surface temperature

b) risk of explosive gas atmosphere; see Sec 2, [6.1]:
   - explosion group
   - temperature class.

10.1.3 Where electrical equipment is permitted in hazardous areas, all switches and protective devices are to interrupt all poles or phases and, where practicable, to be located in a non-hazardous area unless specifically permitted otherwise.

Such switches and equipment located in hazardous areas are to be suitably labelled for identification purposes.

10.1.4 For electrical equipment installed in Zone 0 hazardous areas, only the following types are permitted:

- certified intrinsically-safe apparatus Ex(ia)
- simple electrical apparatus and components (e.g. thermocouples, photocells, strain gauges, junction boxes, switching devices), included in intrinsically-safe circuits of category "ia" not capable of storing or generating electrical power or energy in excess of limits stated in the relevant rules, and accepted by the appropriate authority
- equipment specifically designed and certified by the appropriate authority for use in Zone 0.

Table 13 : Minimum nominal cross-sectional areas

Service	Nominal cross-sectional area	
	external wiring mm²	internal wiring mm²
Power, heating and lighting systems	1,0	1,0
Control circuits for power plant	1,0	1,0
Control circuits other than those for power plant	0,75	0,5
Control circuits for telecommunications, measurement, alarms	0,5	0,2
Telephone and bell equipment, not required for the safety of the ship or crew calls	0,2	0,1
Bus and data cables	0,2	0,1

10.1.5 For electrical equipment installed in Zone 1 hazardous areas, only the following types are permitted:

- any type that may be considered for Zone 0
- certified intrinsically-safe apparatus Ex(ib)
- simple electrical apparatus and components (e.g. thermocouples, photocells, strain gauges, junction boxes, switching devices), included in intrinsically-safe circuits of category "ib" not capable of storing or generating electrical power or energy in excess of limits stated in the relevant rules, and accepted by the appropriate authority
- certified flameproof Ex(d)
- certified pressurised Ex(p)
- certified increased safety Ex(e)
- certified encapsulated Ex(m)
- certified sand filled Ex(q)
- certified specially Ex(s)
- through runs of cable.

10.1.6 *(1/1/2022)*

For electrical equipment installed in Zone 2 hazardous areas, only the following types are permitted:

- any type that may be considered for Zone 1
- tested specially for Zone 2 (e.g. type "n" protection)
- pressurised, and accepted by the appropriate authority
- encapsulated, and accepted by the appropriate authority
- the type which ensures the absence of sparks and arcs and of "hot spots" during its normal operation (~~minimum class of protection~~electrical equipment having an enclosure of at least IP55).

10.1.7 When apparatus incorporates a number of types of protection, it is to be ensured that all are suitable for use in the zone in which it is located.

10.2 Electrical cables

10.2.1 Electrical cables are not to be installed in hazardous areas except as specifically permitted or when associated with intrinsically safe circuits.

10.2.2

All cables installed in Zone 0, Zone 1 and weather exposed areas classified Zone 2 are to be sheathed with at least one of the following:

a) a non-metallic impervious sheath in combination with braiding or other metallic covering

b) a copper or stainless steel sheath (for mineral insulated cables only).

10.2.3 All cables installed in non-weather exposed Zone 2 areas are to be provided with at least a non-metallic external impervious sheath.

10.2.4 Cables of intrinsically safe circuits are to have a metallic shielding with at least a non-metallic external impervious sheath.

10.2.5 The circuits of a category "ib" intrinsically safe system are not to be contained in a cable associated with a category "ia" intrinsically safe system required for a hazardous area in which only category "ia" systems are permitted.

10.3 Electrical installations in battery rooms

10.3.1

Only intrinsically safe apparatus and certified safe type lighting fittings may be installed in compartments assigned solely to large vented storage batteries; see Sec 11, [6.2.1].

The associated switches are to be installed outside such spaces.

Electric ventilator motors are to be outside ventilation ducts and, if within 3 m of the exhaust end of the duct, they are to be of an explosion-proof safe type. The impeller of the fan is to be of the non-sparking type.

Overcurrent protective devices are to be installed as close as possible to, but outside of, battery rooms.

Electrical cables other than those pertaining to the equipment arranged in battery rooms are not permitted.

Electrical equipment for use in battery rooms is to have minimum explosion group IIC and temperature class T1.

10.3.2 Standard marine electrical equipment may be installed in compartments assigned solely to valve-regulated sealed storage batteries.

10.3.3

Where vented (see Note 1) type batteries replace valve-regulated sealed (see Note 2) types, the requirements of Sec 11 are to be complied with.

Note 1: A vented battery is one in which the cells have a cover provided with an opening through which products of electrolysis and evaporation are allowed to escape freely from the cells to atmosphere.

Note 2: A valve-regulated battery is one in which cells are closed but have an arrangement (valve) which allows the escape of gas if the internal pressure exceeds a predetermined value.

10.4 Electrical equipment allowed in paint stores and in enclosed spaces leading to paint stores

10.4.1 General *(1/1/2022)*

Electrical equipment is to be installed in paint stores and in ventilation ducts serving such spaces only when it is essential for operational services

Certified safe type equipment of the following type is acceptable:

a) intrinsically safe Exi

b) flameproof Exd

c) pressurised Exp

d) increased safety Exe

e) special protection Exs

Cables (through-runs or terminating cables) of armoured type or installed in metallic conduits are to be used.

10.4.2 Minimum Requirements *(1/1/2022)*

The minimum requirements for certified safe type equipment are as follows:

- explosion group II B
- temperature class T3.

Note 1: The paint stores and inlet and exhaust ventilation ducts under [10.4.1] are classified as Zone 1 and areas on open deck under [10.4.3], b) as Zone 2, as defined in IEC 60092-502 (Electrical Installation in ships-part 502: Tankers-special features).

Note 2: A watertight door may be considered as being gas-tight.

10.4.3 Special requirements *(1/1/2022)*

a) Switches, protective devices and motor control gear of electrical equipment installed in a paint store are to interrupt all poles or phases and are preferably to be located in a non-hazardous space.

10.4.4

b) In areas on open deck within 1m of inlet and exhaust ventilation openings or within 3 m of exhaust mechanical ventilation outlets, the following electrical equipment may be installed:

- electrical equipment with the type of protection as permitted in paint stores ~~or~~;
- equipment of protection class Exn ~~or~~;
- appliances which do not generate arcs in service and whose surface does not reach unacceptably high temperature ~~or~~;
- appliances with simplified pressurised enclosures or vapour-proof enclosures (~~minimum class of protection~~ electrical equipment having an enclosure of at least IP55) whose surface does not reach unacceptably high temperature; or
- cables as specified in [10.4.1].

10.4.5

c) The enclosed spaces giving access to the paint store may be considered as non-hazardous, provided that~~-~~:

- the door to the paint store is a gas-tight door with self-closing devices without holding back arrangements,
- the paint store is provided with an acceptable, independent, natural ventilation system ventilated from a safe area, and
- warning notices are fitted adjacent to the paint store entrance stating that the store contains flammable liquids.

Note 1: ~~The paint stores and inlet and exhaust ventilation ducts under 10.4.4 are classified as Zone 1 and areas on open deck under 10.4.4 as Zone 2, as defined in IEC standard 60092 502, Electrical Installation in ships part 502: Tankers special features.~~

Note 2: ~~A watertight door may be considered as being gas-tight.~~

10.5 Electrical installations in stores for welding gas (acetylene) bottles

10.5.1 The following equipment may be installed in stores for welding gas bottles provided that it is of a safe type appropriate for Zone 1 area installation:

- lighting fittings
- ventilator motors where provided.

10.5.2 Electrical cables other than those pertaining to the equipment arranged in stores for welding gas bottles are not permitted.

10.5.3 Electrical equipment for use in stores for welding gas bottles is to have minimum explosion group IIC and temperature class T2.

10.6 Special ships

10.6.1 For installations in hazardous areas in:

- oil tankers, chemical tankers and liquefied gas carriers, see Pt E, Ch 7, Sec 5, Pt E, Ch 8, Sec 10 or Pt E, Ch 9, Sec 10
- ships arranged with spaces for the carriage of vehicles, see Pt E, Ch 1, Sec 4 or Pt E, Ch 12, Sec 4.

11 Recording of the Type, Location and Maintenance Cycle of Batteries

11.1 Battery schedule

11.1.1

Where batteries are fitted for use for essential and emergency services, a schedule of such batteries is to be compiled and maintained. The schedule, required in Sec 1,

SECTION 10 MISCELLANEOUS EQUIPMENT

1 Lighting fittings

1.1 Applicable requirements

1.1.1 Lighting fittings are to comply with IEC Publications 60598 and 60092-306.

Lighting fittings complying with other standards will be specially considered by the Society.

1.2 Construction

1.2.1 The temperature of terminals for connection of supplying cables is not to exceed the maximum conductor temperature permitted for the cable (see Sec 3, [9.9]).

Where necessary, luminaires are to be fitted with terminal boxes which are thermally insulated from the light source.

1.2.2 Wires used for internal connections are to be of a temperature class which corresponds to the maximum temperature within the luminaire.

1.2.3 The temperature rise of parts of luminaires which are in contact with the support is not to exceed 50°C. The rise is not to exceed 40°C for parts in contact with flammable materials.

1.2.4 The temperature rise of surface parts which can easily be touched in service is not to exceed 15°C.

1.2.5 High-power lights with higher surface temperatures than those in [1.2.2] and [1.2.3] are to be adequately protected against accidental contact.

2 Accessories

2.1 Applicable requirements

2.1.1 Accessories are to be constructed in accordance with the relevant IEC Publications, and in particular with Publication 60092-306.

2.2 Construction

2.2.1 Enclosures of accessories are to be of metal having characteristics suitable for the intended use on board, or of flame-retardant insulating material.

2.2.2 Terminals are to be suitable for the connection of stranded conductors, except in the case of rigid conductors for mineral-insulated cables.

3 Plug-and-socket connections

3.1 Applicable requirements

3.1.1 *(1/1/2022)*

Plug-and-socket connections are to comply with IEC Publication 60092-306 and with the following additional standards in relation to their use:

- in accommodation spaces, day rooms and service rooms (up to 16 A, 250 V a.c.): IEC Publication 60083 or 60320, as applicable
- for power circuits (up to 250 A, 690 V a.c.): IEC Publication 60309
- for electronic switchgear: IEC Publications, e.g. 60130 and 60603
- for refrigerated containers: ISO 1496-2
- for high voltage shore connections: IEC Publications 62613-1 ~~and 62613-2~~ (see Pt F, Ch 13, Sec 15).

4 Heating and cooking appliances

4.1 Applicable requirements

4.1.1 Heating and cooking appliances are to comply with the relevant IEC Publications (e.g. those of series 60335), with particular attention to IEC 60092-307.

4.2 General

4.2.1 Heating elements are to be enclosed and protected with metal or refractory material.

4.2.2 The terminals of the power supply cable are not to be subjected to a higher temperature than that permitted for the conductor of the connection cable.

4.2.3 The temperature of parts which are to be handled in service (switch knobs, operating handles and the like) is not to exceed the following values:

- 55°C for metal parts
- 65°C for vitreous or moulded material.

4.3 Space heaters

4.3.1 The casing or enclosure of heaters is to be so designed that clothing or other flammable material cannot be placed on them.

4.3.2 The temperature of the external surface of space heaters is not to exceed 60°C.

4.3.3 Space heaters are to be provided with a temperature limiting device without automatic reconnection which automatically trips all poles or phases not connected to

APPENDIX 2 BATTERY POWERED SHIPS

1 General

1.1 Application

1.1.1 *(1/1/2022)*

The provisions of this Appendix apply to ships where batteries, other than Lead and Nickel-Cadmium and Nickel-Metal-Hydride batteries, are installed to supply essential or not-essential services and emergency services, except batteries embedded in consumer products like computers and similar appliances.

1.1.2 *(1/1/2019)*

The requirements in this Appendix are applicable to installations with a variety of lithium battery chemistry; since the battery technology is under development, additional requirements may be required by the Society on a case by case basis.

1.1.3 *(1/1/2022)*

The Society may consider different ~~requirements from~~arrangements than those stated in this Appendix, provided that they ensure an equivalent level of safety, to be demonstrated by appropriate risk analysis techniques.

1.2 Definitions

1.2.1 *(1/1/2022)*

The following definitions and abbreviations are additional to those given in the other Parts of the Rules:

- Battery Management System (BMS): an electronic system that controls and monitors the state of the batteries by protecting the batteries from operating outside its safe operating area.
- Energy Management System (EMS): a system providing monitoring and control of the energy.
- Cell: an individual electrochemical unit of a battery consisting of electrodes, separators, electrolyte, container and terminals.
- Battery: assembly of cells ready for use as storage of electrical energy characterized by its voltage, size terminal arrangement, capacity and rate capability.
- Battery space: compartments (rooms, lockers or boxes) used primarily for accommodation of ~~lithium~~ batteries ~~properly constructed and efficiently ventilated and cooled in such a way to keep the battery system at a specified set of environmental conditions~~.
- Battery system: the ~~whole~~ battery installation including battery banks, electrical interconnections, BMS and other safety features.
- Module: group of cells connected together either in a series and/or parallel configuration.
- State of Charge (SOC): state of charge ~~in~~expressed as a percentage of the rated capacity giving an indication of the energy available ~~for the discharge of~~ from the battery.
- State of Health (SOH): general condition of a battery, including its ability to deliver the specified performance compared with a new battery.
- Venting: release of excessive internal pressure from a cell/battery in a manner intended by design to preclude rupture or explosion.
- Explosion: failure that occurs when a cell container or battery case opens violently and major components are forcibly expelled.
- Fire: the emission of flames from a cell or battery.
- Upper limit of the charging voltage: the highest allowable charging voltage ~~in the cell operating region~~ as specified by the cell Manufacturer.

1.3 Documentation to be submitted

1.3.1 *(1/1/2019)*

In addition to the documents required in Sec 1, for battery powered ships the plans and documents listed in Tab 1 are to be submitted.

The Society reserves the right to request the submission of additional documents in the case of non-conventional design or if it is deemed necessary for the evaluation of the systems and components.

2 System design

2.1 General

2.1.1 *(1/1/2019)*

Battery installations may replace generator sets in the main source of electrical power on condition that the capacity of the battery installation is sufficient for the intended operation of the ship and such design capacity is stated in the class certificate as an operational limitation.

2.1.2 *(1/1/2019)*

In ships or units where the main source of electrical power is based on battery installations only, the battery installation is to be divided into at least two independent battery systems located in two separate battery spaces, each having a capacity sufficient for the intended operation of the ship.

Table 1 : Documentation to be submitted *(1/1/2022)*

No.	A/I (1)	Document
1	A	Block diagram and electrical wiring diagram of the battery system and system interface~~s~~d to the battery system, including control, monitoring and alarm system, emergency shutdown, PMS, etc.
2	I	~~Functional description of the controls and mechanisms to enhance battery safety, such as battery management system (BMS), energy management system (EMS), shutdown mechanism, etc.~~Technical specification of the batteries, including technical data (electrical characteristics like voltage and capacity, discharge and recharge rates), battery chemistry and functional description of cell/battery system including at least cell/batteries configuration, safety devices (BMS), interfaces to monitoring/safety, diagnostic, including the list of controlled and monitored parameters.
3	I	Functional description of the energy management system (EMS), when required (see [2.1.3]).
~~3~~4	~~I~~A	A risk assessment ~~which cover~~addressing all potential hazards represented by the type (chemistry) of batteries, the evaluation of the risk factors and measures to control and reduce the identified risks. Note: for the Risk Assessment reference is to be made to Tasneef "Guide for Risk Analysis".
~~4~~5	A	Test program~~s which~~ Note: the test program is to include the functional tests as per [5.2] (alarm system, safety system, control system, etc.) ~~per [5]~~ and further tests, if any, resulting from the Risk Assessment for the specific ~~lithium~~ battery system.
~~5~~6	A	Electrical load balance capable of~~to~~ reflecting the operational mode stated in the battery system operating philosophy (max- imum designed deterioration rate is to be included).
~~6~~7	~~I~~A	A general arrangement plan of battery installation including the indication of structural fire protection and the safety systems **(2)** **(3)**.
8	I	Battery Manufacturer's instructions on active fire extinguishing system and confirmation about suitability of the proposed extinguishing agent for the specific type of batteries.
9	I	Statement of conformity of the batteries to IEC 62619, IEC 62620 and IEC 60529.
10	I	Copy of type approval certificate of the battery systems, when the aggregate capacity exceeds 20 kWh
~~7~~	~~I~~	~~Description of cell/battery design including at least electrical characteristics (e.g. voltage, capacity, etc.), safety devices, cell/batteries configuration, battery chemistry, method of activation, discharge and recharge rates for the batteries, etc.~~
~~8~~	~~I~~	~~Technical specification of the lithium batteries, including data and environmental conditions.~~
~~9~~	~~I~~	~~Test report which is to detail the results of all tests detailed in the approved Test program.~~
~~10~~	~~I~~	~~Software description including description of the basic and communication software installed in each hard- ware unit, description of application software, description of functions, performance, constraints and dependencies between modules or other components and user manual including instructions during software maintenance.~~
11	I	An overall description of the ~~propulsion and power installation and of~~ battery system operating philosophy for each operational mode (including charging) ~~when battery installation is used as storage of power for the propulsion system or as part of the main source of electrical power~~.
12	I	Operation and maintenance manuals including instructions for the safe connection/disconnection of batteries (see [5.~~2~~4]).
13	A	Hazardous area classification (if applicable to the specific battery chemistry) and list of certified safety type electrical equipment installed in hazardous areas (as applicable).

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

(2) Where a battery space is provided, based on the Risk Assessment (see [4.2]), evidence of the solution adopted for the battery space is to be given in the ship's active (detection and fighting) and passive fire protection, gas detection system and ventilation system drawings.

(3) The plan has to show:

- the battery pack arrangement with respect ~~of~~to the space it is being installed in
- the clearance distances between the other ancillary equipment in the space and the battery pack.

No.	A/I (1)	Document
14	I	Test Report of battery system at cellular, modular and system level in order to identify the damage potential of a possible thermal runaway event (Propagation Test) including gas analysis and explosion analysis as appli-cable and depending on the safety concept adopted.
15	I	Battery system maker statement confirming suitability of the selected fire extinguishing system and ventila-tion arrangement for the specific project.

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

(2) Where a battery space is provided, based on the Risk Assessment (see [4.2]), evidence of the solution adopted for the battery space is to be given in the ship's active (detection and fighting) and passive fire protection, gas detection system and ventilation system drawings.

(3) The plan has to show:

- the battery pack arrangement with respect ~~of~~to the space it is being installed in
- the clearance distances between the other ancillary equipment in the space and the battery pack.

2.1.3 *(1/1/2022)*

When batteries are used as storage of power for the propulsion or dynamic positioning system or as part of the main source of electrical power, an Energy Management System (EMS) according to [3.5] is to be provided.

2.1.4 *(1/1/2019)*

Where the batteries are used for propulsion and steering of the ship, the system is to be so arranged that the electrical supply to equipment necessary for propulsion and steering will be maintained or immediately restored in the case of battery system failure.

2.1.5 *(1/1/2022)*

Cables connecting each battery system to the main switchboard are to be arranged as per Sec 11, [5.2].

2.1.6 *(1/1/2022)*

A Risk Assessment, to be initiated in the design phase, is to be carried out to cover, but not limited to:

- evaluation of the risk factors,
- measures to control and reduce the identified risk, including potential gas development (e.g. toxic, corrosive), fire and explosion risk and
- action to be implemented.

The outcome of the assessment will give the additional measures to be adopted for minimizing the risks related to the use of batter~~y~~ies and among such measures, ~~will also establish~~ if the battery system needs to be installed in a space assigned to batteries only.

2.1.7 *(1/1/2022)*

The risk assessment has:

- to identify risks due to external heating, fire or flooding
- to identify any fault in the battery system that may cause malfunction to essential ~~or~~services including but not limited to propulsion and steering or to emergency services and ~~has~~ measures to mitigate the related risk ~~with appropriate measures~~,
- to evaluate any risk related to the location~~,~~ of batteries in the same space~~, of batteries~~with ~~and~~ other system~~s~~ supporting ship's essential or emergency services, including pipes and electrical cables, distribution switchboards and so on, including but not limited to thermal runaway of the battery system, external and internal short-circuit,
- to ~~identify measures to prevent loss~~evaluate any risk related to the location, in the same space, of ~~propulsion, steering~~ batteries and ~~emergency~~other systems related to non essential services ~~upon failure such as thermal runaway of the battery system~~,
- ~~to address battery component thermal runaway, cell balancing, external and internal short circuit,~~
- to address sensor failures (e.g. temperature measurement sensor failure, individual cell voltage measurement sensor failure) and alarm, control and safety system failures (e.g. BMS and EMS failures including power and communication failures)~~.~~,
- to assess the selected fire extinguishing and ventilation arrangement according to battery system maker guide-lines considering the specific design features of the ship.

2.1.8 *(1/1/2019)*

Battery cells of different physical characteristics, chemistries and electrical parameters are not to be used in the same electrical circuit.

2.1.9 *(1/1/2019)*

The batteries are to be properly located (see [4]) and, where necessary, insulated to prevent overheating of the system.

2.1.10 *(1/1/2022)*

The minimum required degree of protection is to be, in rela-tion to place of installation of the battery system, ~~is that specified in~~according to Sec 3, [4]. Where water-based fire extinguishing system is used in the battery space, IP 44 is required as a minimum (see Note 1 and Note 2).

Note 1: if other fire-extinguish systems are used, the minimum IP can be reduced as result of the risk assessment.

Note 2: where the risk assessment identifies risks from water immersion (e.g. when batteries are installed below the freeboard deck), the batteries are to have a minimum degree of protection IP X7.

2.2 Constructional requirements

2.2.1 *(1/1/2019)*

Battery enclosure covering modules and cells are to be made of flame retardant materials.

2.2.2 *(1/1/2019)*

Each cell or battery case is to incorporate a pressure relief mechanism or is to be constructed in such a way to relieve excessive internal pressure at a value and rate that will be precluded rupture, explosion and self-ignition.

2.2.3 *(1/1/2019)*

A thermal protection device, capable to disconnect the battery in case of high temperature, is to be provided in the battery.

2.2.4 *(1/1/2022)*

The design and construction of battery modules have to reduce the risk of a thermal propagation ~~from cell to cell~~ due to a cell thermal runaway, maintaining it confined at the lowest possible level (e.g. confined within a module). This may be achieved by means of partition plates or sufficient distance in accordance with maker recommendation to prevent escalation between battery modules in case of a thermal runaway.

2.2.5 *(1/1/2019)*

Terminals are to have clear polarity marking on the external surface of the battery. The size and shape of the terminal contacts are to ensure that they can carry the maximum current. External terminal contact surfaces are to be made of conductive materials with good mechanical strength and corrosion resistance. Terminal contacts are to be arranged so as to minimize the risk of short circuits.

2.2.6 *(1/1/2022)*

The battery system is to be provided with a Battery Management System (BMS) according to [3.2]. ~~The battery charger is to be interfaced with and controlled by the BMS.~~

2.3 Electrical protection

2.3.1 *(1/1/2022)*

The outgoing circuits of the~~Each~~ battery system ~~is~~are to be protected against overload and short-circuit ~~in each separate circuit~~ by means of fuses or multi- pole circuit breakers having isolating capabilities.

2.3.2 *(1/1/2022)*

An emergency shutdown system is to be installed and capable ~~to~~of disconnecting the battery system in an emergency.

2.3.3 *(1/1/2022)*

The battery system is to have means for isolating purpose for maintenance purposes. This isolating device is to be independent of the emergency shutdown arrangement.

2.3.4 ~~*(1/1/2019)*~~

~~Each circuit supplied by a battery system is to be provided with:~~

- ~~switchgear for isolating purposes~~
- ~~over current protection, up to short circuit protection.~~

2.3.5 ~~*(1/1/2019)*~~

~~If the battery system is composed by paralleled strings, each string of batteries is to be provided with individual protection.~~

~~The complete battery is to be provided with a disconnecting device between the battery system and the DC distribution.~~

2.4 Battery charger

2.4.1 *(1/1/2022)*

Battery chargers are to comply with the requirements of Sec 7.

2.4.2 *(1/1/2019)*

The battery charger is to be designed to operate without exceeding the limits given by the battery system Manufacturer (e.g. current and voltage level).

2.4.3 *(1/1/2022)*

~~Communication between battery charger and battery management system is to be implemented.~~The battery charger is to be interfaced with and controlled by the BMS.

2.4.4 *(1/1/2022)*

Any failure in the battery charger, including charging/discharging failure, is to give an alarm in a continuously manned control position.

3 Control, monitoring, alarm and safety systems

3.1 General

3.1.1 *(1/1/2019)*

For the purpose of these rules, unless differently state in the text, a required alarm is to be intended as an audible and visual alarm and is to be given in a continuously manned control position.

3.1.2 *(1/1/2022)*

~~Electronic and programmable equipment and systems~~Control, monitoring, alarm and safety systems are to comply with the requirements of Chapter 3 and are to be type approved or type tested according to Ch 3, Sec 6.

3.2 Battery management systems (BMS)

3.2.1 *(1/1/2019)*

The BMS and related monitoring and safety systems (see [3.4]) are to have self-check facilities.

In the event of a failure, an alarm is to be activated.

3.2.2 *(1/1/2019)*

The BMS is to be continuously powered so that a single failure of the power supply system does not cause any degradation of the BMS functionality; an alarm is to be given in the event of failure of any of the power supplies.

Unless the power supply is derived from different strings of batteries, one of the power supplies is to be derived from the emergency source of electrical power.

Where each battery is fitted with a BMS card, the individual cards may have a single power supply from the relevant battery.

An alarm is to be given and safety action taken in the event of loss of all the power supplies.

3.2.3 *(1/1/2022)*

~~The BMS is to provide limits and monitor as appropriate at least:~~The battery management system (BMS) is to:

- ~~charging/discharging of the battery,~~provide limits for charging and discharging of the battery,
- ~~battery temperature and~~protect against over-current, over-voltage and under-voltage by disconnection of the battery system,
- ~~cell to cell balancing.~~protect against over-temperature by disconnection of the battery system,
- provide cell and module balancing.

3.2.4 *(1/1/2022)*

The following parameters are to be continuously monitored and indications are to be provided at a local control panel and in a continuously manned control position for:

- ~~cell voltage,~~system voltage,
- ~~cell temperature,~~max, min, average cell voltage,
- ~~battery current,~~max, min and average cell or module temperature,
- ~~ambient temperature,~~battery string current.
- ~~availability of cooling system (e.g. of the ventilation system or of the liquid cooling system).~~

3.2.5 *(1/1/2019)*

When battery system is used as storage of power for the propulsion system or as part of the main source of electrical power, State of Charge (SOC) and State of Health (SOH) of the batteries are to be displayed at a continuously manned control station.

3.3 Alarm system

~~**3.3.1** *(1/1/2019)*~~

~~The alarm system is to be continuously powered and an alarm is to be given in the event of failure of the normal power supply.~~

~~**3.3.2** *(1/1/2019)*~~

~~Failure within alarm system, including outside connections, is to activate an alarm.~~

3.3.1~~3~~ *(1/1/2019)*

Abnormal conditions which can develop into safety hazards are to be alarmed before reaching the hazardous level.

3.3.2~~4~~ *(1/1/2019)*

Any abnormal condition in the battery system is to initiate an alarm.

3.3.3~~5~~ *(1/1/2019)*

~~T~~At least the following conditions or events have to initiate an alarm at a local control panel and in a continuously manned control position:

- ~~operation~~safety intervention of the BMS of the battery system ~~protective device~~,
- ~~high cell temperature,~~
- high ambient temperature,
- failure of ~~ventilation~~cooling system or leakage of liquid cooling system,
- ~~cell under and overvoltage,~~low ventilation flow inside the battery room,
- ~~high cell pressure or opening of cell safety venting device~~overvoltage and undervoltage,
- ~~intervention of the Emergency Shutdown System of the battery system.~~cell voltage unbalance,
- high cell temperature,
- other safety protection functions.

Other possible abnormal conditions are to be considered on the basis of the outcome of the Risk Assessment (see [2.1.~~6~~7]) and relevant mitigating measures are to be adopted~~ (e.g. gas detection, smoke detection, heat detection, over- current, ventilation failure, undervoltage, voltage unbalance between battery cells, charging failure, etc.)~~.

3.3.4~~6~~ *(1/1/2019)*

When batteries are used as storage of power for the propulsion or dynamic positioning systems or as part of the main source of electrical power, an alarm is to be given on the bridge when State of Charge (SOC) reaches minimum required capacity for ship intended operations.

3.4 Safety system

3.4.1 *(1/1/2022)*

The safety systems are to be:

- designed so as to limit the consequence of internal failures (e.g. failure in the safety system is not to cause shut down of battery system)
- self-monitoring,
- capable ~~to~~of acting on the controlled system following the fail-to safety principle,
- capable of detecting sensor malfunctions.

3.4.2 *(1/1/2019)*

The safety systems are to be activated automatically in the event of identified conditions which could lead to damage of the battery system. Activation of any automatic safety actions is to activate an alarm. Manual override of safety functions is not to be possible.

3.4.3 *(1/1/2019)*

Voltage of any one of the single cells is not to exceed the upper limit of the charging voltage as specified by the cell Manufacturer. The battery charger is to be stopped when the upper limit of the charging voltage is exceeded for any one of the single cells.

3.4.4 *(1/1/2022)*

~~The~~An emergency shutdown (ESD) system is to be arranged as a separated hardwired circuit and it is to be independent from the control system.

3.4.5 *(1/1/2019)*

Activation means of the ESD are to be provided locally, from outside the battery space, and from a continuously manned control station.

3.4.6 *(1/1/2019)*

When battery installation is used as storage of power for the propulsion or dynamic positioning systems or as part of the main source of electrical power, the emergency shutdown is also to be located on the bridge.

3.4.7 *(1/1/2019)*

When battery installation is used as storage of power for the propulsion or DP systems or as part of the main source of electrical power, in case of over temperature in the battery system, an alarm and a request of manual load reduction is to be given on the bridge at a temperature lower than the one causing intervention of the BMS. As an alternative an automatic load reduction system may be provided. Its intervention is to generate an alarm.

3.4.8 *(1/1/2019)*

Other possible abnormal conditions, which could lead to damage or additional hazards to battery system, are to be considered on the basis of the outcome of the Risk Assessment.

3.4.9 *(1/1/2019)*

Sensors are to be designed to withstand the local environment.

3.4.10 *(1/1/2019)*

The enclosure of the sensor and the cable entry are to be appropriate to the space in which they are located.

~~**3.4.11** *(1/1/2019)*~~

~~Sensors for safety functions are to be independent from sensors used for other purposes (e.g. for control, indication and alarm systems), unless the effect of sensor loss on safety of the battery system and on essential or emergency services is within the acceptance criteria of the risk analysis per [2.1.7].~~

3.4.11~~2~~ *(1/1/2019)*

Cables to be operable under fire conditions (e.g. where required as result of the Risk Assessment), are to be of a fire-resistant type complying with IEC Publication 60331 series.

3.5 Energy Management system

3.5.1 *(1/1/2022)*

When required per [2.1.3], ~~A~~an energy management system (EMS) is to be provided complying with the requirements of Chapter 3 consisting of several levels of controls and alarm functions, such as:

- monitoring and alarm functions of all power sources, inverters and disconnectors;
- voltage and power control for DC distribution system;
- available power and charge/discharge status of the storage energy source;
- interface with Power Management System (PMS) for combinations of AC and DC distribution systems;
- inverter control for the overall system.

The energy management system (EMS) is to be independent from~~:~~ the battery management system (BMS) for lithium batteries, however EMS may be integrated in the PMS.

- ~~the power management system (PMS), and~~
- ~~the battery management system (BMS) for lithium batteries.~~

~~The energy management system is to be redundant and redundancy is to be ensured also to the relevant power supplies.~~ The EMS~~It~~ is to be continuously supplied by uninterruptible power supply systems (UPS) and a failure is to initiate an alarm in a manned location.

The energy management system is to be type tested or type approved according to the tests listed in Ch 3, Sec 6, Tab 1, as far as applicable (see Note 1).

Note 1: If the energy management functionality is implemented in another system, e.g. as part of the power management system (PMS), then the systems are to be certified together.

3.5.2 *(1/1/2019)*

The EMS is to be capable to provide at least the following information on the bridge:

- energy available from batteries (SOC),
- power available from batteries,
- time or range for which the battery can provide energy according to actual operational conditions,
- alarm for minimum capacity reached,
- battery state of health (SOH).

4 Location

4.1 General

4.1.1 *(1/1/2022)*

~~Battery spaces~~Batteries are to be arranged aft of collision bulkhead and in such a way that danger to persons and damage to vessel due to failure of the batteries (e.g. caused by gassing, explosion, and fire) is minimized.

4.1.2 *(1/1/2019)*

Batteries are not to be located in a battery box on the open deck exposed to sun and frost.

They are to be located where they are not exposed to excessive heat, extreme cold, spray, steam, shocks or vibration or other conditions which would impair their safety, performance or accelerate deterioration.

4.1.3 *(1/1/2019)*

Batteries are to be located in such a way that the ambient temperature remains within the Manufacturer's specification at all times.

4.1.4 *(1/1/2022)*

Batteries are to be suitably housed by means of compartments (rooms, lockers or boxes) used primarily for their accommodation which are to be properly constructed and efficiently ventilated and cooled (as necessary) in such a way to keep the battery system at a specified set of environmental conditions.

4.1.5 *(1/1/2019)*

Battery system is to be arranged following the Manufacturer's prescriptions in particular to prevent cascade effects in case of a thermal runaway (e.g. partition plates or distance in accordance with Manufacturer's recommendations).

4.1.6 *(1/1/2022)*

Batteries, used as storage of power for the propulsion or dynamic positioning systems or as part of the main source of electrical power, are to be located in a battery space placed within the extreme borders of the main machinery space or adjacent to it.

4.1.7 *(1/1/2022)*

When the main source of electrical power is based on battery installations only, one of the two battery systems required in [2.1.2] is to be placed in a battery space located in the same machinery space of the main switchboard.

4.1.8 *(1/1/2019)*

Depending on the battery chemistry, it may be necessary to define a hazardous area for the installation of appropriate equipment (see Tab 1 No. 6).

4.1.9 *(1/1/2019)*

The battery space is not to contain other systems supporting essential or emergency services, including piping and electric cables serving such systems, in order to prevent their loss upon possible failures (e.g. thermal runaway) in the battery system, unless the potential loss of essential or emergency services is within the acceptance criteria of the risk analysis per [2.1.6].

4.2 Battery space

4.2.1 *(1/1/2019)*

When required, based on [4.1.6] or the Risk Assessment (see [2.1.6]), a space assigned to batteries only is to be foreseen.

4.2.2 *(1/1/2019)*

Access to this space is to be through self-closing doors. As an alternative normally closed doors with alarm may be considered.

4.2.3 *(1/1/2019)*

External hazards, such as fire and water ingress are to be taken into account in the Risk Assessment, in order to assess the risk associated with an external event (e.g. a fire spreading from adjacent rooms to the battery space, water flooding and so on) and possible countermeasures (e.g. suitable segregation of the battery space).

No heat sources or high fire risk equipment are to be located in battery spaces.

4.2.4 *(1/1/2022)*

A fire detection system and a fixed fire extinguishing system appropriate to the battery chemistry are to be provided in the battery space.

The type of is to be chosen following the battery Manufacturer's instructions.

Examples of fire extinguishing systems may be a powder or a gas based or water-based fixed fire extinguishing system provided that the suitability of the extinguishing agent for the specific type of batteries is confirmed by the battery Manufacturer and its use does not produce corrosive, toxic or harmful substances.

Automatic release is only acceptable for small, not accessible, battery spaces.

Where an automatic release of fire extinguishing media is accepted, its activation is to be confirmed by more than one sensor.

4.2.5 *(1/1/2022)*

The battery spaces are to be fitted with a forced ventilation system of extraction type, which is to be:

- independent from any other ventilation system serving other ship's spaces,
- provided with local manual stop, still available in case of failure of the automatic and or remote control system,
- provided with indication of ventilation running and of battery space ambient temperature,.
- with a capacity (rate) according to battery manufacturer guidelines on the basis of the gas release identified in the gas analysis or propagation test,
- fitted with inlet from open air,
- fitted with exhaust outlet to open air far from accommodation and machinery ventilation inlets,
- fitted with non-sparking fans driven by a certified safe type electric motor in case the ventilation duct is considered to contain ex-plosive atmosphere in case of thermal runaway.

4.2.6 *(1/1/2019)*

Appropriate means to maintain the battery working temperature within the Manufacturer's declared limits are to be provided (e.g. by means of liquid cooled solutions or ventilation systems provided with control of air temperature).

4.2.7 *(1/1/2022)*

Battery modules with liquid cooling are to be designed such that the risk of a cooling liquid leakage inside the module is minimized.

The cooling system is to include at least two pumps for each primary and secondary circuits: one main and one standby. The standby pump can be omitted only if the consequences of main pump failure are addressed in the risk assessment [2.1.7].

4.2.8 *(1/1/2022)*

In case of liquid cooled solutions, thea ventilation system is anyway required not for maintaining the working temperature within the Manufacturer's declared limits, but to extract possible gases or vapours in consequence of a battery abnormal condition.

4.2.9 *(1/1/2019)*

Depending on the battery chemistry, a gas detection system, for the gases that may be emitted from the battery system in the event of a serious fault, may be requested as an outcome of the risk assessment.

In this case,

- an alarm at 30% of LEL and automatic disconnection of batteries are to be provided,
- an alarm at 60% of LEL and automatic disconnection of all electrical equipment non certified of safety type for the specific hazardous area, gas, vapour are to be provided.

A failure in the gas detection system is to be alarmed but is not to cause above mentioned automatic disconnections.

4.2.10 *(1/1/2022)*

Depending on the battery chemistry, appropriate ventilation to prevent the formation of explosive atmospheres in the battery space (e.g. to limit the concentration of flammable gasses and thereby reduce the risk for fire) is to be provided.

At this purpose the highest rate of gas emissions ~~from the single cell~~ is to be considered.

4.2.11 *(1/1/2019)*

Depending on the battery chemistry, when a hazardous area is to be considered, mechanical exhaust non-sparking fan driven by a certified safe type electric motor, and inlet from open air are to be arranged.

4.2.12 *(1/1/2019)*

Battery spaces on passenger ships carrying more than 36 passengers are to be treated as a cat.11 space (auxiliary machinery space with high fire risk).

4.2.13 *(1/1/2022)*

Battery spaces on passenger ships carrying not more than 36 passengers, and on cargo shipsare to be insulated in way of other spaces as indicated in Tab 2.

4.2.14 *(1/1/2019)*

Battery spaces are to be considered as spaces not normally manned.

4.2.15 *(1/1/2022)*

The battery space is not to contain other systems supporting essential or emergency services, including piping and electric cables serving such systems, in order to prevent their loss upon possible failures (e.g. thermal runaway) in the battery system.

Table 2 *(1/1/2019)*

Bulk-head	Con-trol Station 1	Corri-dor 2	Accom-moda-tion spaces 3	Stair-ways 4	Service spaces (low risk) 5	Machin- ery Space of cat A 6	Machi nery Space 7	Cargo 8	Service spaces (high risk) 9	Open deck 10	Special cate-gory/ Roro spaces 11	Muster stations
Li Bat-tery Space	A60	A15	A30	A15	A0	A60	A0	A60	A30	A0	A60	A60
Li Bat-tery Space Below	A60	A60	A30	A60	A0	A60	A0	A60	A30	A0	A60	A60
Li Bat-tery Space Above	A0	A0	A0	A0	A0	A60	A0	A60	A0	A0	A60	A60

5 Testing ~~and inspection~~

5.1 General

5.1.1 *(1/1/2022)*

Battery systems are to be tested by the Manufacturer.

5.1.2 *(1/1/2022)*

Batteries are to be subjected to functional and safety tests according to IEC Publication 62619 and 62620 or in accordance with other equivalent national or international standards.

5.1.3 *(1/1/2022)*

When the aggregate capacity of a battery system exceeds the rating of 20 kWh, the battery system is to be of a type approved in accordance with the Society "Rules for the type approval certification of lithium battery systems".

5.2 Testing and inspection at Manufacturer premises

5.2.1 *(1/1/2022)*

Battery systems are to be tested by the Manufacturer~~.~~ according to a test program proposed by the Manufacturer and approved by the Society and which is to include at least functional tests of battery system/BMS and control, monitoring and safety systems and further tests, if any, resulting from the Risk Assessment.

Table 3 _(1/1/2022)

No.	Test/inspection
1	Examination of the technical documentation, as appropriate, and visual inspection
2	Functional test of the BMS, including safety functions and applicable alarms listed in [3.3.3]
3	Dielectrical strength (high voltage test) **(1)**
4	Insulation resistance test **(1)**
5	Sensor failure test (e.g. power supply failure, disconnection, short circuit, etc.)
6	Emergency shutdown (ESD) functional test
7	Communication failure between BMS and battery charger
8	Testing of the cooling system when submitted to acceptance testing together with the battery system
9	Check of test certificate for prescribed degree of protection
(1) Refer to Sec 8, [3.3] and [3.4]. In order to prevent damages to the electronic components of the battery system, the electronic components can be disconnected during the high voltage test.	

5.2.2 ~~(1/1/2019)~~

~~Battery systems having a capacity of 50 kWh or above are to be tested at the presence of a Tasneef surveyor.~~

~~However, where the testing laboratory is an independent and recognized laboratory complying with the Chapter 5, item [3] of Tasneef "Rules for testing, Certification and Acceptance of Marine Materials and Equipment", the tests may be carried out without the presence of a Tasneef surveyor.~~

~~Relevant Test Reports are to be submitted for acceptance.~~

5.2.3 ~~(1/1/2019)~~

~~Battery system associated electronic equipment is to be suitable for use in a marine environment: for this purposes tests are to be carried out according to Ch 3, Sec 6, Tab 1.~~

5.2.4 ~~(1/1/2019)~~

~~Batteries are to be subjected to functional and safety tests according to IEC Publication 62619 and 62620 or in accordance with other equivalent national or international standards.~~

5.2.5 ~~(1/1/2019)~~

~~Battery chargers are to be tested according to Sec 7 and in addition the correct operation of the communication system between the charger and the BMS is to be verified. Details of relevant tests are to be indicated in the Test Programs (see Tab 1 No. 4).~~

5.2.6 ~~(1/1/2019)~~

~~Performance tests are to be carried out on the battery system according to a test program which is to be submitted for approval (see [1.3.1]) and which is to include functional tests (alarm system, safety system, control system, etc.) and further tests, if any, resulting from the Risk Assessment.~~

5.2.7 ~~(1/1/2019)~~

~~When battery installation is used as storage of power for the propulsion or dynamic positioning systems or as part of the main source of electrical power, tests for the verification of the battery SOH are to be carried out (e.g. complete charge/discharge cycle or other methods as per Manufacturer's indications).~~

5.2.8 ~~(1/1/2019)~~

~~For type approved products, tests to verify the conformity of the product with the approved prototype are to be carried out before installation on board; the tests are to be carried out according to a test program which is to include functional tests (alarm system, safety system, control system, etc.) and further tests, if any, resulting from the Risk Assessment.~~

5.3 Testing and inspection after installation on board

5.3.1 (1/1/2022)

After installation, and after any important repair or alteration which may affect the safety of the arrangement, following a check of compliance with the plans, the battery system is to be subjected to tests and inspections, to the satisfaction of the Surveyor in charge.

5.3.2 (1/1/2022)

Performance tests are to be carried out on the battery system; the test program is to include functional tests as per Table 4 and fur-ther tests, if any, resulting from the Risk Assessment.

Table 4 (1/1/2022)

No.	Test/verification
1	Insulation resistance test as per Sec 15, [3.3]
2	Test of the functionality of the battery system and BMS and its auxiliaries, including alarms, and safety functions, emergency stop, including simulation of changes in parameters and simulation of sensor failure and of communication failure (e.g. with battery charger)
3	Test of the functionality of the auxiliary services in the battery space (e.g. ventilation, liquid cooling, gas detection, fire detection, leakage detection)
4	Verification of proper calculation and indication of SOC and SOH (when required per [3.2.4]) **(1)**
5	Verification of correct regulation of charging and discharging currents
6	Verification of the functionality of the EMS (when required per [2.1.3])
7	Test of the independent disconnecting device as per [2.3.3]
(1) Tests for the verification of the battery SOH are to be carried out (e.g. complete charge/discharge cycle or other methods as per Manufacturer's indications).	

5.4 Plans to be kept on board

5.4.1 *(1/1/2022)*

An operation manual is to be kept on board which includes at least:

- charging procedure,
- normal operation procedures, including instructions for the safe connection/disconnection of batteries,
- emergency operation procedures,
- estimated battery deterioration (ageing) rate curves, considering modes of operation.

5.4.2 *(1/1/2022)*

A maintenance manual for systematic maintenance and functional testing is to be kept on board. The plan is to which includes at least:

- tests on all the equipment affecting the battery system (e.g. instrumentation, sensors, etc.),
- recommended test intervals to reduce the probability of failure,
- recommended survey plan (annual and renewal surveys),
- functional tests of control, monitoring, safety and alarm system,
- verification of the State of Health (SOH),
- instructions for Software Maintenance.

5.5 ~~Testing and inspection after installation on board~~

5.5.1 ~~*(1/1/2019)*~~

~~After installation, and after any important repair or alteration which may affect the safety of the arrangement, following a check of compliance with the plans, the battery system is to be subjected at least to the following tests and inspections, to the satisfaction of the Surveyor in charge:~~

- ~~visual inspection,~~
- ~~operational tests,~~
- ~~tests of all the alarms and safety functions,~~
- ~~charging and discharging capacities,~~
- ~~emergency shutdown operation,~~
- ~~checking of operation of sensors, including simulation of changes in parameters and simulation of sensor failure,~~
- ~~simulation of communication failure,~~
- ~~insulation resistance test,~~
- ~~correct operation of ventilation, cooling, gas detection system, fire detection system and fire extinguishing system, etc., where provided.~~

SECTION 6 QUALIFICATION SCHEME FOR WELDERS OF HULL STRUCTURAL STEELS

1 Scope

1.1 Application

1.1.1 *(1/1/2018)*

This Section gives requirements for a qualification scheme for welders intended to be engaged in the fusion welding of the following steels:

- Normal and higher strength hull structural steels, including corrosion resistant steels;
- YP47 steel plates for longitudinal structural members in the upper deck region of container carriers;
- Steel forgings for hull structures;
- Steel castings for hull structures.

1.1.2 *(1/1/2018)*

This qualification scheme does not cover welders engaged in oxy-acetylene welding.

1.1.3 *(1/1/2022)*

This qualification scheme does not cover welding of pipes and pressure vessels.

1.1.4 *(1/1/2022)*

Alternative welding Standards or Codes are to be applied in full, cross-mixing requirements of Standards and Codes is not permitted.

1.1.5 *(1/1/2022)*

Existing qualifications are to be renewed in accordance with the requirements in this section when they become due.

2 General

2.1

2.1.1 *(1/1/2018)*

Those welders intended to be engaged in welding of hull structures in shipyards and manufacturers shall be tested and qualified in accordance with this scheme and issued with a qualification certificate endorsed by the Society.

2.1.2 *(1/1/2022)*

The welding operator responsible for setting up and/or adjustment of fully mechanized and automatic equipment, such as submerged arc welding, gravity welding, electrogas welding and MAG welding with auto-carriage, etc., must be qualified whether he operates the equipment or not. However a welding operator, who solely operates the equipment without responsibility for setting up and/or adjustment, does not need qualification provided that he has experience of the specific welding work concerned and the production welds made by the operators are of the required quality.

The qualification test and approval range of the welding operator are left to the discretion of the Society with reference to ISO 14732:2013.

2.1.3 *(1/1/2018)*

This Section is applicable to welding of hull structures both during new construction and the repair of ships.

2.1.4 *(1/1/2018)*

The training of welders, control of their qualification and maintenance of their skills are the responsibility of shipyards and manufacturers. The Society Surveyor is to verify and be satisfied that the welders are appropriately qualified.

2.1.5 Equivalence of national or international standards to this Section *(1/1/2022)*

Welders or welding operators qualified in accordance with national or international welder qualification standards may also be engaged in welding of hull structures at the discretion of the Society provided that ~~the qualification testing, range of approval and revalidation requirements are~~ standard is considered equivalent to those provided in this Section from technical perspective covering examination, testing and range approval.

Even if the requirements stipulated in the standards are applied, the requirement for revalidation of welders' qualification are to be in accordance with [6.2.1].

3 Range of qualification of welders

3.1 Application

3.1.1 *(1/1/2018)*

A welder is to be qualified in relation to the following variables of welding:

a) base metal

b) welding consumables type

c) welding process

d) type of welded joint

e) plate thickness

f) welding position

3.1.2 *(1/1/2018)*

Base metals for qualification of welders or welding operators are combined into one group with a specified minimum yield strength ReH≤460 N/mm^2. The welding of any one metal in this group covers qualification of the welder or welding operator for the welding of all other metals within this group.

3.1.3 *(1/1/2018)*

For manual metal arc welding, qualification tests are required using basic, acid or rutile covered electrodes. The type of covered electrodes (basic, acid or rutile) included in the range of approval is left at the discretion of the Society.

Welding with filler material qualifies for welding without filler material, but not vice versa.

3.1.4 *(1/1/2018)*

The welding processes for welder's qualification are to be classified in Tab 1 as,

M - Manual welding

S - Semi-automatic welding/Partly mechanized welding

T - TIG welding

Each testing normally qualifies only for one welding process. A change of welding process requires a new qualification test.

Table 1 : Welding processes for welder's qualification *(1/1/2022)*

Symbol	Welding process in actual welding works		ISO 4063:2009
M	Manual welding	Manual metal arc welding (metal arc welding with covered electrode)	111
S	Partly mechanized welding	Metal inert gas (MIG) welding	131
		Metal active gas (MAG) welding	135,138 **(1)**
		Flux cored arc (FCA) welding	136 **(2)**
T	TIG welding	Tungsten inert gas (TIG) welding	141

The Society may require separate qualification for solid wires, metal-cored wires and flux-cored wires as follows:

(1) A change from MAG welding with solid wires (135) to that with metal cored wires (138), or vice versa is permitted.

(2) A change from a solid or metal cored wire (135/138) to a flux cored wire (136) or vice versa requires a new welder qualification test

3.1.5 *(1/1/2018)*

The types of welded joint for welder's qualification are to be classified as shown in Tab 2 in accordance with the qualification test.

Table 2 : Types of welded joint for welder's qualification *(1/1/2018)*

Type of welded joint used in the test assembly for the qualification test				Type of welded joint qualified
Butt weld	Single sided weld	With backing	A	A, C, F
		Without backing	B	A, B, C, D, F
	Double sided weld	With gouging	C	A, C, F
		Without gouging	D	A, C, D, F
Fillet weld	-	-	F	F

Welders engaged in full/partial penetration T welds shall be qualified for butt welds for the welding process and the position corresponding to the joints to be welded.

3.1.6 *(1/1/2018)*

For fillet welding, welders who passed the qualification tests for multi-layer technique welding can be deemed as qualified for single layer technique, but not vice versa.

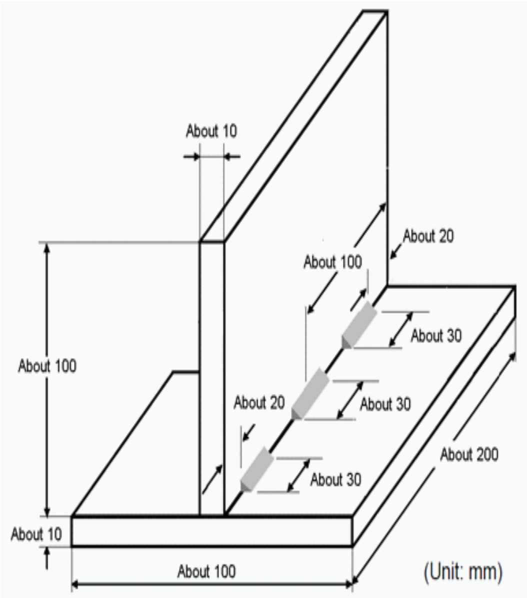
3.1.7 *(1/1/2018)*

The qualified plate thickness range arising from the welder qualification test plate thickness is shown in Tab 3.

Table 3 : Plate thicknesses for welder's qualification *(1/1/2018)*

Thickness of test assembly T (mm)	Qualified plate thickness range t (mm)
$T < 3$	$T \le t \le 2T$
$3 \le T < 12$	$3 \le t \le 2T$
$12 \le T$	$3 \le t$

Figure 6 : Dimensions and types of test assembly for tack fillet welds *(1/1/2018)*



4.2.3 *(1/1/2018)*

Testing materials and welding consumables shall conform to one of the following requirements or to be of equivalent grade approved by the Society.

a) Testing materials
- Hull structural steels specified in Ch 2, Sec 1, [2] and Ch 2, Sec 1, [12]
- Hull structural forged steels specified in Ch 2, Sec 3, [2]
- Hull structural cast steels specified in Ch 2, Sec 4, [2]
- Hull structural steels with specified minimum yield point 460 N/mm^2 specified in Ch 2, Sec 1, [11]

b) Welding consumables
- Consumables for hull structural steels specified in Sec 2
- Consumables for YP47 steels specified in Ch 2, Sec 1, [11.4.3].

4.2.4 *(1/1/2018)*

The welder qualification test assembly is to be welded according to a welding procedure specification (WPS or pWPS) simulating the conditions in production, as far as practicable.

4.2.5 *(1/1/2018)*

Root run and capping run need each to have a minimum of one stop and restart. The welders are allowed to remove minor imperfections only in the stop by grinding before restart welding.

4.3 Examination and test

4.3.1 *(1/1/2018)*

The test assemblies specified in [4.2] shall be examined and tested as follows:

a) For butt welds
- Visual examination
- Bend test

Note 1: Radiographic test or fracture test may be carried out in lieu of bend test except the gas-shielded welding processes with solid wire or metal cored wire.

b) For fillet welds
- Visual examination
- Fracture test

Note 2: Two macro sections may be taken in lieu of the fracture test.

c) For tack welds
- Visual examination
- Fracture test

Additional tests may be required, at the discretion of the Society.

4.3.2 Visual examination *(1/1/2022)*

The welds shall be visually examined prior to the cutting of the test specimen for the bend test and fracture test. The result of the examination is to show the absence of cracks or other serious imperfections.

Imperfections detected are to be assessed in accordance with quality level B in ISO 5817:2014, except for the following imperfection types for which level C applies:
- Excess weld metal
- Excess penetration
- Excessive convexity
- Excessive throat thickness.

4.3.3 Bend test *(1/1/2018)*

Transverse bend test specimens are to be in accordance with Ch 1, Sec 2, [3].

The mandrel diameter to thickness ratio (i.e. D/T) is to be that specified for welding consumable (Sec 2 and Ch 2, Sec 1, [11]) approvals +1.

Two face bend test and two root bend test specimens are to be tested for initial qualification test, and one face and one root bend test specimens for extension of approval. For thickness 12mm and over, four side specimens (two side specimens for extension of approval) with 10 mm in thickness may be tested as an alternative.

At least one bend test specimen shall include one stop and restart in the bending part, for root run or for cap run.

The test specimens are to be bent through 180 degrees. After the test, the test specimens shall not reveal any open defects in any direction greater than 3mm. Defects appearing at the corners of a test specimen during testing should be investigated case by case.

4.3.4 Radiographic test *(1/1/2022)*

When radiographic testing is used for butt welds, imperfections detected shall be assessed in accordance with ISO 5817:2014, level B.

4.3.5 Fracture test (Butt welds) *(1/1/2022)*

When fracture test is used for butt welds, full test specimen in length is to be tested in accordance with ISO 9017:2017.

Imperfections detected shall be assessed in accordance with ISO 5817:2014, level B.

4.3.6 Fracture test (Fillet welds) *(1/1/2022)*

The fracture test is to be performed by folding the upright plate onto the through plate.

Evaluation shall concentrate on cracks, porosity and pores, inclusions, lack of fusion and incomplete penetration. Imperfections that are detected shall be assessed in accordance with ISO 5817:2014, level B.

4.3.7 Macro examination *(1/1/2018)*

When macro examination is used for fillet welds, two test specimens are to be prepared from different cutting positions; at least one macro examination specimen shall be cut at the position of one stop and restart in either root run or cap run. These specimens are to be etched on one side to clearly reveal the weld metal, fusion line, root penetration and the heat affected zone.

Macro sections shall include at least 10mm of unaffected base metal.

The examination is to reveal a regular weld profile, through fusion between adjacent layers of weld and base metal, sufficient root penetration and the absence of defects such as cracks, lack of fusion etc.

4.4 Retest

4.4.1 *(1/1/2018)*

When a welder fails a qualification test, the following shall apply.

a) In cases where the welder fails to meet the requirements in part of the tests, a retest may be welded immediately, consisting of another test assembly of each type of welded joint and position that the welder failed. In this case, the test is to be done for duplicate test specimens of each failed test.

   All retest specimens shall meet all of the specified requirements.

b) In cases where the welder fails to meet the requirements in all parts of the required tests or in the retest prescribed in [4.4.1] a), the welder shall undertake further training and practice.

c) When there is specific reason to question the welder's ability or the period of effectiveness has lapsed, the welder shall be re-qualified in accordance with the tests specified in [4.2] and [4.3].

4.4.2 *(1/1/2018)*

Where any test specimen does not comply with dimensional specifications due to poor machining, a replacement test assembly shall be welded and tested.

5 Certification

5.1

5.1.1 *(1/1/2022)*

Qualification certificates are normally issued when the welder has passed the qualification test in accordance with ~~by~~ the Society's Rules. Each Shipyard and Manufacturer shall be responsible for the control of the validity of the certificate and the range of the approval.

5.1.2 *(1/1/2018)*

The following items shall be specified in the certificate:

a) Range of qualification for base metal, welding processes, filler metal type, types of welded joint, plate thicknesses and welding positions.

b) Expiry date of the validity of the qualification.

c) Name, date of birth, identification and the photograph of the welder.

d) Name of shipbuilder / manufacturer.

5.1.3 *(1/1/2018)*

When a certificate is issued, the relative documents such as test reports and/or re-validation records shall be archived as annexes to the copy of certificate according to the rules of the Society.

5.1.4 *(1/1/2018)*

The status of approvals of each individual qualification is to be demonstrated to the Classification Society when requested.

6 Period of Validity

6.1 Initial approval

6.1.1 *(1/1/2022)*

Normally the validity of the welder's approval begins from the issue date of qualification certificate when all the required tests are satisfactorily completed.

The certificate is to be signed at six-month intervals by the shipyards/manufacturers personnel who is responsible for production weld quality provided that all the following conditions are fulfilled:

a) The welder shall be engaged with reasonable continuity on welding work within the current range of approval. An interruption for a period no longer than six months is permitted.

b) The welder's work shall in general be in accordance with the technical conditions under which the approval test is carried out.

c) There shall be no specific reason to question the welder's skill and knowledge.

6.1.2 *(1/1/2022)*

The certificate is to be signed at six-month intervals by the shipyards/manufacturers personnel who is responsible for production weld quality provided that all the following conditions are fulfilled:

a) The welder shall be engaged with reasonable continuity on welding work within the current range of approval. An interruption for a period no longer than six months is permitted.

b) The welder's work shall in general be in accordance with the technical conditions under which the approval test is carried out.

c) There shall be no specific reason to question the welder's skill and knowledge.

6.1.3 *(1/1/2022)*

If any of these conditions are not fulfilled, the Society is to be informed and the certificate is to be cancelled.

The validity of the certificate may be maintained in agreement with the Society as specified in [6.2]. The maintenance scheme of qualification is in accordance with [6.2.1] a) or b).

6.1.4 *(1/1/2022)*

The validity of the certificate may be maintained in agreement with the Society as specified in [6.2]. The chosen maintenance option of qualification in accordance with [6.2.1] a) or b) or c) is to be stated on the certificate at the time of issue.

6.2 Maintenance of the approval

6.2.1 *(1/1/2022)*

Revalidation shall be carried out by the Society. The skill of the welder shall be periodically verified by one of the following options:

a) The welder shall be re-tested every 3 years.

b) Every 2 years, two welds made during the last 6 months of the 2 years validity period shall be tested by radiographic or ultrasonic testing or destructive testing and shall be recorded. The weld tested shall reproduce the initial test conditions except for the thickness. These tests revalidate the welder's qualifications for an additional 2 years.

c) A welder's qualification for any certificate shall be valid as long as it is signed according to [6.1.2] subject that all the following conditions are fulfilled. In this option, the fulfilment of all the conditions is to be verified by the Society. The frequency of verification by the Society is to be no longer than 3 years and is to be agreed between the Society and the shipyards/manufacturers.

   1) The welder is working for the same shipyard/manufacturer which is responsible for production weld quality as indicated on his or her qualification certificate.

   2) Society shall verify that the welder quality management system of the shipyard/manufacturer includes as minimum:

      - A designated person responsible for the coordination of the welder quality management system
      - List of welders and welding supervisors in shipyard/manufacturer
      - If applicable, list of subcontracted welders
      - Qualification certificate of welders and description of the associated management system
      - Training requirements for welder qualification programme
      - Identification system for welders and WPS used on welds
      - Procedure describing the system in place to monitor each welder performance based on results of welds examination records (e.g. repair rate, etc.) including the criteria permitting the maintenance of the welder qualification without retesting.

   3) The shipyards/manufacturers have to document at least once a year that the welder has produced acceptable welds in accordance with construction quality standards and Society's requirements in the welding positions, type of welds and backing conditions covered by its certificate. Which documents are required and how to document the evidences should be in agreement between the Society and the shipyards/manufacturers.

6.2.2 *(1/1/2018)*

The Society has to verify compliance with the above conditions and sign the maintenance of the welder's qualification certificate.

Part E
Service Notations

Chapter 1
RO-RO CARGO SHIPS

SECTION 4 ELECTRICAL INSTALLATIONS

1 General

1.1 Documentation to be submitted

1.1.1 In addition to the documentation requested in Pt C, Ch 2, Sec 1, Tab 1, the following is to be submitted for approval:

a) plan of hazardous areas

b) document giving details of types of cables and safety characteristics of the equipment installed in hazardous areas.

Table 1 : Electrical equipment permitted in closed ro-ro cargo spaces *(1/1/2022)*

Hazardous area	Spaces		Electrical equipment
	N°	Description	
Zone 1	1	Closed ro-ro cargo spaces except areas under item 3	a) any type that may be considered for zone 0 b) certified intrinsically safe apparatus Ex(ib) c) simple electrical apparatus and components (e.g. thermocouples, photocells, strain gauges, junction boxes, switching devices), included in intrinsically-safe circuits of category “ib” not capable of storing or generating electrical power or energy in excess of limits stated in the relevant rules d) certified flameproof Ex(d) e) certified pressurised Ex(p) f) certified increased safety Ex(e) g) certified encapsulated Ex(m) h) certified sand filled Ex(q) i) certified specially Ex(s) j) cables sheathed with at least one of the following: • a non-metallic impervious sheath in combination with braiding or other metallic covering • copper or stainless steel sheath (for mineral-insulated cables only)

Hazardous area	Spaces		Electrical equipment
	N°	Description	
Zone 1	2	Exhaust ventilation ducts	As stated under item 1
Zone 2	3	On condition that the ventilation system is so designed and operated as to provide continuous ventilation of the cargo spaces at the rate of at least 10 air changes per hour whenever vehicles are on board: • areas above a height of 450mm from the deck • areas above a height of 450mm from each platform for vehicles, if fitted, without openings of sufficient size permitting penetration of petrol gases downward • areas above platforms for vehicles, if fitted, with openings of sufficient size permitting penetration of petrol gases downward	a) any type that may be considered for zone 1 b) tested specially for zone 2 (e.g. type "n" protection) c) pressurised d) encapsulated e) the type which ensures the absence of sparks and arcs and of "hot spots" during its normal operation (~~minimum class of protection~~electrical equipment having an enclosure of at least IP55) f) cables sheathed with at least a non -metallic external impervious sheath

1.2 Safety characteristics

1.2.1 The explosion group and temperature class of electrical equipment of a certified safe type for use with explosive petrol-air mixtures are to be at least IIA and T3.

2 Installation

2.1 Installations in closed ro-ro cargo spaces

2.1.1 Except as provided for in [2.1.2], electrical equipment is to be of a certified safe type as stated in Pt C, Ch 2, Sec 3, [10.1.5] and electrical cables are to be as stated in Pt C, Ch 2, Sec 3, [10.2.2].

2.1.2 Above a height of 450 mm from the deck and from each platform for vehicles, if fitted, except platforms with openings of sufficient size permitting penetration of petrol gases downwards, electrical equipment as stated in Pt C, Ch 2, Sec 3, [10.1.6] and electrical cables as stated in Pt C, Ch 2, Sec 3, [10.2.3]are permitted, on condition that the ventilation system is so designed and operated as to provide continuous ventilation of the cargo spaces at the rate of at least 10 air changes per hour whenever vehicles are on board.

2.1.3 Electrical equipment and cables in an exhaust ventilation duct are to be as stated in [2.1.1].

2.1.4 The requirements in this item are summarised in Tab 1.

2.2 Installations in cargo spaces other than ro-ro cargo spaces but intended for the carriage of motor vehicles

2.2.1 The provisions of [2.1] apply.

2.2.2 All electric circuits terminating in cargo holds are to be provided with multipole linked isolating switches located outside the holds. Provision is to be made for locking in the off position.

This requirement does not apply to safety installations such as fire, smoke or gas detection systems.

3 Type approved components

3.1

3.1.1 Alarm systems for closing devices of openings and water leakage detection systems if of electronic type, as well as television surveillance systems, are to be type approved or in accordance with [3.1.2].

3.1.2 Case-by-case approval based on submission of adequate documentation and execution of tests may also be granted at the discretion of the Society.

Part E

Service Notations

Chapter 5

ORE CARRIERS

SECTION 3 HULL AND STABILITY

Symbols

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

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

E : Young's modulus, in N/mm², to be taken equal to:

- $E = 2{,}06.10^5$ N/mm² for steels in general
- $E = 1{,}95.10^5$ N/mm² for stainless steels.

1 General

1.1 Loading manual and loading instruments

1.1.1 The specific requirements in Pt B, Ch 11, Sec 2 for ships with the service notation **ore carrier ESP** and equal to or greater than 150 m in length are to be complied with.

2 Stability

2.1 Intact stability

2.1.1 General

The stability of the ship for the loading conditions in Pt B, Ch 3, App 2, [1.2.5] is to be in compliance with the requirements in Pt B, Ch 3, Sec 2. Where the ship is intended also for the carriage of grain, the requirements in Ch 4, Sec 3, [2.2.2] and Ch 4, Sec 3, [2.2.3] are to be complied with.

3 Design loads

3.1 Hull girder loads

3.1.1 Still water loads *(1/1/2022)*

In addition to the requirements in Pt B, Ch 5, Sec 2, [2.1.2], still water loads are to be calculated for the following loading conditions, subdivided into departure and arrival conditions as appropriate:

- alternate light and heavy cargo loading conditions at maximum draught
- homogeneous light and heavy cargo loading conditions at maximum draught

Figure 1 : Symmetrical gusset/shedder plates

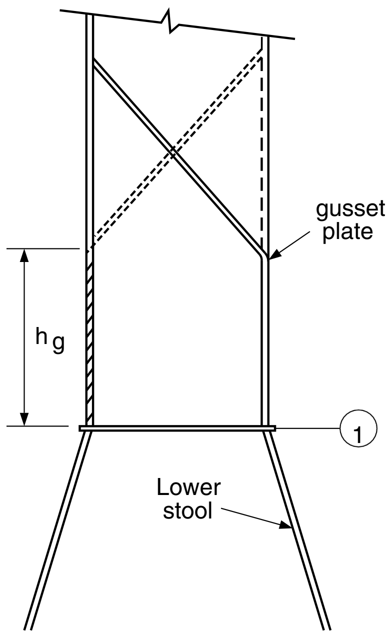
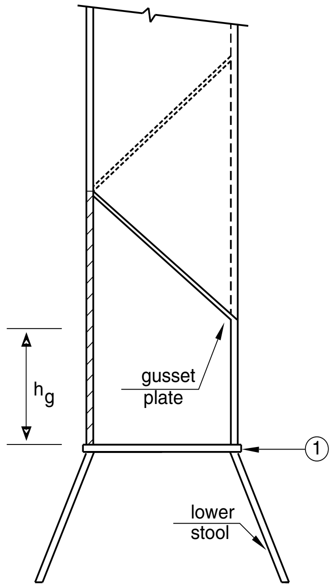
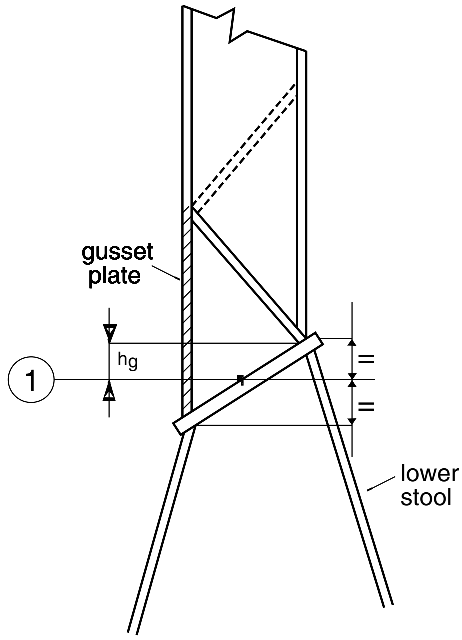


Figure 2 : Asymmetrical gusset/shedder plates



- ballast conditions; App 1 contains the guidance for partially filled ballast tanks in ballast loading conditions.
- short voyage conditions where the ship is to be loaded to maximum draught but with a limited amount of bunkers
- multiple port loading/unloading conditions
- deck cargo conditions, where applicable
- typical loading sequences where the ship is loaded from commencement of cargo loading to reaching full deadweight capacity, for homogeneous conditions, relevant part load conditions and alternate conditions where applicable. Typical unloading sequences for these conditions are also to be included. The typical loading/unloading sequences are also to be developed so as not to exceed applicable strength limitations. The typical loading sequences are also to be developed paying due attention to the loading rate and deballasting capability.
- typical sequences for change of ballast at sea, where applicable.

Figure 3 : Asymmetrical gusset/shedder plates Sloping stool top plate



4 Structure design principles

4.1 Double bottom structure

4.1.1 The double bottom is to be longitudinally framed.

The girder spacing is to be not greater than 4 times the spacing of bottom or inner bottom ordinary stiffeners and the floor spacing is to be not greater than 3 frame spaces.

Solid floors are to be fitted in line with the transverse primary supporting members in wing tanks and intermediate floors are to be added at mid-span between primary supporting members.

4.1.2 Other arrangements may be accepted by the Society, on a case-by-case basis, depending on the results of the analysis carried out according to Pt B, Ch 7, App 1 for the primary supporting members in the cargo holds.

4.1.3 Scarfing of the double bottom structure into the wing tanks is to be properly ensured. The inner bottom plating is generally to be prolonged within the wing tanks by adequately sized horizontal brackets in way of floors.

4.2 Side structure

4.2.1 In ships greater than 120 m in length, the side shell is to be longitudinally framed.

In general, the spacing of vertical primary supporting members is to be not greater than 6 times the frame spacing.

4.2.2 Other arrangements may be accepted by the Society, on a case-by-case basis, depending on the results of the analysis carried out according to Pt B, Ch 7, App 1 for the primary supporting members in the cargo hold.

APPENDIX 1 GUIDELINES FOR BALLAST LOADING CONDITIONS OF CARGO VESSELS INVOLVING PARTIALLY FILLED BALLAST TANKS

1 General guidance note

1.1 Introduction

1.1.1 *(1/1/2022)*

This Appendix is intended to provide guidance and interpretation of "Partially filled ballast tanks in ballast loading conditions" in Pt B, Ch 5, Sec 2, [2.1.2], b) and illustrates the conditions (C) necessary for checking longitudinal strength for a conventional ore carrier with two pairs of large wing water ballast tanks partly filled during the ballast voyage.

1.1.2 *(1/1/2022)*

In the Figures, the conditions only intended for strength verification (not operational) are marked with a star (*).

2 Conventional (with usual arrangement of WBT) ore carrier with two pairs of partially filled ballast water tanks

2.1 General

2.1.1 *(1/1/2022)*

Fig. 1 show the operational loading conditions, departure condition (C1), four intermediate conditions (C2-C5) and arrival condition (C6), for a conventional (with usual arrangement of WBT) ore carrier with partial filling of both BW tank no.1 (P/S) and 7 (P/S) during voyage.

Table 1 : Filling level in partially filled BW tanks nos.1 (P/S) and 7 (P/S) for the operational conditions during ballast voyage *(1/1/2022)*

Loading condition	Consumables	Filling level, WBT 1(P/S)	Filling level, WBT 7(P/S)
C1 - Departure	100%	f_{1dep}%	f_{7dep}%
C2 – Intermediate 1	50% (1)	f_{1dep}%	f_{7dep}%
C3 – Intermediate 2	50% (1)	f_{1int}%	f_{7int}%
C4 – Intermediate 3	20% (1)	f_{1int}%	f_{7int}%
C5 – Intermediate 4	20% (1)	f_{1arr}%	f_{7arr}%
C6 - Arrival	10%	f_{1arr}%	f_{7arr}%

Note:
(1) % consumables to be specified, indicated to 50% and 20 %

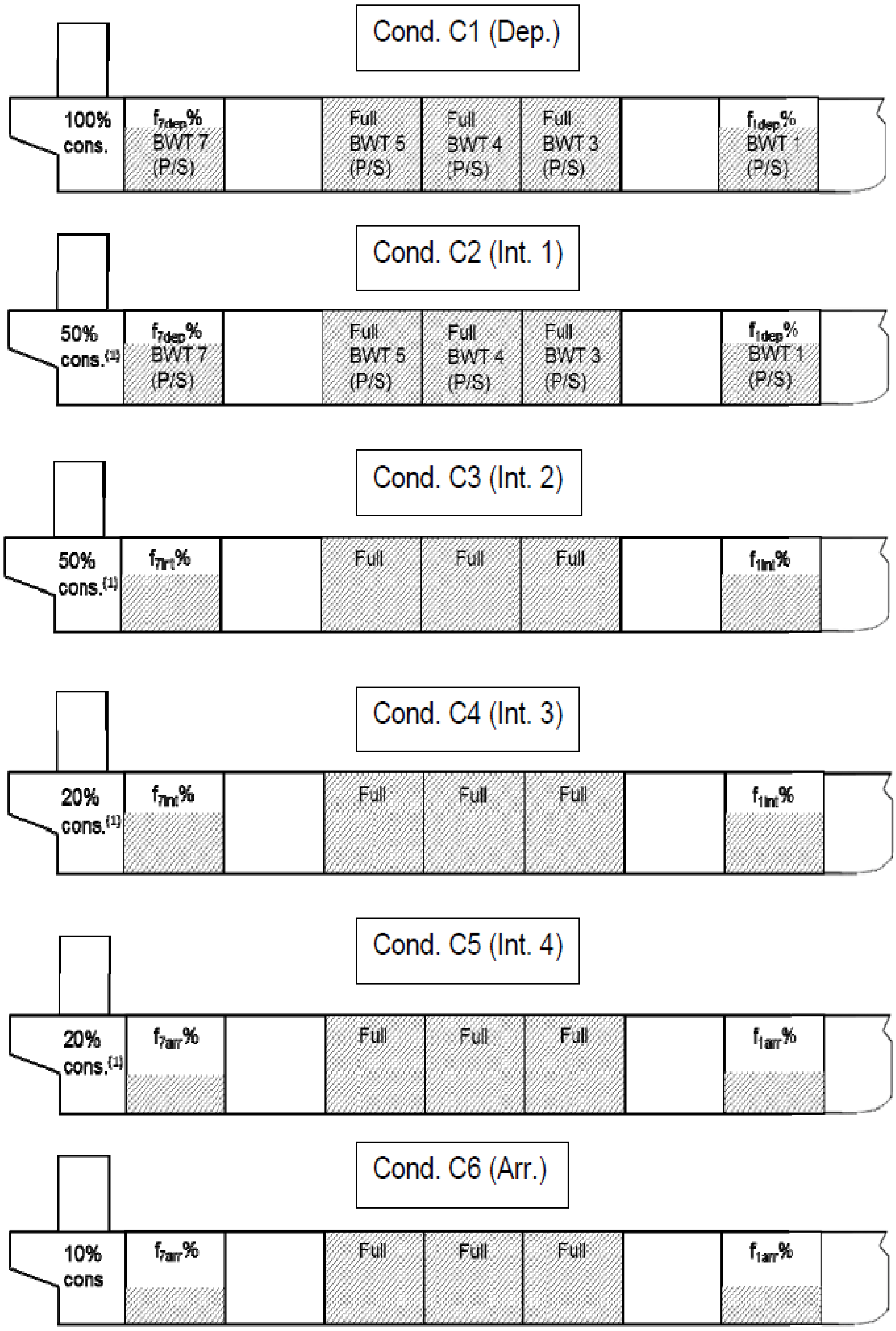
Fig. 2 and Fig 3 show the additional twelve loading conditions (C1-1 ~ C1-12) which are to be added for longitudinal strength verification of the departure condition (C1).

Fig. 4 and Fig 9 show the additional 32 loading conditions (C2-1 ~ C2-12, C3-1 ~ C3-4, C4-1 ~ C4-12 and C5-1 ~ C5-4) which are to be added for longitudinal strength verification of the intermediate conditions (C2 ~ C5).

Fig. 10 and Fig 11 show the additional twelve loading conditions (C6-1 ~ C6-12) which are to be added for longitudinal strength verification of the arrival condition (C6).

For the additional loading conditions, the maximum and the minimum filling level of BW tank are according to trim and propeller immersion limitations given in Pt B, Ch 5, Sec 2, [2.1.2], b).

Figure 1 : _(1/1/2022)_



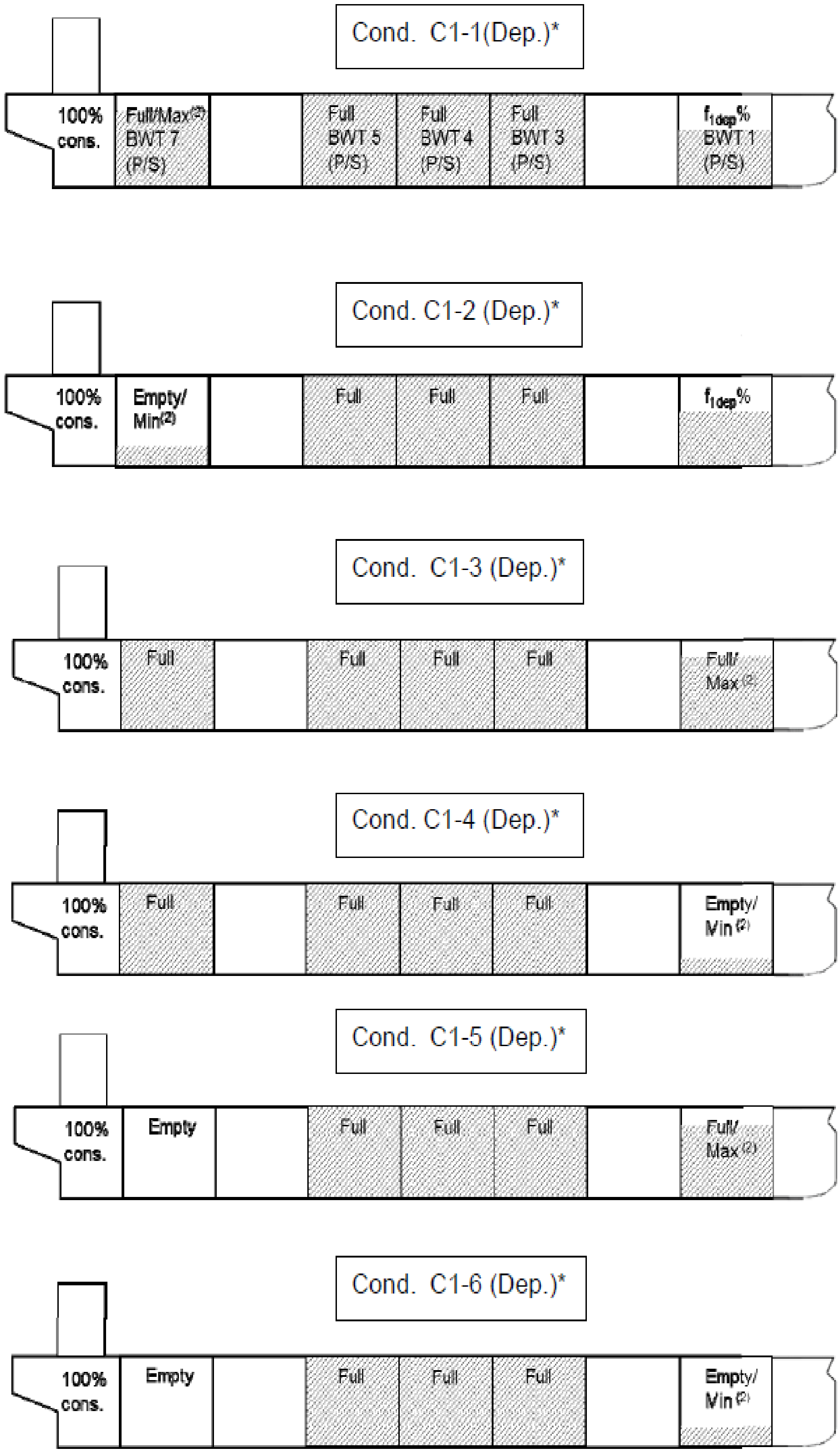
Ore Carrier. Partial filling of BW Tank no.1 (P/S) and 7 (P/S) during ballast voyage, operational conditions C1-C6.

Notes:

(1) The intermediate condition(s) to be specified incl. % consumables.

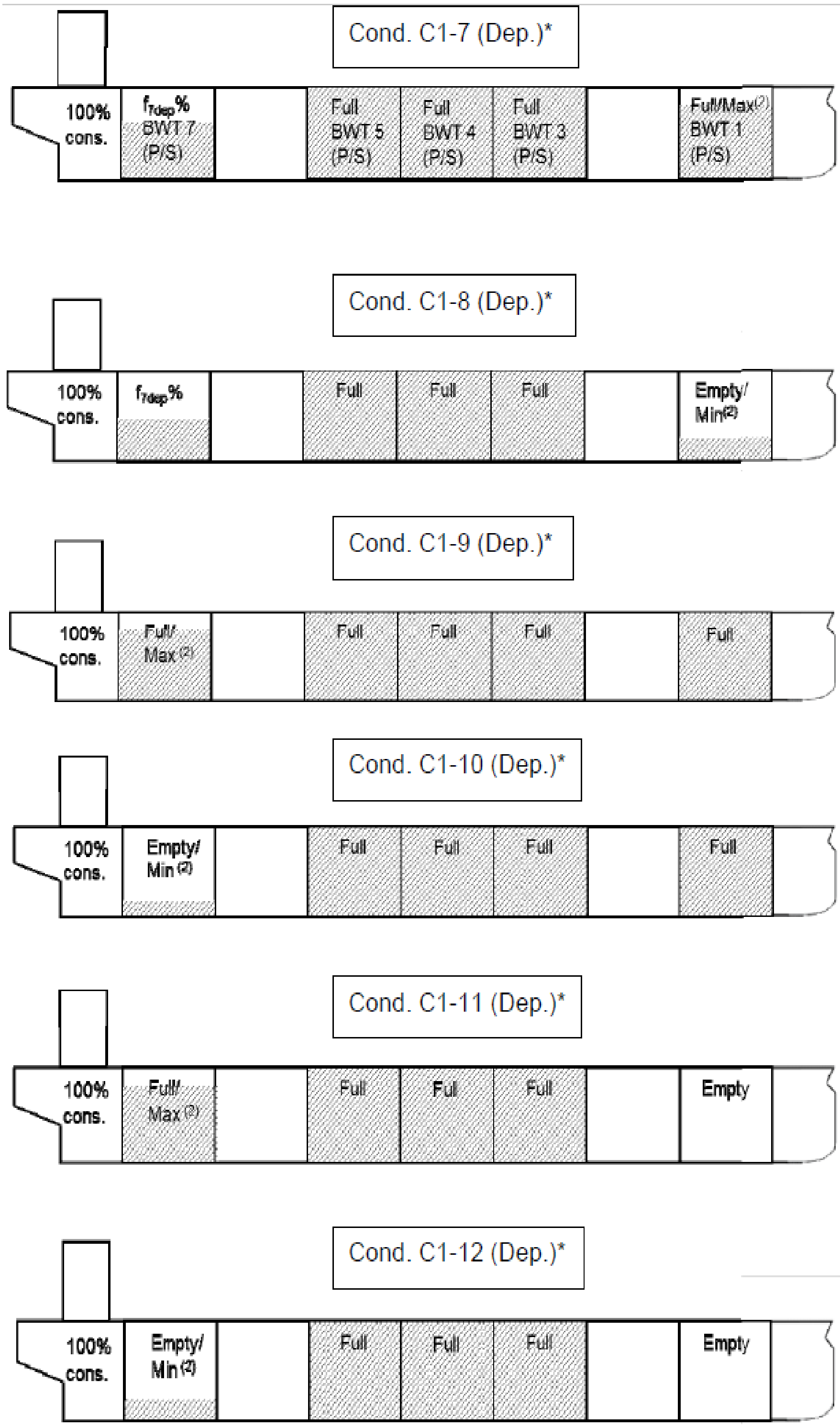
(2) Figures 2-11: Maximum and minimum filling level of BW tank according to trim and propeller immersion limitations given in Pt B, Ch 5, Sec 2, [2.1.2], b).

Figure 2 : (1/1/2022)



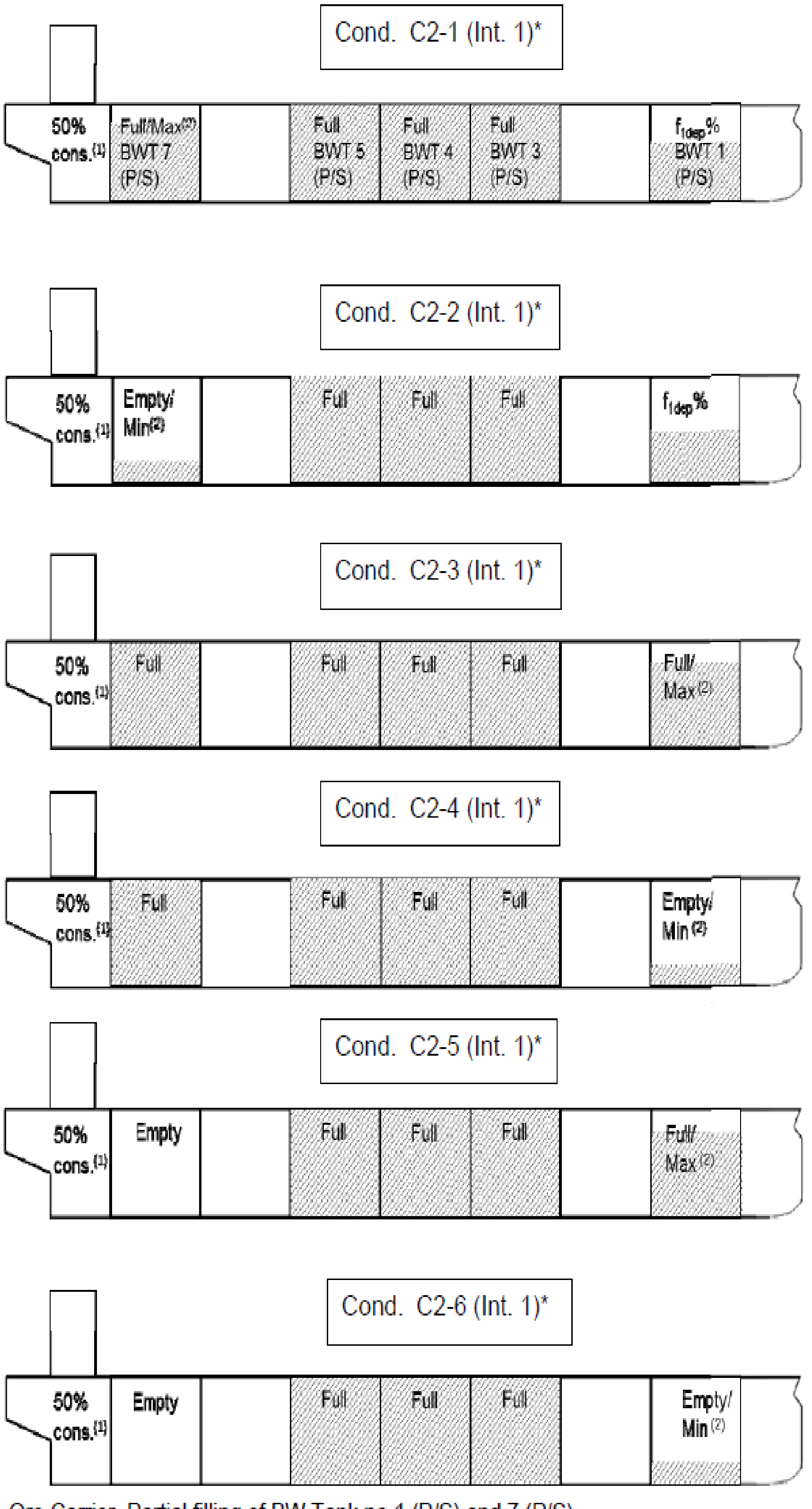
Ore Carrier. Partial filling of BW Tank no.1 (P/S) and 7 (P/S) during voyage. Departure conditions C1-1~C1-6, only intended for strength verification (not operational) are marked: *

Figure 3 : *(1/1/2022)*



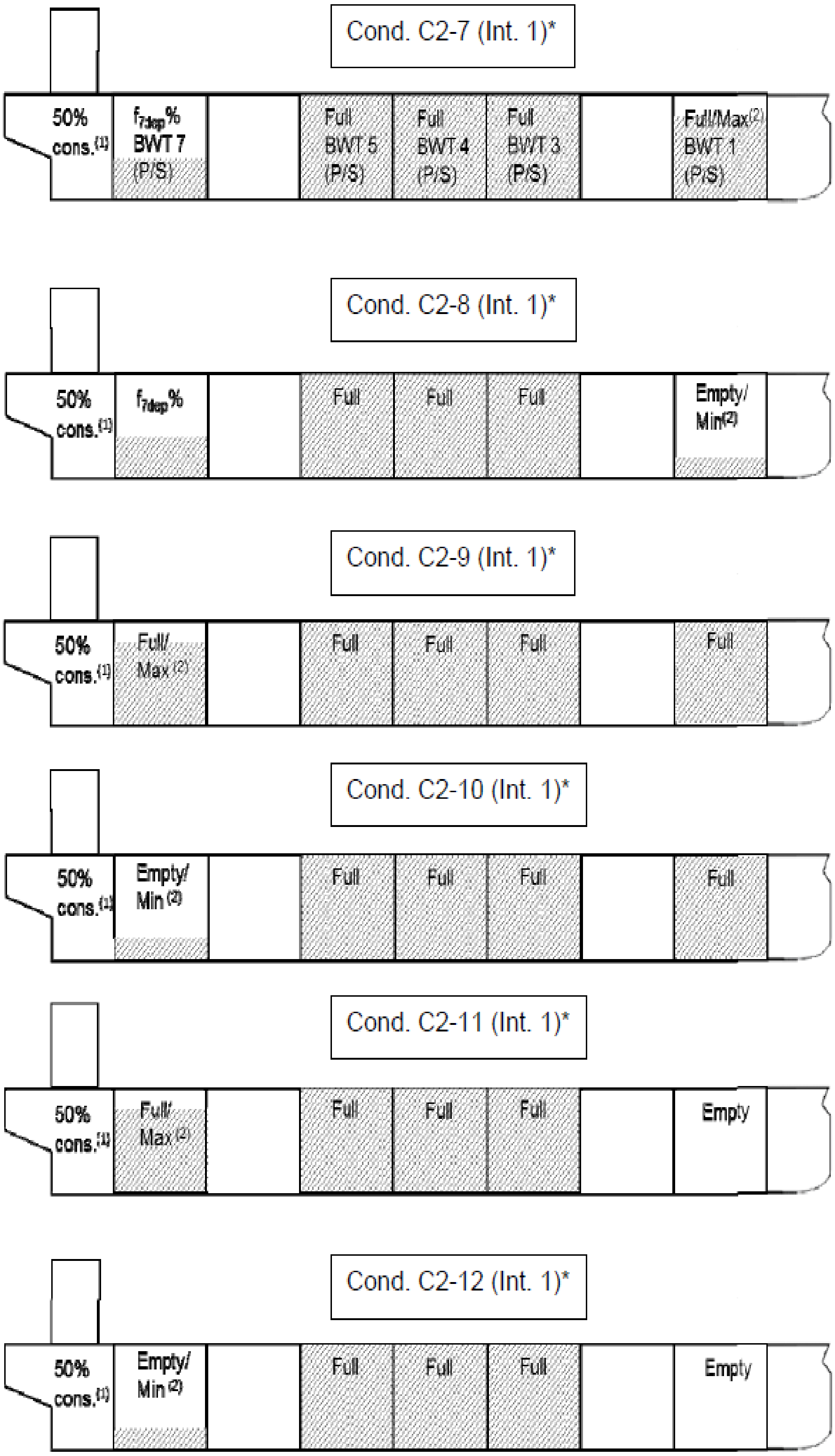
Ore Carrier. Partial filling of BW Tank no.1 (P/S) and 7 (P/S) during voyage. Departure conditions CD1-7~C1-12, only intended for strength verification (not operational) are marked: *

Figure 4 : _(1/1/2022)_



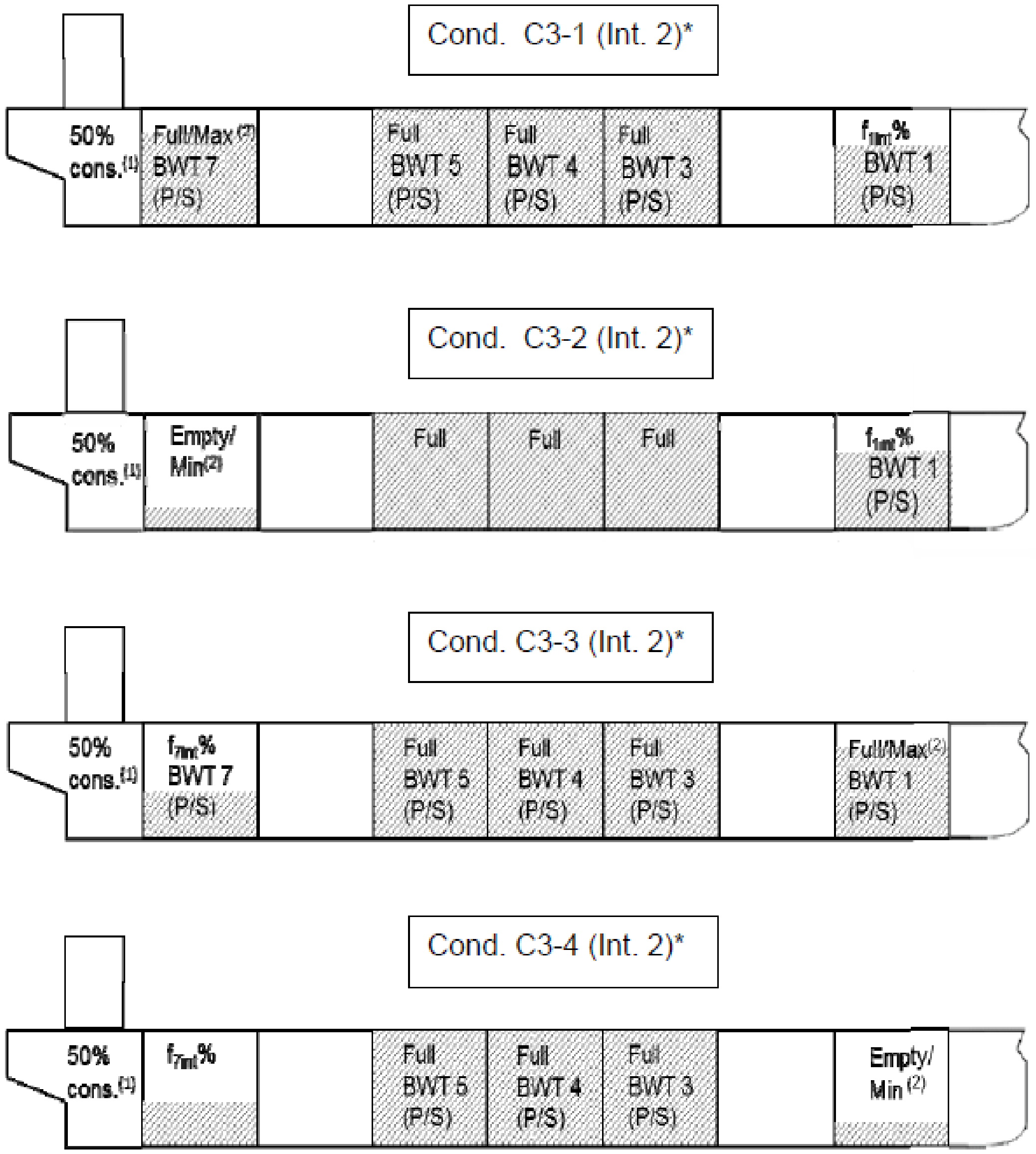
Ore Carrier. Partial filling of BW Tank no.1 (P/S) and 7 (P/S) during voyage. Intermediate conditions C2-1~C2-6, only intended for strength verification (not operational) are marked: *

Figure 5 : _(1/1/2022)_



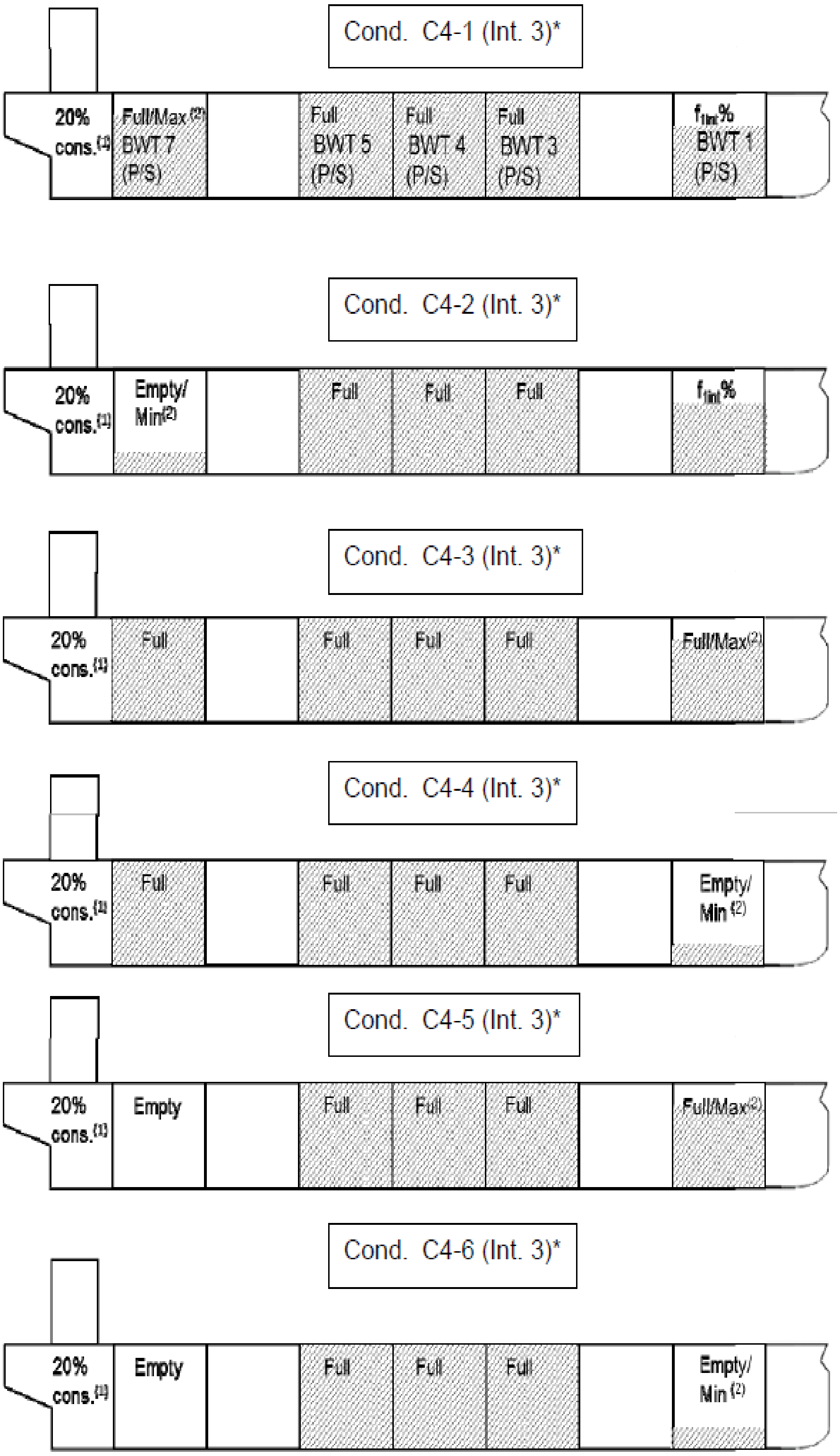
Ore Carrier. Partial filling of BW Tank no.1 (P/S) and 7 (P/S) during voyage. Intermediate conditions C2-7~C2-12, only intended for strength verification (not operational) are marked: *

Figure 6 : *(1/1/2022)*



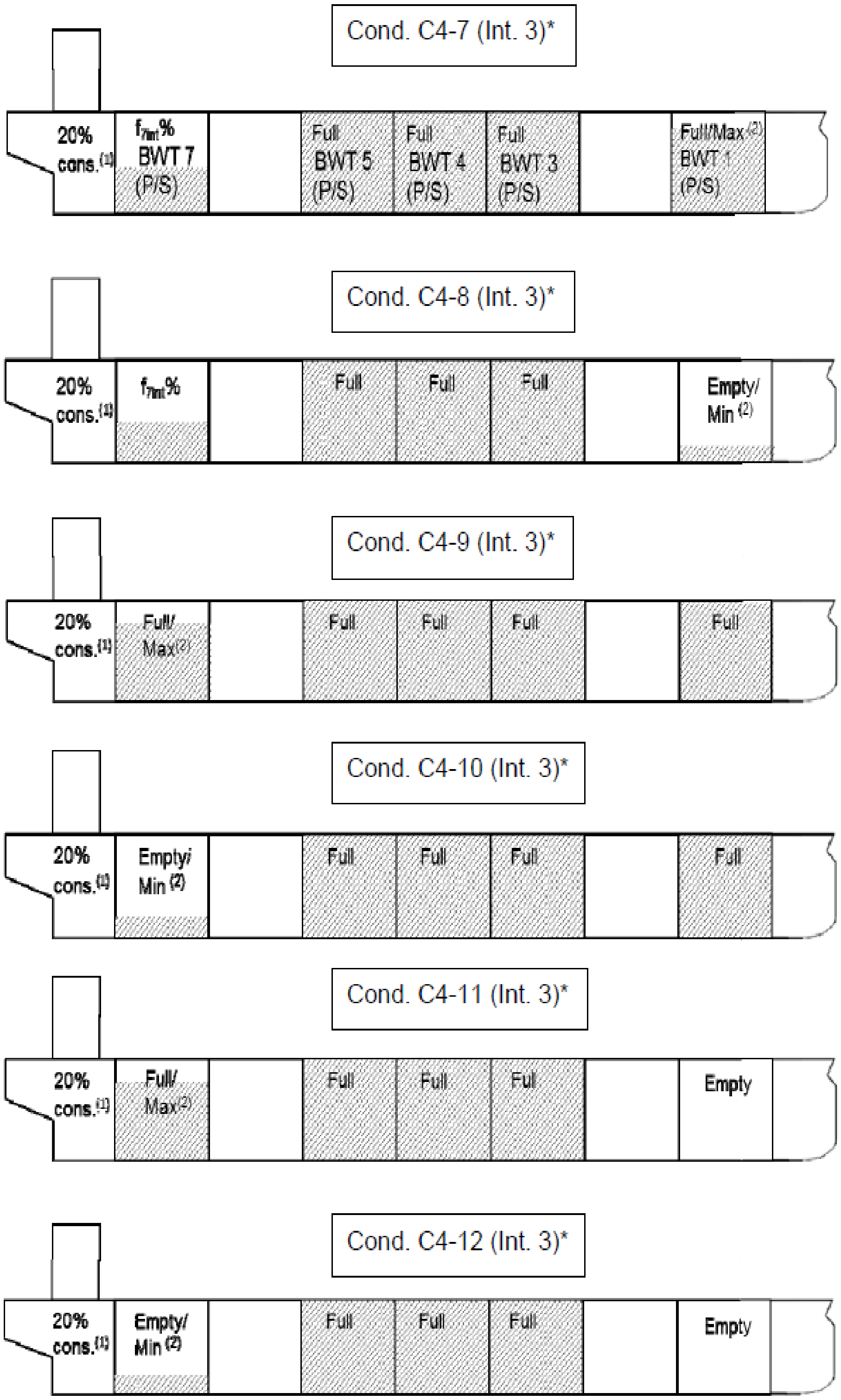
Ore Carrier. Partial filling of BW Tank no.1 (P/S) and 7 (P/S) during voyage. Intermediate conditions C3-1~C3-4, only intended for strength verification (not operational) are marked: *

Figure 7 : *(1/1/2022)*



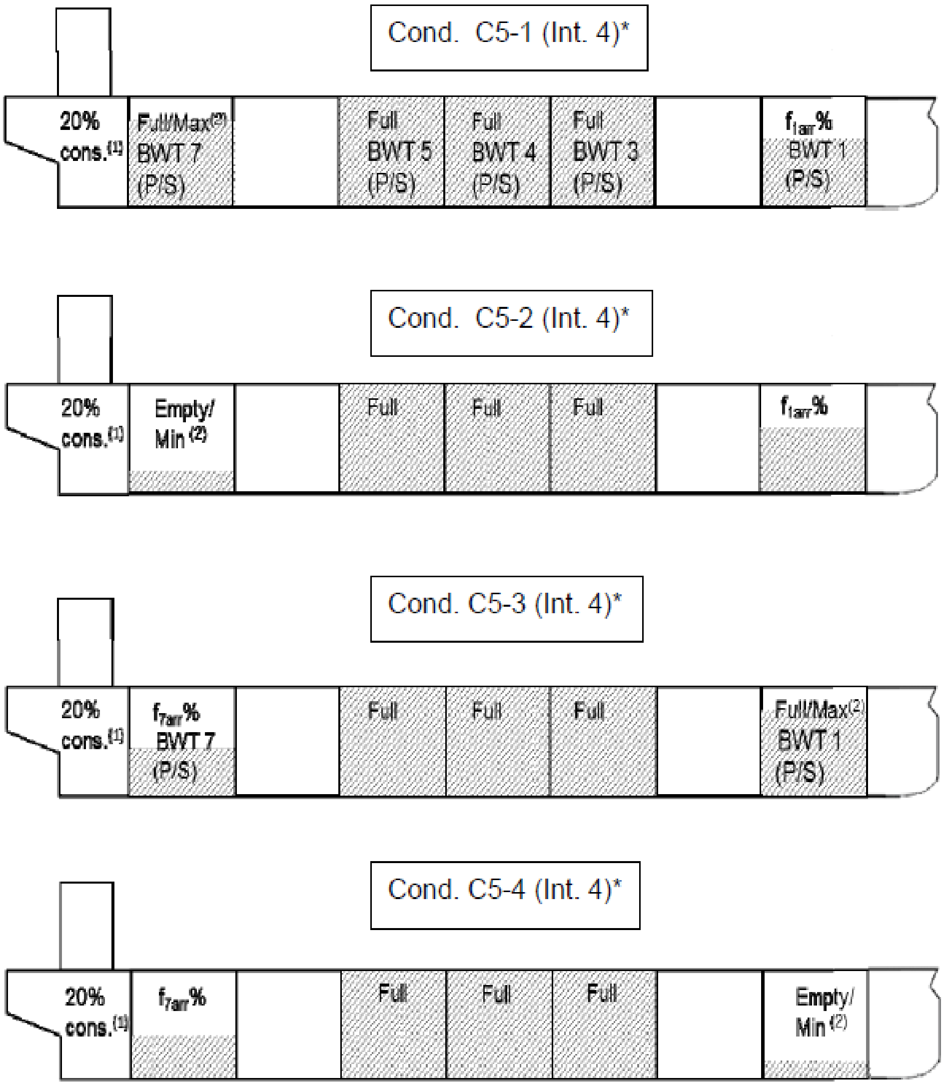
Ore Carrier. Partial filling of BW Tank no.1 (P/S) and 7 (P/S) during voyage. Intermediate conditions C4-1~C4-6, only intended for strength verification (not operational) are marked: *

Figure 8 : _(1/1/2022)_



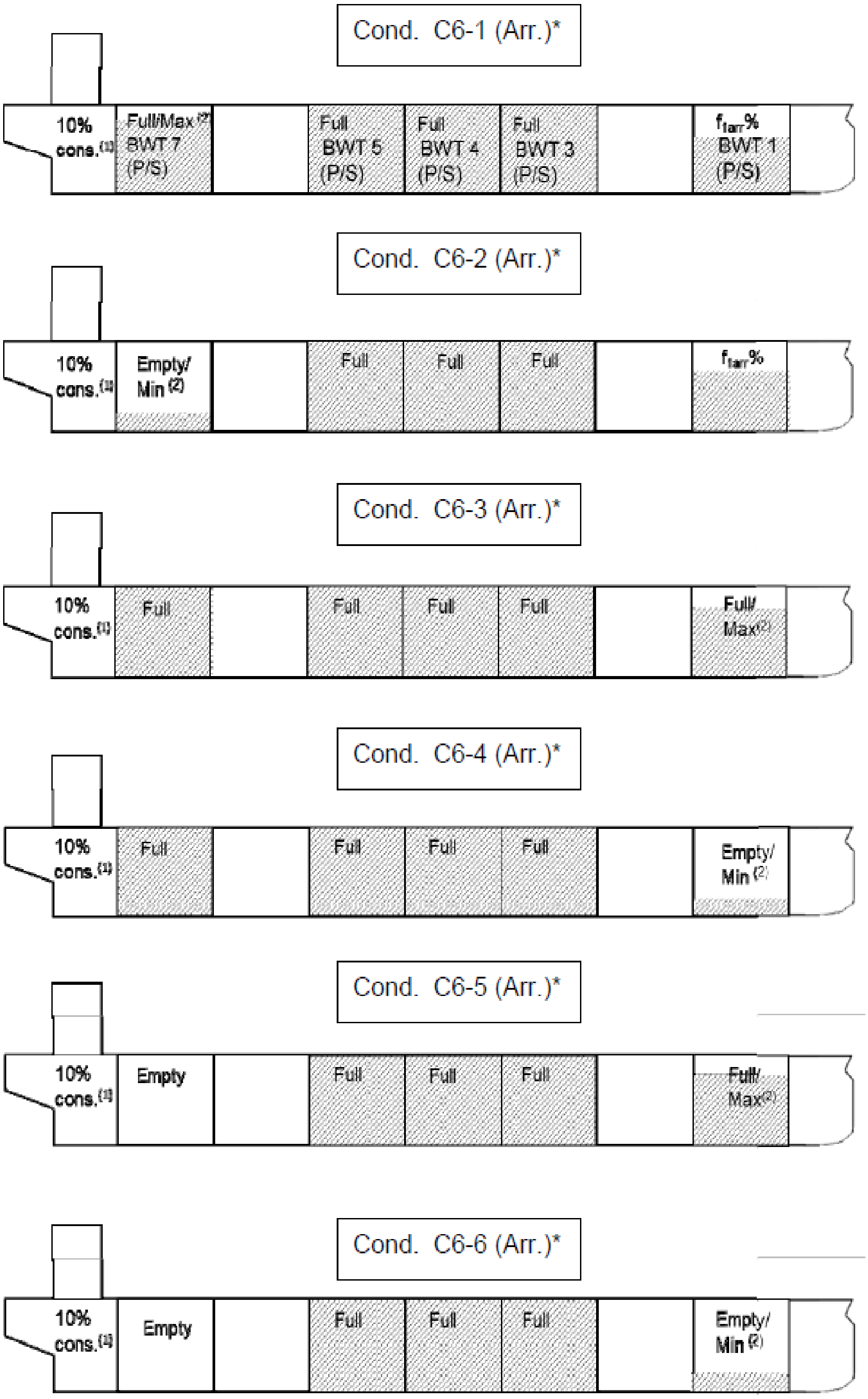
Ore Carrier. Partial filling of BW Tank no.1 (P/S) and 7 (P/S) during voyage. Intermediate conditions C4-7~C4-12, only intended for strength verification (not operational) are marked: *

Figure 9 : _(1/1/2022)_



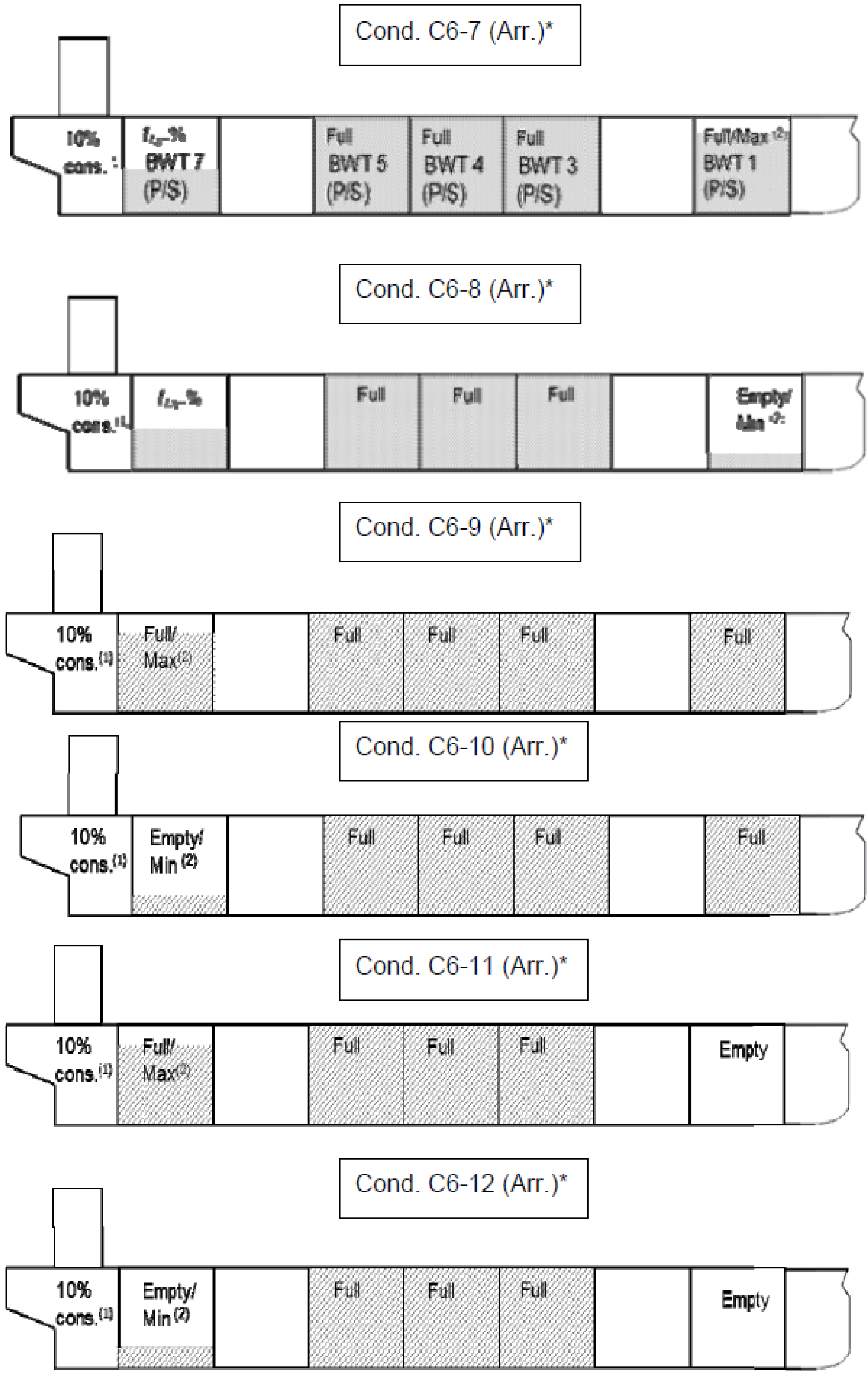
Ore Carrier. Partial filling of BW Tank no.1 (P/S) and 7 (P/S) during voyage. Intermediate conditions C5-1~C5-4, only intended for strength verification (not operational) are marked: *

Figure 10 : _(1/1/2022)_



Ore Carrier. Partial filling of BW Tank no.1 (P/S) and 7 (P/S) during voyage. Arrival conditions C6-1~C6-6, only intended for strength verification (not operational) are marked: *

Figure 11 : _(1/1/2022)_



Ore Carrier. Partial filling of BW Tank no.1 (P/S) and 5 (P/S) during voyage. Arrival conditions C6-7~C6-12, only intended for strength verification (not operational) are marked: *

Part E
Service Notations

Chapter 11
PASSENGER SHIPS

SECTION 3 HULL AND STABILITY

1 Stability

1.1 Intact stability

1.1.1 General

Every passenger ship regardless of size is to be inclined upon its completion and the elements of its stability determined. The Master is to be supplied with such information satisfactory to the Society as is necessary to enable him by rapid and simple processes to obtain accurate guidance as to the stability of the ship under varying conditions of service. A copy of the stability information is to be furnished to the Society.

Where any alterations are made to a ship so as to materially affect the stability information supplied to the Master, amended stability information is to be provided. If necessary the ship is to be re-inclined.

1.1.2 Standard requirements

In addition to Pt B, Ch 3, Sec 2, [2] the requirements in [1.1.3] to [1.1.5] are to be complied with for the loading conditions defined in Pt B, Ch 3, App 2, [1.2.1] and Pt B, Ch 3, App 2, [1.2.9].

1.1.3 Crowding of passengers

The angle of heel on account of crowding of passengers to one side as defined in [1.1.4] may not exceed 10° and any event the freeboard deck is not to be immersed.

For ships lesser than 20 m in length, the angle of heel is not to be greater than the angle corresponding to a freeboard of 0,1 m before the deck's immersion, or 12° if less.

In elaborating the stability booklet, the following is to be assumed:

- *A minimum weight of 75 kg for each passenger except that this value may be increased subject to the approval of the Society. In addition, the mass and distribution of the luggage is to be approved by the Society.*
- *The height of the centre of gravity for passengers shall be assumed equal to:*
  - *1 m above deck level for passengers standing upright. Account may be taken, if necessary, of camber and sheer of deck; and*
  - *0,3 m above the seat in respect of seated passengers.*
- *Passengers and luggage shall be considered to be in the spaces normally at their disposal, when assessing compliance with the criteria given in Pt B, Ch 3, Sec 2 [2.1.2] to [2.1.5].*
- *Passengers without luggage shall be considered as distributed to produce the most unfavourable combination of passenger heeling moment and/or initial metacentric height, which may be obtained in practice, when assessing compliance with the criteria given in [1.1.4] and [1.1.5], respectively. In this connection, a value higher than four persons per square metre is not necessary.*

1.1.4 Maximum turning angle

The angle of heel on account of turning may not exceed 10° when calculated using the following formula:

$$M_R = 0,200\frac{V_0^2}{L_{WL}}\Delta\left(KG - \frac{d}{2}\right)$$

where:

M_R : *Heeling moment, in kNm*

V_0 : *Service speed, in m/s*

L_{WL} : *Length of ship at waterline, in m*

Δ : *Displacement, in t*

d : *Mean draught, in m*

KG : *Height of centre of gravity above keel, in m.*

1.1.5 *Where anti-rolling devices are installed in a ship, the Society is to be satisfied that the above criteria can be maintained when the devices are in operation.*

1.1.6 Ships engaged in still waters *(1/1/2022)*

a) Loading conditions

In addition to the loading conditions considered in Pt B, Ch 3, App 2, [1.2.1] and Pt B, Ch 3, App 2, [1.2.9], the loading condition at arrival, without cargo, with necessary water ballast, with all passengers, on all decks assigned to them, crowded on the same side of the ship, is also to be considered.

If in any real loading condition the stability of the ship is less favourable than in the requested conditions, the stability requirements are also to be checked in such real condition.

In elaborating the stability booklet, the following is to be assumed:

- weight of each person equal to 75 kg;
- centre of gravity of each person, both standing and sitting, equal to 0,90 m above the upper surface of the relevant deck;
- maximum allowable number of persons equal to the number of sitting places plus two passengers/m^2 in the areas available for passengers, clear from the persons seated.

A higher number of standing persons may be assumed provided that the competent authority agrees.

In calculating the area in which the passengers are crowded among the benches, the distance between two of them may be reduced by 0,3 m x l (length of the bench) to exclude the area obstructed by sitting passengers.

b) Stability requirements in all required loading conditions

The following stability requirements are to be complied with:

1) (r-a) to be not less than 0,30 m.

   To this end passengers are to be considered accommodated taking all the sitting places and areas assigned to them with 4 passengers/m^2, starting from the highest deck and proceeding to lower decks until the maximum allowable number of passengers is exceeded;

2) Distance between the upper surface of the main deck, at side, from the waterline in the final equilibrium status of heeled ship (residual minimum freeboard) to be not less than 0,20 m. For this purpose, passengers are to be considered accommodated on one side of the ship only, from the ship's centreline, taking all the sitting places and areas assigned to them with 4 passengers/m^2, starting from the highest deck and proceeding to lower decks until the maximum allowable number of passengers is exceeded.

   If the number of all the passengers on one side of the ship does not reach the maximum allowable number, the surplus of passengers is to be ignored in calculating the transversal heeling of the ship.

3) The maximum allowable number of passengers is to be the lower of 1 and 2 above. Such number may be further reduced taking into account the following:

   - if the value calculated according to 1 leads to a value of (r-a) less than 0,30 m and this cannot be avoided by the use of ballast of the ship, or by other suitable operations, such number is to be decreased in the calculation by unloading a suitable number of passengers, starting from the lower deck, until (r-a) not less than 0,30 m is reached. Therefore, the resulting reduced number of passengers is to replace the one resulting from 1
   - if the residual freeboard, calculated through the passenger distribution according to 2, is less than 0,20 m and it cannot be increased by ballasting the ship, or by other suitable operations, the number of passengers calculated according to 2 is to be decreased in the calculation by unloading a suitable number of passengers, starting from those standing closest to the midship plane on the lower deck. Obviously, in such operation an upper deck is not affected by unloading of passengers as far as first all those standing, and then those sitting, in the lower deck are unloaded.

     The resulting reduced number of passengers is to replace the one resulting from 2.

4) In the case of longitudinal obstructions, such as seats, railings or nets, fitted to prevent passengers from crowding on one side of the ship, the Society may, at its discretion, relax the above-mentioned requirements, reducing the level of crowding of standing persons. Such longitudinal obstructions may be partially movable for the purpose of ensuring a suitable distribution of embarking passengers; nevertheless, the crew undertakes to put the longitudinal obstructions temporarily removed back in place, before the voyage starts.

5) To facilitate the calculations, it is permissible not to take into account both the shear and the camber of the ship, but to evaluate the vertical positions of all the centres of gravity referring to the section at ½ L.

6) Any opening sidescuttles located below the upper deck which, because of the transversal heeling of the ship, may have their lowest point less than 0,20 m above the final waterline, are to be fitted with efficient devices such that they can be effectively closed and secured, under the Master's responsibility, while the passengers are on board. Such condition is to be noted in the ship's logbook. It is allowable in the calculations that such sidescuttles are partially or fully submerged at the end of the heeling.

7) In the case of decked ships of length less than 20 m, item b) applies ~~except that~~and the required residual freeboard on the side of passenger crowding, to be not less than 0,20 m, is to correspond to a heeling angle not more than 15°. In the case of ships without decks, the residual freeboard after heeling due to the crowding of passengers on one side of the ship is to be not less than 0,30 m with an angle of heel not greater than 15°.

2 Structure design principles

2.1 Hull structure

2.1.1 Framing

In general, the strength deck and the bottom of passenger ships of more than 100 m in length are to be longitudinally framed.

Where a transverse framing system is adopted for such ships, it is to be considered by the Society on a case-by-case basis.

3 Hull girder strength

3.1 Basic criteria

3.1.1 Strength deck

In addition to the requirements in Pt B, Ch 6, Sec 1, [2.2], the contribution of the hull structures up to the strength deck to the longitudinal strength is to be assessed through a finite element analysis of the whole ship in the following cases:

- when the size of openings in the side shell and/or longitudinal bulkheads located below the deck assumed by the Designer as the strength deck decrease significantly the capability of the plating to transmit shear forces to the strength deck
- when the ends of superstructures which are required to contribute to longitudinal strength may be considered not effectively connected to the hull structures in way.

6 Hull outfitting

6.1 Equipment

6.1.1 Number of mooring lines

The specific requirements in Pt B, Ch 10, Sec 4, [3.5] for ships with the service notation **passenger ship** are to be complied with.

6.1.2 Ships having L ≤ 30 m and navigation notation other than unrestricted navigation

For ships having L ≤ 30 m and navigation notation other than **unrestricted navigation**:

- the equipment in stockless anchor and chain cables (or ropes according to Pt B, Ch 10, Sec 4, [3.3.5]) may be obtained from Tab 2
- the equipment in mooring lines of wire or natural fibre may be obtained from Tab 3.

Table 3 : Mooring lines *(1/1/2022)*

Equipment number EN A < EN ≤ B		Mooring lines		
A	B	N	Length of each line, in m	Ship Design Minimum Breaking Load ~~Breaking load~~, in kN
19	50	2	40	32
50	70	3	40	34
70	90	3	50	37
90	110	3	55	39
110	130	3	55	44
130	150	3	60	49
150	175	3	60	54

7 Windows and sidescuttles

7.1 Application

7.1.1

The requirements in [7.2] apply to windows and sidescuttles, located in positions which are exposed to the action of sea and/or bad weather.

7.2 Thickness of glasses

7.2.1 General

The minimum thickness t, in mm, of glasses is to be obtained from the formula in [7.2.2] and [7.2.3], where:

b : length of the shorter window side, in mm

p : design pressure, in kN/m², defined in [7.2.4]

d : diameter of the window, in mm

$$\beta = 0,54A_r - 0,078A_r^2 - 0,17 \quad \text{for } (A_r < 3)$$

$$\beta = 0,75 \quad \text{for } A_r \geq 3$$

$$A_r = \frac{a}{b}$$

a : length of the longer window side, in mm

7.2.2 Rectangular windows

$$t = \frac{b}{200}\sqrt{\beta p}$$

7.2.3 Circular windows

$$t = \frac{d}{400}\sqrt{p}$$

7.2.4 Design pressure *(1/7/2020)*

The design pressure p, in KN/m², is to be obtained from Tab 4, where:

where:

f_w : 12,5 in way of sides and ends of superstructures

f_w : 7,5 in way of house fronts

Z_1 : vertical distance, in m, from the base line to the point where the calculated pressure p_0 is 15 kN/m²

Z_2 : vertical distance, in m, from the base line to the deck immediately above Z_1

Z_w : vertical distance, in m, from the base line to the point under consideration

H_{td} : sum of the two 'tweendeck heights, in m, above Z_2

$$p_0 = 10ac[bf - (z - T)]$$

a : Coefficient defined in Tab 5 to be taken not greater than the maximum value, a_{max}, specified in Tab 5

c : Coefficient taken equal to:

$$c = 0,3 + 0,7\frac{b_1}{B_1}$$

Part E
Service Notations

Chapter 12
RO-RO PASSENGER SHIPS

SECTION 3 HULL AND STABILITY

1 Stability

1.1 Intact stability

1.1.1 General

Every ro-ro passenger ship regardless of size is to be inclined upon its completion and the elements of its stability determined. The Master is to be supplied with such information satisfactory to the Society as is necessary to enable him by rapid and simple processes to obtain accurate guidance as to the stability of the ship under varying conditions of service. A copy of the stability information is to be furnished to the Society.

Where any alterations are made to a ship so as to materially affect the stability information supplied to the Master, amended stability information is to be provided. If necessary the ship is to be re-inclined.

The Society may allow the inclining test of an individual ship to be dispensed with provided basic stability data are available from the inclining test of a sister ship and it is shown to the satisfaction of the Society that reliable stability information for the exempted ship can be obtained from such basic data.

1.1.2 Periodical lightweight check

At periodical intervals not exceeding five years, a lightweight survey is to be carried out on all ro-ro passenger ships to verify any changes in lightship displacement and longitudinal centre of gravity. The ship is to be re-inclined whenever, in comparison with the approved stability information, a deviation from the lightship displacement exceeding 2% or a deviation of the longitudinal centre of gravity exceeding 1% of L_s is found, or anticipated.

1.1.3 Standard requirements

In addition to Pt B, Ch 3, Sec 2, [2] the requirements in [1.1.4] to [1.1.7] are to be complied with for the loading conditions defined in Pt B, Ch 3, App 2, [1.2.1] and Pt B, Ch 3, App 2, [1.2.9].

1.1.4 Crowding of passengers

The requirements of Ch 11, Sec 3, [1.1.3] apply.

1.1.5 Maximum turning angle

The requirements of Ch 11, Sec 3, [1.1.4] apply.

1.1.6 Anti-rolling devices

Where anti-rolling devices are installed in a ship, the Society is to be satisfied that the above criteria can be maintained when the devices are in operation.

1.1.7 Stability booklet for ro-ro ships

The stability booklet of ro-ro ships is to contain information concerning the importance of securing and maintaining all closure watertight integrity, due to the rapid loss of stability which may result when water enters the vehicle deck and the fact that capsize can rapidly occur.

2 Structure design principles

2.1 General

2.1.1 Wood sheathing is recommended for caterpillar trucks and unusual vehicles.

It is recommended that a piece of wood of suitable thickness should be fitted under each crutch in order to distribute the mass over the plate and the nearest stiffeners.

2.2 Hull structure

2.2.1 Framing

In general, the strength deck and the bottom are to be longitudinally framed.

Where a transverse framing system is adopted for such ships, it is to be considered by the Society on a case by case basis.

2.2.2 Side structures

Where decks are fitted with ramp openings adjacent to the ship's side, special consideration is to be given to the supports for the side framing.

3 Design loads

3.1 Wheeled loads

3.1.1 The wheeled loads induced by vehicles are defined in Pt B, Ch 5, Sec 6, [6].

3.2 Accommodation

3.2.1 Lowest 0,5 m of bulkheads forming vertical division along escape routes

The still water and inertial pressures transmitted to the structures *belonging to lowest 0,5 m of bulkheads and other partitions forming vertical divisions along escape routes* are to be obtained, in kN/m², as specified in Pt B, Ch 5, Sec 6, [7], where the value p_S is to be taken not less than 1,5 kN/m² *to allow them to be used as walking surfaces from the side of the escape route with the ship at large angles of heel.*

6.3.5 The indicator system is to be designed on the fail-safe principle and is to show by visual alarms if the door is not fully closed and not fully locked and by audible alarms if securing devices become open or locking devices become unsecured.

The power supply for the indicator system is to be independent of the power supply for operating and closing the doors and is to be provided with a backup power supply.

The sensors of the indicator system are to be protected from water, ice formation and mechanical damage.

6.3.6 The indication panel on the navigation bridge is to be equipped with a mode selection function "harbour/sea voyage", so arranged that an audible alarm is given if the vessel leaves harbour with the doors not closed and with any of the securing devices not in the correct position.

6.3.7 A water leakage detection system with audible alarm and television surveillance is to be arranged to provide an indication to the navigation bridge and to the engine control room of leakage through the inner door.

6.4 Movable decks and inner ramps

6.4.1 The requirements applicable to movable decks and inner ramps are defined in PtB, Ch9, Sec8, [1].

6.5 External ramps

6.5.1 The requirements applicable to external ramps are defined in PtB, Ch9, Sec8, [2].

7 Hull outfitting

7.1 Equipment

7.1.1 Number of mooring lines

The specific requirements in PtB, Ch10, Sec4, [3.5] for ships with the service notation **ro-ro passenger ship** are to be complied with.

7.1.2 Ships having L ≤ 30 m and navigation notation other than unrestricted navigation

For ships having L ≤ 30 m and navigation notation other than **unrestricted navigation**:

- the equipment in stockless anchor and chain cables (or ropes according to Pt B, Ch 10, Sec 4, [3.3.5]) may be obtained from Tab 2
- the equipment in mooring lines of wire or natural fibre may be obtained from Tab 3.

Table 3 : Mooring lines *(1/1/2022)*

Equipment number EN A < EN ≤ B		Mooring lines		
A	B	N	Length of each line, in m	~~Breaking load~~ Ship Design Minimum Breaking Load, in kN
19	50	2	40	32
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70	90	3	50	37
90	110	3	55	39
110	130	3	55	44
130	150	3	60	49
150	175	3	60	54

SECTION 5 ELECTRICAL INSTALLATIONS

1 General

1.1 Documentation to be submitted

1.1.1 In addition to the documentation requested in Pt C, Ch 2, Sec 1, Tab 1, the following are to be submitted for approval:

a) plan of hazardous areas
b) document giving details of types of cables and safety characteristics of the equipment installed in hazardous areas
c) diagrams of indicator systems for shell doors, loading doors and similar appliances, television surveillance or water leakage detection systems
d) diagrams of the supplies to the supplementary emergency lighting systems.

1.2 Safety characteristics

1.2.1 The explosion group and temperature class of electrical equipment of a certified safe type for use with explosive petrol-air mixtures are to be at least IIA and T3.

2 Supplementary emergency lighting

2.1

2.1.1 *In addition to the emergency lighting required in* Ch11, Sec5, [2.2], *on every passenger ship with ro-ro cargo spaces or special category spaces:*

a) all passenger public spaces and alleyways shall be provided with supplementary electric lighting that can operate for at least three hours when all other sources of electrical power have failed and under any condition of heel. The illumination provided shall be such that the approach to the means of escape can be readily seen. The source of power for the supplementary lighting shall consist of accumulator batteries located within the lighting units that are continuously charged, where practicable, from the emergency switchboard. Alternatively, any other means of lighting which is at least as effective may be accepted by the Society. The supplementary lighting shall be such that any failure of the lamp will be immediately apparent. Any accumulator battery provided shall be replaced at intervals having regard to the specified service life in the ambient conditions that they are subject to in service;

b) a portable rechargeable battery operated lamp shall be provided in every crew space alleyway and recreational space and every working space which is normally occupied unless supplementary emergency lighting, as required in (a), is provided.

3 Installation

3.1 Installations in special category spaces situated above the bulkhead deck

3.1.1 On any deck or platform, if fitted, on which vehicles are carried and on which explosive vapours might be expected to accumulate, except platforms with openings of sufficient size permitting penetration of petrol gases downwards, electrical equipment and cables are to be installed at least 450 mm above the deck or platform.

Electrical equipment is to be as stated in Pt C, Ch 2, Sec 3, [10.1.6] and electrical cables as stated in Pt C, Ch 2, Sec 3, [10.2.3].

3.1.2 Where the installation of electrical equipment and cables at less than 450 mm above the deck or platform is deemed necessary for the safe operation of the ship, the electrical equipment is to be of a certified safe type as stated in Pt C, Ch 2, Sec 3, [10.1.5] and the electrical cables are to be as stated in Pt C, Ch 2, Sec 3, [10.2.2].

3.1.3 Electrical equipment and cables in exhaust ventilation ducts are to be as stated in [3.1.2].

3.1.4 The requirements in this item are summarised in Tab 1.

Table 1 : Electrical equipment permitted in special category spaces above the bulkhead deck *(1/1/2022)*

Hazardous area	Spaces		Electrical equipment
	No.	Description	
Zone 1	1	Areas at less than 450 mm above the deck or platforms for vehicles, if fitted, without openings of sufficient size permitting penetration of petrol gases downward.	a) any type that may be considered for zone 0 b) certified intrinsically safe apparatus Ex(ib) c) simple electrical apparatus and components (e.g. thermocouples, photocells, strain gauges, junction boxes, switching devices), included in intrinsically-safe circuits of category "ib" not capable of storing or generating electrical power or energy in excess of limits stated in the relevant rules, d) certified flameproof Ex(d) e) certified pressurised Ex(p) f) certified increased safety Ex(e) g) certified encapsulated Ex(m) h) certified sand filled Ex(q) i) certified specially Ex(s) j) cables sheathed with at least one of the following: • a non-metallic impervious sheath in combination with braiding or other metallic covering • copper or stainless steel sheath (for mineral insulated cables only).
Zone 1	2	Exhaust ventilation ducts.	As stated under item 1.
Zone 2	3	• areas above a height of 450 mm from the deck • areas above a height of 450 mm from each platform for vehicles, if fitted, without openings of sufficient size permitting penetration of petrol gases downward • areas above platforms for vehicles, if fitted, with openings of sufficient size permitting penetration of petrol gases downward.	a) any type that may be considered for zone 1 b) tested specially for zone 2 (e.g. type "n" protection) c) pressurised, d) encapsulated e) the type which ensures the absence of sparks and arcs and of "hot spots" during its normal operation (minimum class of protectionelectrical equipment having an enclosure of at least IP55) f) cables sheathed with at least a non-metallic external impervious sheath.

3.2 Installations in special category spaces situated below the bulkhead deck

3.2.1 Any electrical equipment installed is to be as stated in Pt C, Ch 2, Sec 3, [10.1.5] and electrical cables are to be as stated in Pt C, Ch 2, Sec 3, [10.2.2].

3.2.2 Electrical equipment and cables in exhaust ventilation ducts are to be as stated in [3.2.1].

3.2.3 The requirements in this item are summarised in Tab 2.

3.3 Installations in cargo spaces other than special category spaces intended for the carriage of motor vehicles

3.3.1 The requirements for installations in special category spaces situated below the bulkhead deck, as stated in [3.2], apply.

3.3.2 All electric circuits terminating in cargo holds are to be provided with multipole linked isolating switches located outside the holds. Provision is to be made for locking in the off position.

This requirement does not apply to safety installations such as fire, smoke or gas detection systems.

4 Type approved components

4.1

4.1.1 Accumulator lamps for the supplementary electric lighting, alarm systems for closing devices of openings and water leakage detection systems if of electronic type, and television surveillance systems are to be type approved or in accordance with [4.1.2].

4.1.2 Case-by-case approval based on submission of adequate documentation and execution of tests may also be granted at the discretion of the Society.

Part E
Service Notations

Chapter 13
SHIPS FOR DREDGING ACTIVITY

SECTION 2 HULL AND STABILITY

Symbols

T : Navigation draught, in m, corresponding to the international freeboard

T_D : Dredging draught, in m, corresponding to the dredging freeboard

C : Wave parameter defined in Pt B, Ch 5, Sec 2 or Pt B, Ch 8, Sec 1, as applicable

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

n, n_1 : Navigation coefficients, defined in Pt B, Ch 5, Sec 1, [2.6] or Pt B, Ch 8, Sec 1, [1.5], as applicable

n_D : Navigation coefficient in dredging situation, defined in [3.3.1]

s : Spacing, in m, of ordinary stiffeners

δ : Specific gravity of the mixture of sea water and spoil, taken equal to:

$$\delta = \frac{P_D}{V_D}$$

P_D : Maximum mass, in t, of the spoil contained in the hopper space

V_D : Volume of the hopper space, in m³, limited to the highest weir level

g : Gravity acceleration, in m/s²:

$g = 9{,}81$ m/s²

ℓ_p : Length, in m, of the hopper well

a : Distance from the bottom to the sealing joint located at the lower part of the hopper well, in m

h_1 : Distance, in m, from spoil level to base line when working at the dredging freeboard (see Fig 8)

h_2 : Distance, in m, from spoil level to base line when working at the international freeboard (see Fig 8)

h_4 : Distance, in m, from the lowest weir level to base line

T_3 : Navigation draught, in m, with well filled with water up to waterline

T_4 : Navigation draught, in m, with well filled with water up to the lowest weir level

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

R_m : Minimum ultimate tensile strength, in N/mm², of the material.

1 Stability

1.1 Intact stability

1.1.1 General

In addition to the requirements of Pt B, Ch 3, Sec 2, dredgers are to comply with the provisions of [1.1.2] and [1.1.3] as applicable.

1.1.2 Intact stability

a) Loading conditions

In the working condition, dredging equipment is to be considered positioned so as to produce the most severe combination of inclining moment and/or initial metacentric height. In particular, for grab dredgers, the mass, in **t**, of the dredged materials contained in the grab of volume **V**, in m³, is to be considered equal to 1,6 **V**; for bucket dredgers the mass, in **t**, contained in each bucket of volume **V**, in m³, of the top of the chain is to be considered equal to 2 **V**. For suction pipes of trailing suction dredgers, the mass of the dredged spoil is to be considered equal to 1,3 t/m³.

Bucket dredgers are generally not allowed to proceed to sea without first dismantling the dredging equipment.

For the calculation of displacement, the volumes of hoppers and wells intended for the carriage of sand and spoil, even if closed in their lower part by means of non-watertight doors, are to be considered as part of the ship's body and the weight of the water within, when there is no cargo, is to be considered as additional cargo. On the other hand, wells for the arrangement of bucket chains, cutter heads or ladder pumps are to be considered as buoyancy losses.

b) Influence of free surfaces

1) In the calculation of initial metacentric height, the effects of free surfaces may be disregarded when the mass density of spoil is greater than 1 t/m³; otherwise, they are assumed to be fluid cargoes.

2) In the calculation of righting levers, account is to be taken of the shifting of cargo that occurs in way of the various angles of heel of the dredger, considering any variation in displacement and the position of the centre of gravity due to the discharge of mud and the re-entry of sea water. The angle of shifting of the cargo q_R is to be assumed as a function of the angle of heel q_G and the mass density γ, in t/m³, according to the following formulas:

$$\theta_R = \theta_G \quad \text{for } \gamma \leq 1$$

The calculations justifying the proposed scantlings and, as the case may be, the pre-stresses are to be submitted to the Society for approval.

10.4.3 The scantlings of the rod are to be based on F_m and on the smaller value of $R_{eH}/2$ and $R_m/2,4$, for the mean permissible stress in traction. A calculation proving the adequate buckling strength of the rod is to be submitted to the Society for approval.

10.4.4 The scantlings of the lugs and the pins at each end of the hydraulic cylinder are to be based on F_m.

10.5 Inspection and testing

10.5.1 In addition to inspections required in [10.1.2], where applicable, welded joints connecting parts subject to the load F_m are to fulfil the requirements for class 1 pressure vessels or equivalent.

10.5.2 Completed cylinders and attached piping up to and including the first isolating valve are to undergo, at works, a pressure test at the greater of the values $1,4P_S$ and $1,2P_m$ applied on the rod side and a pressure test at $1,4P_C$ on the bottom side for the fully extended position.

10.5.3 The completed hydraulic circuit is to be subjected, on board, to pressure tests at 1,4 times the relevant maximum service pressure for normal conditions or static loads, for the part of the circuit considered.

10.6 Relief valve setting

10.6.1 At least one relief valve of appropriate capacity is to protect each part of the circuit which may be subject to overpressure due to external loads or due to pump action; in general, relief valves on the rod side of each cylinder or group of cylinders are to be set at P_m, while P_C applies to the bottom side for relief valve setting purposes.

Parts of the circuit possibly subject to overpressure from pumps only are to be protected by relief valves set at pressure P_P.

11 Rudders

11.1 General

11.1.1 The rudder stock diameter obtained from Pt B, Ch 10, Sec 1, [4] is to be increased by 5%.

11.2 Additional requirements for split hopper dredgers and split hopper units

11.2.1 Each half-hull of ships with either of the service notations **split hopper unit** or **split hopper dredger** is to be fitted with a rudder complying with the requirements of Pt B, Ch 10, Sec 1.

11.2.2 An automatic system for synchronising the movement of both rudders is to be fitted.

12 Equipment

12.1 General

12.1.1 The requirements of this Article apply to ships having normal ship shape of the underwater part of the hull.

For ships having unusual ship shape of the underwater part of the hull, the equipment is to be considered by the Society on a case-by-case basis.

12.1.2 The equipment obtained from [12.1.4] or [12.1.5] is independent of anchors, chain cables and ropes which may be needed for the dredging operations.

12.1.3 The Equipment Number EN is to be obtained from the following formula:

$$EN = 1,5(LBD)^{2/3}$$

When calculating EN, bucket ladders and gallows may not be included.

12.1.4 For ships equal to or greater than 80 m in length and for ships with EN, calculated according to [12.1.3], equal to or greater than 795, the equipment is to be obtained from Pt B, Ch 10, Sec 4, [3], with EN calculated according to Pt B, Ch 10, Sec 4, [2] and not being taken less than 795, considering the following:

- to apply the formula, the displacement considered is that of the navigation draught, taking into account the cylinder housings and the free space between the two half-hulls
- the chain cable diameter is to be read off after moving to the next line below in the applicable Table.

12.1.5 For ships other than those defined in [12.1.4], the equipment is to be obtained from Tab 17.

Where such ships are assigned one of the following navigation notations:

- **summer zone**
- **tropical zone**
- **coastal area**,

the equipment is to be obtained by consulting Tab 17 one line higher.

Where such ships are assigned the navigation notation **sheltered area**, the equipment is to be obtained by consulting Tab 17 two lines higher.

Table 18 : Ships for dredging activities - Towlines and mooring lines *(1/1/2022)*

Equipment number EN A< EN ≤ B		Towline (1)		Mooring lines		
A	B	Minimum length, in m	Ship Design Minimum Breaking LoadBreaking load, in kN	N	Length of each line, in m	Ship Design Minimum Breaking LoadBreaking load, in kN
35	45	120	88	2	90	59
45	60	120	93	2	90	64
60	80	120	98	2	90	68
80	92	130	107	2	90	73
92	102	130	117	2	110	78
102	112	130	127	2	110	83
112	130	140	137	2	110	88
130	155	140	147	2	135	93
155	185	140	156	2	135	98
185	210	150	166	2	135	102
210	250	150	176	2	135	107
250	285	150	186	2	135	112
285	315	150	196	2	135	117
315	350	160	215	2	160	122
350	385	160	240	2	160	127
385	415	160	265	2	160	132
415	450	160	295	2	160	137
450	485	160	320	2	160	142
485	515	160	340	3	160	147
515	550	160	365	3	160	152
550	585	160	390	3	160	157
585	635	160	415	3	160	161
635	685	160	440	4	160	166
685	715	160	465	4	160	170
715	750	160	490	4	160	175
750	795	180	515	4	160	180

(1) The towline is not compulsory. It is recommended for ships having length not greater than 180 m.

Part E
Service Notations

Chapter 14
TUGS

SECTION 2 HULL AND STABILITY

1 General

1.1 Application

1.1.1 *(1/7/2016)*

The requirements of this Section apply to ships with one of the following service notations:

- **tug**, mainly intended for towing services, which are to comply with the requirements in [2]
- **salvage tug**, having specific equipment for salvage services, which are to comply with the requirements in [2] and [3]
- **escort tug**, mainly intended for escort services such as for steering, braking and otherwise controlling escorted ships, which are to comply with the requirements in [2] and [4].

Ships with the additional service feature **barge combined** (units designed to be connected with barges) are to comply with the applicable requirements in Sec 3.

Ships with the additional service feature **rescue** (units specially equipped for the rescue of shipwrecked persons and for their accommodation) are to comply with the requirements given in [2.11].

Ships with the additional service feature **standby vessel** (unit specially intended to perform rescue and standby services) are to comply with the requirements given in [2.12].

2 Tugs, salvage tugs and escort tugs

2.1 General

2.1.1 In general, tugs are completely decked ships provided with an ample drift surface and, where intended for service outside sheltered areas, with a forecastle or half forecastle, or at least with a large sheer forward.

Tugs of unusual design are to be considered by the Society on a case-by-case basis.

2.2 Stability

2.2.1 Openings *(1/1/2021)*

a) Openings which cannot be closed weathertight:

Openings in the hull, superstructures or deckhouses which cannot be closed weathertight are to be considered as unprotected openings and, consequently, as down-flooding points for the purpose of stability calculations (the lower edge of such openings is to be taken into account).

b) Ventilation openings of machinery space and emergency generator room:

It is recognised that for tugs, due to their size and arrangement, compliance with the requirements of ICLL Reg. 17(3) for ventilators necessary to continuously supply the machinery space and the emergency generator room may not be practicable. Lesser heights of the coamings of these particular openings may be accepted if the openings:

- are positioned as close to the centreline and as high above the deck as practicable in order to maximise the down-flooding angle and to minimise exposure to green water
- are provided with weathertight closing appliances in combination with suitable arrangements, such as separators fitted with drains
- are equipped with efficient protective louvers and mist eliminators
- have a coaming height of not less than 900 mm above the deck
- are considered as unprotected openings and, consequently, as down-flooding points for the purpose of stability calculations.

2.2.2 Stability booklet *(1/1/2021)*

The stability booklet for ships engaged in harbour, coastal or ocean going towing operations and/or escort operations is to contain additional information on:

- maximum bollard pull
- details on the towing arrangement, including location and type of the towing point(s) such as towing hook, staple, fairlead or any other point serving that purpose
- recommendations on the use of roll reduction systems
- If any wire, etc. is included as part of the lightship weight, clear guidance on the quantity and size is to be given
- maximum and minimum draught for towing and escort operations
- instructions on the use of the quick-release device

2.2.3 Intact stability

The stability of the ship for the loading conditions in Pt B, Ch 3, App 2, [1.2.11] is to be in compliance with the requirements in Pt B, Ch 3, Sec 2.

2.2.4 Additional intact stability criteria *(1/1/2021)*

All the loading conditions reported in the trim and stability booklet which are intended for towing operations are also to be checked in order to investigate the ship's capability to withstand the effect of the transverse heeling moments induced by the combined action of the towline force and the thrust vector (self-tripping, see [2.2.5]), and induced by the hydrodynamic resistance of the hull (tow-tripping, see [2.2.6]).

2.6 Rudder and bulwarks

2.6.1 Rudder

For tugs, the rudder stock diameter is to be increased by 5% with respect to that calculated according to Pt B, Ch 10, Sec 1, [4].

2.6.2 Bulwarks

The bulwarks are to be sloped inboard to avoid distortions likely to occur during contact. Their height may be reduced where required by operational necessities.

2.7 Equipment

2.7.1 Equipment number for tugs with the navigation notation "unrestricted navigation" *(1/1/2022)*

For tugs with the navigation notation **unrestricted navigation**, the equipment number EN is to be obtained from Pt B, Ch 10, Sec 4, [2.1.2]~~the following formula:~~

~~$EN = \Delta^{2/3} + 2 (a B + \Sigma h_n b_n) + 0,1 A$~~

~~where:~~

~~Δ : Moulded displacement of the tug, in t, to the summer load waterline~~

~~a : Freeboard amidships from the summer load waterline to the upper deck, in m~~

~~h_n : Height, in m, at the centreline of tier "n" of superstructure or deckhouse having a breadth greater then B/4. Where a house having a breadth greater than B/4 is above a house with a breadth of B/4 or less, the upper house is to be included and the lower ignored.~~

~~b_n : Breadth, in m, of the widest superstructure or deckhouse of each tier having a breadth greater than B/4~~

~~A : Area, in m², in profile view, of the parts of the hull, superstructures and houses above the summer load waterline which are within the length L_E and also have a breadth greater than B/4~~

~~L_E : Equipment length, in m, equal to L without being taken less than 96% or greater than 97% of the total length of the summer load waterline.~~

~~Fixed screens or bulwarks 1,5 m or more in height are to be regarded as parts of houses when determining h and A. In particular, the hatched area shown in Fig 3 is to be included.~~

~~The height of hatch coamings and that of any deck cargo may be disregarded when determining h and A.~~

For tugs where the vertical extent of the superstructure is much greater than usual, the Society may require an increased equipment number EN.

2.7.2 Equipment number for tugs with the navigation notation coastal area or sheltered area

For tugs with the navigation notation **coastal area** or **sheltered area**, the equipment number EN is to be obtained from the following formula:

$EN = 2,51 (L B D)^{2/3}$

For tugs where the vertical extent of the superstructure is much greater than usual, the Society may require an increased equipment number EN.

For tugs with total block coefficient C_B less than 0,60, at a draught T equal to 0,85 D, the equipment number EN is to be obtained from the following formulae:

$EN = 1,76 (L B D)^{2/3}$

For tugs where the vertical extent of the superstructure is much greater than usual, the Society may require an increased equipment number EN.

2.7.3 Anchors, chain cables and ropes *(1/1/2017)*

Tugs with notation **unrestricted navigation** or **summer navigation** with equipment number EN calculated according [2.7.1], are to be provided with equipment in anchors, chain cables and ropes obtained from Pt B, Ch 10, Sec 4.

Tugs with notation **unrestricted navigation** or **summer navigation** with equipment number EN calculated according g [2.7.1] equal to or less than 205, may reduce the number of anchor to one, and the mass of that anchor can be reduced to half of the mass indicated in Pt B, Ch 10, Sec 4, Tab 1. In the case only one anchor is adopted, the total lenght of anchor chain cable may be reduced to half of that indicated in Pt B, Ch 10, Sec 4, Tab 1. No reduction is forseen for chain cable diameter.

Tugs with the navigation notation **coastal area** or **sheltered area** with equipment number EN calculated according [2.7.2], are to be provided with equipment in anchors, chain cables and ropes obtained from Tab 1 and Tab 2.

2.7.4 Additional equipment

Tugs are to be fitted with the additional equipment specified in Tab 3.

2.8 Towing arrangements

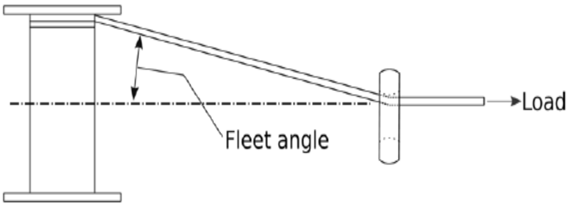
2.8.1 General

In general, towing hooks and winches are to be arranged in way of the ship's centreline, in such a position as to minimise heeling moments in normal working conditions.

2.8.2 Definitions *(1/7/2021)*

- Emergency release system: refers to the mechanism and associated control arrangements that are used to release the load on the towline in a controlled manner under both normal and black out conditions
- Maximum design load: is the maximum load that can be held by the winch as defined by the manufacturer (the manufacturer's rating)
- Fleet angle: is the angle between the applied load (towline force) and the towline as it is wound onto the winch drum.

Figure 2 : Towline 'fleet angle' *(1/7/2021)*



2.8.3 Hooks and winches *(1/1/2020)*

The hook and the winch materials are to comply with the applicable requirements of Part D.

The maximum towing force T, in kN, defined in [2.2.5], is to be specified in the structural arrangement plans of the hook and the winch.

The hooks and the winches are to be subjected to a static test, where the testing force C_T is to be not less than that obtained from Tab 4 as a function of T.

Winches may be equipped with a device for automatic adjustment of the tow.

All towing winches are to be fitted with an emergency release system.

Figure 3 : ~~Effective area of bulwarks or fixed screens to be included in the Equipment Number~~

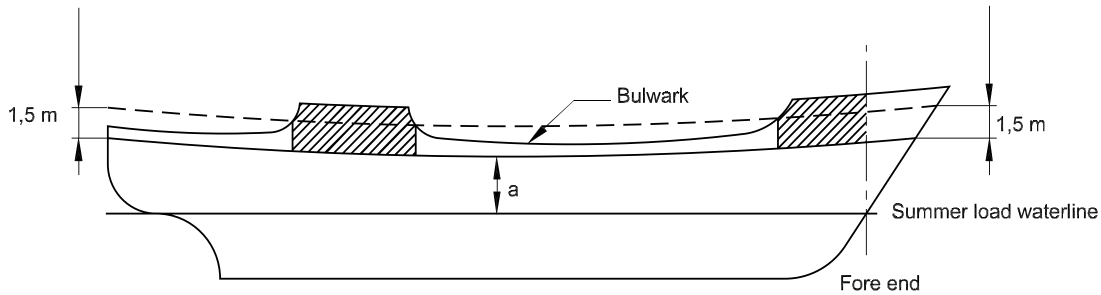


Table 2 : Mooring lines for tugs with the navigation notation coastal area or sheltered area *(1/1/2022)*

Equipment number EN A< EN ≤ B		Mooring lines				
A	B	N	Ship Design Minimum Breaking LoadBreaking load, in kN	N	Ship Design Minimum Breaking LoadBreaking load, in kN	Length of each line, in m
0	55	1	24,5	1	59,8	110
55	64	1	24,5	1	66,7	110
65	74	1	24,5	1	73,5	110
75	84	1	24,5	1	80,4	110
85	94	1	30,4	1	86,3	110
95	104	1	34,3	1	91,2	110
105	114	1	38,2	1	95,1	110
115	124	1	43,2	1	99,0	110
125	139	1	49,0	1	104	110
140	159	1	58,8	1	111	120
160	179	1	68,6	1	119	120
180	199	1	78,4	1	127	120
200	219	1	88,2	1	136	120
220	244	1	98,0	1	145	120
245	264	1	108	1	154	120
265	289	1	108	1	163	120
290	314	1	108	1	172	130
315	334	1	108	1	174	130
335	364	1	108	2	174	130
365	389	1	108	2	174	130
390	414	1	108	2	174	140
415	444	1	108	2	174	140
445	474	1	108	2	174	140
475	504	1	108	2	174	140
505	534	1	108	2	174	150
535	569	1	108	2	174	150
570	600	1	108	2	174	160

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4.1.2 Characteristics of escort tugs

For classification purposes, the following characteristic is to be specified by the Designer:

- the maximum steering force T_Y, in kN, applied by the tug on the stern of the escorted ship, which is the transverse component of the maximum dynamic towing pull T with respect to the longitudinal axis of the escorted ship. This maximum force is generated at some value of the angle α between the line of pull and the direction of the escorted ship, see Fig 43. This force is to be calculated at speeds V, to be defined by the Designer and in general to be comprised between 8 and 10 knots.

  If the tug escort service is carried out within a certain speed range, the maximum steering forces T_Y at the minimum and maximum service speeds V_{MIN} e V_{MAX}, respectively, are to be calculated by the Designer.

T_Y is to be obtained on the basis of the results of full-scale tests (see [4.5]), to be carried out at speed V or, as applicable, at speeds V_{MIN} and V_{MAX}, defined above or alternatively may be evaluated by computer model simulation as indicated in [4.6.1].

Table 5 : Additional equipment for salvage tugs

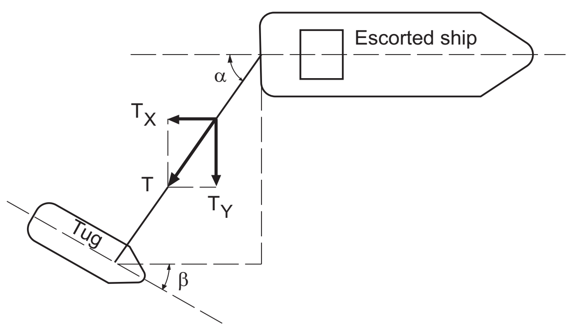
Arrangement or equipment	Number of items
Fixed or movable drainage pumps having approximately the same capacity **(1) (2) (3)**	2 or more pumps of total capacity ≥ 400 m³/h
Fire pumps each capable of throwing two simultaneous jets of water having a horizontal reach not less than 30 m **(4)**	2 pumps, each having a capacity ≥ 60 m³/h
Breathing apparatuses for divers	2
Gas masks with filter	2
Cargo boom	1, with service load ≥ 1 t
Power operated winch capable of producing an adequate pull	1
Water stops to stop leaks of approximately 1 x 2 m	4
Complete set of equipment for flame cutting with at least 25 metres of flexible piping	1
Drain hoses	at least 20 m per pump
Fire hoses	10
Connections for fire main	at least 3
Power operated diver's compressor, with associated equipment **(5)**	1
Additional towline equipment, at least equal to that required for tugs in Tab 3	1
Lamps for underwater operation	2
Floodlight of power ≥ 500 W	1
Working lamps	2
Winding drums with wire ropes	see **(6)**
Electrical cables, each not less than 100 metres long and capable of supplying at least 50 kW	3
Tackles with lifting capacity of 1 t	2
Tackles with lifting capacity of 3 t	2
Radar with a range not less than 24 nautical miles	1
Echo-sounding device with a range of 100 m	1

(1) For each pump fitted on board, a suction strainer and, in the case of non self-priming pumps, a foot valve, are also to be provided.
(2) Where portable pumps are used, they are to be capable of effectively operating even with transverse and longitudinal inclinations up to 20°.
(3) These pumps are additional to the drain pumps intended for the drainage service of the ship.
(4) These pumps may be the same required for drainage purposes provided they have an adequate head.
(5) As an alternative, a compressor for recharging the oxygen tanks of divers may be provided together with two complete sets of equipment for divers.
(6) Winding drums fitted on board are to be capable of housing wire ropes of suitable size and length not normally less than 350 m.

Arrangement or equipment	Number of items
Hydraulic jackets with lifting capacity of 10 t	2
Hydraulic jackets with lifting capacity of 20 t	2
Portable electrical drill with a set of twist bits having diameters up to 20 mm	1

(1) For each pump fitted on board, a suction strainer and, in the case of non self-priming pumps, a foot valve, are also to be provided.
(2) Where portable pumps are used, they are to be capable of effectively operating even with transverse and longitudinal inclinations up to 20°.
(3) These pumps are additional to the drain pumps intended for the drainage service of the ship.
(4) These pumps may be the same required for drainage purposes provided they have an adequate head.
(5) As an alternative, a compressor for recharging the oxygen tanks of divers may be provided together with two complete sets of equipment for divers.
(6) Winding drums fitted on board are to be capable of housing wire ropes of suitable size and length not normally less than 350 m.

Figure 34 : Typical escort configuration



4.1.3 Documentation

In addition to the documents defined in Pt B, Ch 1, Sec 3, the following plans are to be submitted to the Society for information:

- towing arrangement plan, including towline components with relevant minimum breaking loads
- preliminary calculation of maximum steering forces T_Y at speeds V or V_{MAX}, as applicable according to [4.1.2], including the propulsion force which is needed for equilibrating hydrodynamic forces acting on the tug and the towline pull
- preliminary stability calculation.

4.1.4 Propulsion forces

The hydrodynamic forces acting on the tug, the towline pull and the tug propulsion force are to be so designed that these forces are in equilibrium.

However, the engine is to ensure a sufficient thrust for manoeuvring the tug quickly for any angular position β, where β is defined in Fig 43.

4.1.5 Loss of propulsion

In the case of propulsion loss, the heeling moment due to the remaining forces is to lead to a safe equilibrium position of the tug with reduced heel.

4.2 Stability

4.2.1 Intact stability

A stability analysis of the tug is to be carried out taking into account the heeling moment caused by the forces acting on the tug, as shown in Fig 54.

The stability analysis is to consider:

- all potential attitudes of the escort tug relative to the direction of line pull,
- the maximum line pull,
- the resultant combination of heel and trim on the escort tug.

The stability analysis is to include the effects of fenders, skegs, and other appendages on both the reserve buoyancy and the lateral resistance of the escort tug:

The two following intact stability criteria are to be complied with:

$A \geq 1,25\ B$

$C \geq 1,4\ D$

where:

A : Righting lever curve area, in m·rad, measured from the heeling angle θ_C to a heeling angle of 20° (see Fig 65)

B : Heeling arm curve area, in m·rad, measured from the heeling angle θ_C to a heeling angle of 20° (see Fig 65)

C : Righting lever curve area, in m·rad, measured from the angle 0° heel to the heeling angle θ_D (see Fig 76)

D : Heeling arm curve area, in m·rad, measured from the angle 0° heel to the heeling angle θ_D (see Fig 76)

θ_C : Heeling angle of equilibrium, corresponding to the first intersection between heeling and righting arms, to be obtained when the maximum

4.3 Structural design principles

4.3.1 Hull shape

The hull shape is to be such as to provide adequate hydrodynamic lift and drag forces and to avoid excessive trim angles for large heeling angles.

4.3.2 Bulwark

A bulwark is to be fitted all around the weather deck.

4.4 Equipment

4.4.1 Towline breaking steng~~ht~~th *(1/1/2022)*

The towline breaking strength is to be not less than 2,2 times the greater of the static bollard pull load and the maximum line pull.

4.4.2 Towing winches *(1/1/2021)*

The towing winch is to be fitted with a system suitable to reduce the load in order to avoid overload due to dynamic oscillations of the towline. It is to be able to release the towline when the pull is greater than 50% of the towline breaking load.

Escort operations in conditions where dynamic oscillations of the towline are likely to occur may not be based on use of the brakes of the winch drum.

Escort operations performed by escort tugs in calm water conditions, such as in ports and sheltered (confined) waters, may be based on the use of the brakes of the winch drum. As a minimum, the winch brake holding load is to be equal to or greater than two times the maximum steady towline force, T.

4.5 Full-scale tests

4.5.1 Testing

The following requirements apply to full scale tests to be carried out in order to obtain the values of the main characteristics of the tug defined in [4.1.2].

4.5.2 Documentation to be submitted prior to testing

The following documentation is to be submitted to the Society for approval prior to testing:

- test speed of the tug; the speed is to be intended as relative speed with respect to the sea motions, therefore the effects of any possible current are to be taken into account
- main propulsion characteristics (power, maximum orientation angle of the rudder)
- preliminary calculation of the maximum steering force T_Y at the test speed
- calculation of the route deviation of the escorted ship (for the tests, the escorted ship is to be selected so that the route deviation induced by the tug is not too large)
- preliminary stability calculation in the above conditions
- towing arrangement plan, including the load cell and the specification of the breaking loads of the towline components
- documentation relevant to the bollard pull test (see [2.10.1]).

4.5.3 Data to be collected during tests

During the tests, all data needed to define the characteristics of the tug are to be collected, e.g. the relative position ship-tug, their heading and speed, the towline length, the towline angle α (see Fig ~~4~~3), the maximum towing pull T, the ship rudder position, the heeling angle of the tug and any other parameter used in the preliminary calculation.

4.6 Alternative to full-scale tests

4.6.1 Maximum steering force

The maximum steering force T_Y that the tug applies on the assisted ship is to be evaluated by a computer model programme that considers a quasi-steady solution, in which the horizontal forces and moments are balanced. The programme is also to consider the hydrodynamic forces on the escort tug's hull and underwater appendages, the forces acting on the rudder and the thrusts of the propellers.

4.7 Inclinometer

4.7.1 *(1/1/2021)*

Escort tugs are to be equipped with a calibrated heeling angle measurement system (inclinometer). The measured heeling angle is to be displayed in the wheelhouse next to the control desk or another appropriate location.

Part E

Service Notations

Chapter 15

SUPPLY VESSELS

SECTION 3 MACHINERY AND CARGO SYSTEMS

1 General

1.1 Application

1.1.1 *(1/1/2022)*

This Section provides, for ships having the service notation supply vessel, requirements for:

- machinery systems
- cargo tanks and piping systems, in particular where the service features **oil product** or **chemical product** are assigned.
- the calculation of the continuous duty pull of windlasses.

1.2 Documents to be submitted

1.2.1 The documents listed in Tab 1 are to be submitted for approval.

2 Machinery systems

2.1 Bilge system

2.1.1 General

In supply vessels having the service feature **oil product** or **chemical product**, cargo pump rooms, duct keels below cargo tanks, hold spaces in which independent cargo tanks are installed and all gas-dangerous, dry cofferdams are to be served by an independent bilge pumping system entirely situated within the cargo area and fitted with pumps or ejectors. No connection is permitted with the bilge system serving gas-safe spaces of the ship.

2.1.2 Drainage of cargo pump rooms

Pumps and ejectors used for the drainage of cargo pump rooms are also to be capable of leading their delivery to a cargo tank, through a non-return valve and a connection at the tank top. Such provisions are intended to enable the drainage of such spaces in the event of cargo leakages without the risk of sea pollution.

2.1.3 Specific requirement for acids

Spaces for acid storage tanks and acid pumping and piping are to be provided with drainage arrangements of corrosion-resistant materials.

2.2 Other piping systems not intended for cargo

2.2.1 Piping systems serving ballast tanks

Pumps, ballast lines, vent lines and other similar equipment serving permanent ballast tanks are to be independent of similar equipment serving cargo tanks.

2.2.2 Piping systems serving spaces adjacent to cargo tanks

Where intended for ballast water, fuel oil, foam-forming liquids or dispersants, spaces adjacent to cargo tanks may be drained by pumps located in the machinery space, provided that the piping is directly connected to the associated pump and does not run through cargo tanks or cargo storage vessels.

Table 1 : Documents to be submitted

No.	A/I **(1)**	Document **(2)**
1	A	Plan of cargo handling systems intended for: • powdery products such as cement, baryte, bentonite, etc. • liquid muds • oil products **(3)** • chemical products **(4)**
2	A	Plan of gas vents in cargo tanks and cargo storage vessels **(3)** **(4)**
3	A	Plan of level gauging systems in cargo tanks and cargo storage vessels **(3)** **(4)**
4	A	Plan of the draining systems serving bilges in the cargo pump room and other gas-dangerous spaces **(3)** **(4)**
5	A	Plan of the pumping systems serving non-dry spaces adjacent to cargo tanks and cargo storage vessels **(3)** **(4)**

(1) A: To be submitted for approval in four copies
I: To be submitted for information in duplicate
(2) Diagrams are also to include, where applicable, the (local and remote) control and monitoring systems and automation systems.
(3) for ships having the service feature **oil product**.
(4) for ships having the service feature **chemical product**.

6 Requirements for windlass

6.1 Assumptions for the calculation of the continuous duty pull

6.1.1 *(1/1/2022)*

The calculation of the continuous duty pull P_C that the windlass unit prime mover is to be able to supply is based on the following assumptions:

- ordinary stockless anchors
- wind force equal to 6 on Beaufort Scale
- water current velocity 3 knots
- anchorage depth 100 m
- P_C includes the influences of buoyancy and hawse pipe efficiency; the latter is assumed equal to 70%
- the anchor masses assumed are those defined in Pt D, Ch 4, Sec 1, excluding tolerances
- only one anchor is assumed to be raised at a time.

Owing to the buoyancy, the chain masses assumed are smaller than those defined in Pt D, Ch 4, Sec 1, and are obtained, per unit length of the chain cable, in kg/m, from the following formula:

$m_L = 0{,}0218\ d^2$

where d is the chain cable diameter, in mm.

6.2 Calculation of the continuous duty pull

6.2.1 *(1/1/2022)*

The calculation of the continuous duty pull P_C is to be in accordance to Pt C, Ch 1, Sec 15.

Part E
Service Notations

Chapter 18
CABLE LAYING ~~SHIPS~~UNITS

SECTION 1 GENERAL

1 General

1.1 Application

1.1.1 *(1/1/2022)*

Ships complying with the requirements of this Chapter are eligible for the assignment of the service notation cable laying ~~ship~~unit, as defined in Pt A, Ch 1, Sec 2,[4.8.7].

1.1.2 *(1/1/2022)*

Ships dealt with in this Chapter are to comply with the requirements stipulated in Parts A, B, C and D, as applicable, and with the requirements of this Chapter, which are specific to cable laying ~~ship~~units.

1.2 Summary table

1.2.1 *(1/1/2022)*

Tab 1 indicates, for ready reference, the Sections of this Chapter containing specific requirements applicable to cable laying ~~ship~~units.

Table 1 *(1/1/2022)*

Main subject	Reference
Ship arrangement	**(1)**
Hull and stability	Sec 2
Machinery and systems	Sec 3
Electrical installations	**(1)**
Automation	**(1)**
Fire protection, detection and extinction	**(1)**

(1) No specific requirements for cable laying ~~ship~~units are given in this Chapter.

SECTION 3 MACHINERY AND SYSTEMS

1 General

1.1 Propulsion and manoeuvrability

1.1.1 The main propulsion systems of cable laying and/or repair ships are to be capable of:

a) maintaining an adequate speed during the transit condition

b) ensuring a satisfactory manoeuvrability at the speed assumed by the Designer for the performance of cable laying and/or repair operations.

1.2 Documents to be submitted

1.2.1 Tab 1 lists the documents which are to be submitted.

Table 1

No.	A/I **(1)**	Document
1	I	General arrangement of the cable laying equipment
2	I	Design loads on all components of the cable laying equipment
3	A	Structural plans of all components of the cable laying equipment, including gears, pressure vessels, hydraulic systems, etc., as applicable
4	A	Materials and welding details
5	A	Foundations and fastening of the equipment to the ship structures
(1) A = to be submitted for approval in four copies I = to be submitted for information in duplicate		

2 Arrangements for cable laying, hauling and repair

2.1 Typical machinery and equipment of cable laying ~~ship~~units

2.1.1 *(1/1/2022)*

Cable laying ~~ship~~units, in relation to the spe-cial service to be performed, are generally to be provided with the following machinery and equipment:

a) a main windlass for cable hauling or laying, which generally consists of a drum with a horizontal axis (the surface of which is formed by a series of timed conveyors which fleet the cable axially across the face of the drum) housing the repeaters fitted throughout the cable length without damaging them (see Fig 1 (a))

b) a linear tensioner working in conjunction with the main windlass and fitted between it and the cable tank, which maintains the due tension of the cable in relation to the cable type so as to allow effective cable hauling or laying. In order to permit the passage of repeaters, the tensioner may be of the type having either a series of double opposed rubber tyres (see Fig 1 (b)) or pressure-compensated opposed tracks (see Fig 1 (c)).

c) a dynamometer, normally fitted between the main windlass and the bow and stern sheaves, which continuously measures the force required to displace the cable under tension

d) one or more cable transporters, used to move the cable from the tank(s) and the tensioner.

All the above machinery and equipment form the "cable laying or hauling line". More than one line may be fitted on board in the case of special service requirements.

2.2 Design of cable handling machinery and equipment

2.2.1 In general, the scantlings of components of machinery and equipment listed in [2.1] and, more generally, of any other machinery and/or equipment to be used for the laying, hauling or repair of submarine cables are not the subject of specific requirements for class. However, such machiney and equipment are to be designed taking into account the necessary mechanical structural strength with selection of materials appropriate for the intended use based on loads supplied by the Manufacturer.

2.3 Safety

2.3.1 The requirements of this Chapter are based on the assumption that during cable handling all necessary safety measures are taken, due consideration being given to risks connected with the use of machinery and equipment dealt with in [2.1], and that such machinery and equipment are properly used by skilled personnel.

2.4 Testing of cable handling machinery and equipment

2.4.1 General

Machinery covered by [2.1] is to be tested in compliance with the following requirements, with the exception of prime movers and "hydraulic accumulator" type pressure vessels, which are to be tested in compliance with the applicable requirements of the various Sections of the Rules.

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Part E
Service Notations

Chapter 20
FISHING VESSELS

SECTION 3 HULL AND STABILITY

Symbols

x, y, z : X, Y and Z co-ordinates, in m, of the calculation point with respect to the reference co-ordinate system defined in Pt B, Ch 1, Sec 2, [4]

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

p_E : Side and bottom design pressure, in kN/m², for ships less than 65 m in length, to be obtained from the following formula:

$$p_E = 5L^{1/3}\left[1 - \frac{(T-z)}{2T}\right] + 10(T-z) + p_A \quad \text{for } z \le T$$

$$p_E = (5L^{1/3} + p_A)\frac{10}{10+(z-T)} \quad \text{for } z > T$$

p_A : Additional pressure, in kN/m², for ships less than 65 m in length, to be obtained from the following formulae:

$p_A = 0,17L - 1,7x$ for $0 \le x < 0,1L$

$p_A = 0$ for $0,1L \le x < 0,8L$

$p_A = 2,25(x - 0,8L)$ for $0,8L \le x \le L$

p_D : Bottom design pressure, in kN/m², for ships less than 65 m in length, to be obtained from the following formulae:

$p_D = \max(10T;\ 6,6D)$ for $T/D \ge 0,5$

$p_D = 10T + 2,5L^{1/3} + p_A$ for $T/D < 0,5$

p_L : Liquid design pressure, for ships less than 65 m in length, to be taken as the greater of the values obtained, in kN/m² from the following formulae:

$p_L = 10[(h_a + z_{TOP}) - z]$

$p_L = 10\left[\frac{2}{3}(z_{AP} - z)\right]$

h_a : Distance, to be obtained, in m, from the following formula:

$h_a = 1+0,05(L-50)$ without being taken less than 1m,

z_{TOP} : Z co-ordinate, in m, of the highest point of the tank in the z direction

z_{AP} : Z co-ordinate, in m, of the top of the air pipe of the tank in the z direction

s : Length, in m, of the shorter side of the plate panel or spacing, in m, of ordinary stiffeners, or spacing, in m, of primary supporting members, as applicable

ℓ : Length, in m, of the longer side of the plate panel or span, in m, of ordinary stiffeners, measured between the supporting members, or span, in m, of primary supporting members, as applicable (to be taken according to Pt B, Ch 4, Sec 3, [3.2] and Pt B, Ch 4, Sec 3, [4.1]).

1 Stability

1.1 Intact stability

1.1.1 Application

The stability of the ship for the loading conditions in Pt B, Ch 3, App 2, [1.2.13], with the assumptions in [1.1.2], is to be in compliance with the requirements in [1.1.3].

1.1.2 Assumptions for calculating loading conditions

The assumptions for calculating the loading conditions in Pt B, Ch 3, App 2, [1.2.13] are as follows:

- *allowance is to be made for the weight of the wet fishing nets and tackle, etc., on deck*
- *allowance for icing, where this is anticipated to occur, is to be made in accordance with Pt B, Ch 3, Sec 2, [6]*
- *in all cases the cargo is to be assumed to be homogenous unless this is inconsistent with practice*
- *deck cargo is to be included if such a practice is anticipated*
- *water ballast is normally to be included only if carried in tanks which are specially provided for this purpose.*

1.1.3 Intact stability criteria

- *The general intact stability criteria in Pt B, Ch 3, Sec 2, [2] are to be applied to fishing vessels equal to or greater than 24 m in length, except for the requirements below.*
- *The initial metacentric height GM_o is to be not less than 0,35 m for single deck vessels.*
- *The metacentric height GM_o may be reduced to the satisfaction of the Society but in no case is GM_o to be less than 0,15 m for vessels with complete superstructure or vessels equal to or greater than 70 m in length.*

Where arrangements other than bilge keels are provided to limit the angle of roll, the above stability criteria are to be maintained in all operating conditions.

1.1.4 Relaxation of the Rules for ships of length L < 24 m

For decked ships of length less than 20 m, when a practical stability test has been carried out as foreseen in Pt B, Ch 3, Sec 1, [3.2], the initial metacentric height GMo is to be not less than 0,50 m in all the expected loading conditions during the ship's service.

For ships without decks, the residual freeboard on the heeled side due to the practical crowding test is to be not less than 0,20 m.

For ships of length less than 24 m, the requirements relevant to the righting arm diagrams need not be complied with; in any event, for ships of length greater than 20 m, the inclin-

Table 22 : Equipment *(1/1/2022)*

Equipment number EN A< EN ≤ B		Stockless anchors		Stud link chain cables for anchors			Mooring lines		
					Diameter, in mm				
A	B	N	Mass per anchor, in kg	Total length, in m	mild steel	high strength steel	N	Length of each line, in m	Ship Design Minimum Breaking load, in kN
30	40	2	80	165	11		2	50	29
40	50	2	100	192,5	11		2	60	29
50	60	2	120	192,5	12,5		2	60	29
60	70	2	140	192,5	12,5		2	80	29
70	80	2	160	220	14	12,5	2	100	34
80	90	2	180	220	14	12,5	2	100	37
90	100	2	210	220	16	14	2	110	37
100	110	2	240	220	16	14	2	110	39
110	120	2	270	247,5	17,5	16	2	110	39
120	130	2	300	247,5	17,5	16	2	110	44
130	140	2	340	275	19	17,5	2	120	44
140	150	2	390	275	19	17,5	2	120	49
150	175	2	480	275	22	19	2	120	54
175	205	2	570	302,5	24	20,5	2	120	59
205	240	2	660	302,5	26	22	2	120	64
240	280	2	780	330	28	24	3	120	71
280	320	2	900	357,5	30	26	3	140	78
320	360	2	1020	357,5	32	28	3	140	86
360	400	2	1140	385	34	30	3	140	93
400	450	2	1290	385	36	32	3	140	101
450	500	2	1440	412,5	38	34	3	140	108
500	550	2	1590	412,5	40	34	4	160	113
550	600	2	1740	440	42	36	4	160	118
600	660	2	1920	440	44	38	4	160	123
660	720	2	2100	440	46	40	4	160	127

Part E
Service Notations

Chapter 22

PIPE LAYING ~~SHIPS~~UNITS

SECTION 1 GENERAL

1 General

1.1 Application

1.1.1 *(1/1/2022)*

Ships complying with the requirements of this Chapter are eligible for the assignment of the service notation **pipe laying ~~ship~~unit**, as defined in Pt A, Ch 1, Sec 2,[4.8.9].

1.1.2 *(1/1/2022)*

Ships dealt with in this Chapter are to comply with the requirements stipulated in Parts A, B, C and D, as applicable, and with the requirements of this Chapter, which are specific to pipe laying ~~ship~~units.

1.2 Summary table

1.2.1 *(1/1/2022)*

Tab 1 indicates, for ready reference, the Sections of this Chapter containing specific requirements applicable to pipe laying ~~ship~~units.

Table 1 *(1/1/2022)*

Main subject	Reference
Ship arrangement	**(1)**
Hull and stability	Sec 2
Machinery and systems	Sec 3
Electrical installations	**(1)**
Automation	**(1)**
Fire protection, detection and extinction	**(1)**

(1) No specific requirements for pipe laying ~~ship~~units are given in this Chapter

Part E

Service Notations

Chapter 32

OFFSHORE SUPPORT VESSEL

SECTION 1 GENERAL

1 General

1.1 Application

1.1.1 *(1/1/2022)*

Ships complying with the requirements of this Chapter are eligible for the assignment of the service notation **offshore support vessel**, as defined in Pt A, Ch 1, Sec 2, [4.8.11].

1.1.2 *(1/1/2022)*

Ships dealt with in this Chapter are to comply with the requirements stipulated in Parts A, B, C and D of the Rules, as applicable, and with the requirements of Chapter 15, which are specific to supply vessels.

1.2 Summary table

1.2.1 *(1/1/2022)*

Tab 1 indicates, for ready reference, the Sections of this Chapter containing specific requirements applicable to offshore support vessel.

Table 1 *(1/1/2022)*

Main subject	Reference
Ship arrangement	(1)
Hull and stability	Sec 2
Machinery and systems	Sec 3
Electrical installations	Sec 4
Automation	(1)
Fire protection, detection and extinction	(1)
(1) No specific requirements for offshore support vessel are given in this Chapter.	

2 Offshore support vessel with additional service feature W2W

2.1 General

2.1.1 *(1/1/2022)*

This service feature covers the OSVs equipped with a Walk-to-work (W2W) system such as a motion compensated gangway used for personnel transfer from a mobile unit to an offshore facility (e.g. a wind farm) or to another mobile unit.

The selection of the W2W system depends on several factors, such as the OSV characteristics, the envisaged utlization of the W2W, the expected worst environmental conditions, the design technology , etc.

IMCA Marine Renewable Energy Walk to Work (W2W) Decision Support Tool (IMCA Information Note M01/18) is an example of the decisional process that should be followed when undertaking a new W2W project. It shows that the OSVs and W2W systems may be of various nature, thus in the following some basic requirements are provided, leaving the more specific issues to the ad-hoc process of Technology Qualification (TQ) according to the Tasneef "Guide for Technology Qualification Processes".

This process is to cover the W2W system in the context of the specific OSV, with special attention to the interfaces between OSV and W2W and to the type of service the W2W is designed for, in the operating conditions that are to be specified up front.

Guidance for the operational aspects of personnel transfer , which can be taken into account during the design phase, can be found in publications like the "Guidance on the Transfer of Personnel to and from OffshoreVessels and Structures" (IMCA HSSE 025, IMCA LR 012, IMCA M 202 - Rev. 2.1).

2.2 Application

2.2.1 *(1/1/2022)*

OSVs complying with the requirement of this Chapter and equipped with a W2W system certified by the Society according to the "Guide for Technology Qualification Processes" (see App 1) are eligible for the assignment of the service feature **W2W**, as defined in Pt A, Ch 1, Sec 2, [4.8.11] of the Rules rules for the classification of ships.

Note 1: QSCS Classification Society means a Classification Society which is subject to verification of compliance with the IACS Quality System Certification Scheme (QSCS).

2.2.2 *(1/1/2022)*

Ships dealt with in this Article are to comply with the requirements stipulated in Parts A, B, C and D, as applicable and with the specific requirements in this Chapter for the assignment of the service feature **W2W**.

2.2.3 *(1/1/2022)*

The **W2W** system is intended as the whole system and equipment.

The service feature covers the following issues:

a) the ship's ability to maintain its position during W2W operations,

b) the ship's stability during W2W,

c) the hull structural arrangements related to the W2W system and relevant lifting appliances,

d) the electrical system, the auxiliary systems (pneumatic, hydraulic etc., as applicable) and control system to operate the W2W system.

2.3 Position keeping

2.3.1 *(1/1/2022)*

The ship is to be able to maintain its position safely during W2W, whatever the means for position keeping (Dynamic Positioning, anchor mooring etc.).

2.4 General safety criteria

2.4.1 *(1/1/2022)*

The following criteria are additional to those set forth by the Tasneef rules for the classification of ships and take into account the specific arrangement of the W2W gangway.

2.4.2 *(1/1/2022)*

Any single failure on a critical structural, mechanical (active and passive), electrical, hydraulic, pneumatic, control, hardware or software item of the W2W and on any of its auxiliary systems, including the interfaces with the OSV, is not to lead to a hazardous situation for the personnel, the OSV or the facility connected to it.

Any incipient failure is to rise a timely alarm at the W2W control station. Control systems are to be self-monitoring with relevant timely alarms in case of detected failures.

W2W is not to lose control of its motions in case of loss of any kind of power of the W2W or any of its auxiliaries. Before emergency disconnection (e.g. in case of worsening environmental conditions) an alarm is to alert personnel in time to allow for the safe evacuation from the gangway to a safe position.

The fulfilment of such safety criteria is to be demonstrated through a FMEA or equivalent method, which also constitutes a part of the risk assessment required by the TQ. Additional availability criteria may be set forth by stakeholders in the TQ process.

2.5 Documents to be submitted

2.5.1 *(1/1/2022)*

The documents listed in Tab 2 are to be submitted in addition to the documentation requested for the assignment of the additional class notation **DP2** or **DP3**, if applicable (see Pt F, Ch 13, Sec 6).

Table 2 : Documents to be submitted *(1/1/2022)*

No.	A/I (1)	Document
1	I	General arrangement of the W2W system
2	A	Hull structures related to the arrangement of the W2W system, showing the interfaces with the ship
3	A	Electrical load analysis of main and emergency source, showing W2W system related loads
4	A	Drawings of electrical equipment arrangement, including single line diagram and its interface with the ship
5	A	Drawings of auxiliary systems necessary for the W2W system operations, as applicable (hydraulic, pneumatic, etc.)
6	A	General philosophy, technical specification and drawings of the control, monitoring and alarm system and of the relevant control stations
7	A	Communication systems

(1) A = to be submitted for approval in four copies
I = to be submitted for information in duplicate

3 Offshore support vessel with additional service feature WIND TURBINE MAINTENANCE

3.1 Offshore transfer system

3.1.1 *(1/1/2022)*

Offshore support vessels with additional service feature **WIND TURBINE MAINTENANCE** equipped with an offshore transfer system to transfer technicians from the ship to the wind turbine are to be assigned with the additional service feature **W2W**.

SECTION 2 HULL AND STABILITY

1 Offshore support vessel with additional service feature Walk-to-Work (W2W)

1.1 Intact stability criteria during lifting of W2W equipment

1.1.1 *(1/1/2022)*

The following intact stability criteria are to be complied with:

- $\theta_c \leq 15°$
- $GZ_C \leq 0,6\ GZ_{MAX}$
- $A_1 > 0,4\ A_{TOT}$

where:

θ_c : Heeling angle of equilibrium, corresponding to the first intersection between heeling and righting arms (see Fig 1)

GZ_C, GZ_{MAX} : Defined in Fig 1

A_1 : Area, in m·rad, contained between the righting lever and the heeling arm curves, measured from the heeling angle θ_c to the heeling angle equal to the lesser of:

- heeling angle θ_R of loss of stability, corresponding to the second intersection between heeling and righting arms (see Fig 1)
- heeling angle θ_F, corresponding to flooding of unprotected openings which may lead to progressive flooding if they are situated within the range of the positive righting lever curve. Unprotected openings are openings which are not fitted with at least weathertight means of closure (see Fig 1)

A_{TOT} : Total area, in m rad, below the righting lever curve.

In the above formula, the heeling arm, corresponding to equipment lifting, is to be obtained, in m, from the following formula:

$b = (P_d - Z_z) / \Delta$

where:

P : Equipment lifting mass, in t

d : Transverse distance, in m, from W2W equipment to the longitudinal plane (see Fig 1)

Z : Mass, in t, of ballast used to right the ship, if applicable (see Fig 1)

z : Transverse distance, in m, of the centre of gravity of Z to the longitudinal plane (see Fig 1)

Δ : Displacement, in t, in the loading condition considered.

The above check is to be carried out considering the most unfavourable situations of equipment lifting combined with the lesser initial metacentric height GM, corrected according to the requirements in Pt B, Ch 3, Sec 2, [4].

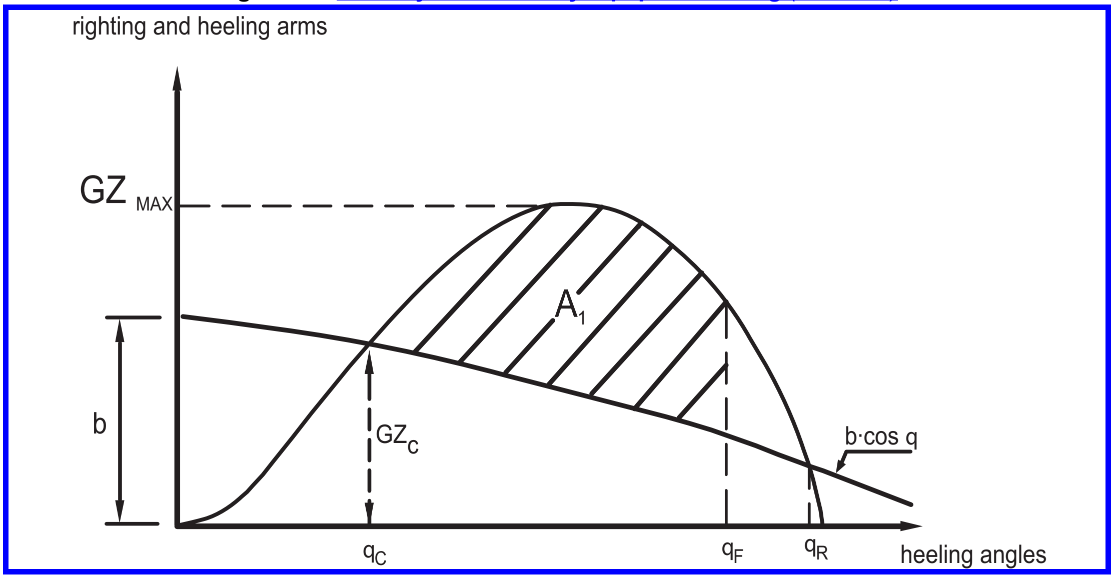
The heeling of the unit is not to produce in the lifting devices higher loads than those envisaged by the Manufacturer, generally expected to be 5° in the boom plane and 2° transversally in the case of a crane.

Table 1 : Documents to be submitted *(1/1/2022)*

No.	I/A (1)	Document
1	I	General arrangement of the W2W system
2	A	Hull structures related to the arrangement of the W2W system, showing the interfaces with the ship
3	A	Electrical load analysis of main and emergency source, showing W2W system related loads
4	I	Plans showing electrical equipment arrangement
5	A	Single line diagrams of communication systems

(1) A = to be submitted for approval, in quadruplicate
I = to be submitted for information, in duplicate

Figure 1 : W2W system stability equipment lifting *(1/1/2022)*



1.2 Hull structural arrangements related to the W2W system

1.2.1 General *(1/1/2022)*

The hull structures related to the arrangement of the W2W system on the ship are to be designed with adequate strength and stiffness to sustain the loads induced by the system during rest and operation, in accordance with the general load criteria in Part B, Chapter 5 and the strength criteria in Part B, Chapter 8 (or, for ships of L > 90 m, Part B, Chapter 7) of the Rules for the classification of ships.

Pedestals and foundations also concern the ship's hull and are to comply with the above structural strength requirements.

1.3 Arrangement and installation of the W2W system

1.3.1 Location *(1/1/2022)*

The W2W is not to be located in spaces containing other machinery or in spaces where explosive gas-air mixtures may be present.

2 Offshore support vessel with additional service feature WIND TURBINE MAINTENANCE

2.1

2.1.1 *(1/1/2022)*

The hull structural strength is to be as required for the main class taking into account necessary strengthening of supporting structures for equipment applied during the maintenance and service of offshore wind farms.

2.1.2 *(1/1/2022)*

All load effects caused by deck cargo and heavy equipment are to be accounted for in the design calculations for all operational phases.

SECTION 3 MACHINERY AND SYSTEMS

1 Offshore support vessel with additional service feature WIND TURBINE MAINTENANCE

1.1 Seakeeping

1.1.1 General *(1/1/2022)*

The ship is to be capable, within given environmental limit conditions, of maintaining the position during operation, either by means of anchoring arrangement or dynamic positioning system.

1.1.2 Dynamic positioning *(1/1/2022)*

Dynamic positioning system, when used to maintain the vessel's position during operations, is to comply with the requirements for the additional class notation **DYNAPOS** (see Pt F, Ch 13, Sec 6).

1.1.3 Station keeping with anchors and cables *(1/1/2022)*

Position mooring with anchors, cable and mooring winches are to fulfill the requirements for position mooring system of Part B, Chapter 9 of Rules for the Classification of Floating Offshore Units at Fixed Locations and Mobile Offshore Drilling Units. Safety precautions are to be considered to prevent damaging seabed equipment and installation by deployment, recovery and station keeping.

SECTION 4 ELECTRICAL INSTALLATIONS

1 Offshore support vessel with additional service feature Walk-to-Work (W2W)

1.1 General

1.1.1 *(1/1/2022)*

For the purpose of W2W, the essential electrical services that need to be in continuous operation to ensure the safe operation of the system at all times are to be taken into account.

A non-exhaustive list of such services is as follows, as applicable.

- Power driven motion compensation system (e.g. dynamic ballast)
- lighting along the W2W system (gangway, platform etc.)
- control, monitoring and alarms
- control stations
- systems that support the W2W motions (hydraulic, pneumatic etc.)
- power driven connection/disconnection systems.

1.2 Main source and emergency source

1.2.1 *(1/1/2022)*

The essential services mentioned above for the period required to the safe completion of the mission both in normal and emergency conditions are to be supplied from both main and emergency sources of electrical power.

1.3 Distribution systems

1.3.1 *(1/1/2022)*

Only insulated (IT) electrical distribution systems are permitted to supply a W2W system. Being insulated, they are to be provided with a device capable of automatic insulation monitoring and, in the case of insulation failure, actuating switch-off and giving an alarm.

Alarm only may be used if a sudden switch-off of the equipment may cause danger to the divers.

Systems using double insulated apparatus or earth fault circuit-breakers will be considered on a case-by-case basis.

When the main power to the W2W system is supplied via a distribution board, this board is to be supplied by two separate feeders from different sections of the main switchboard.

When the emergency power to the W2W system is supplied by the ship, the supply is to be from the ship's emergency switchboard.

1.4 Installation

1.4.1 *(1/1/2022)*

Tensile loads are not to be applied to electrical cables or wiring.

1.5 Communication systems

1.5.1 *(1/1/2022)*

A communication system is to be arranged for direct two-way communication between the bridge and/or control staions and the W2W system.

APPENDIX 1 CERTIFICATION OF THE W2W SYSTEM

1 General

1.1

1.1.1 *(1/1/2022)*

As explained in Sec. 1, the W2W system is to be certified for fitness of service according to the Tasneef "Guide for Tech-nology Qualification Processes", which is to be applied to the system. Salient points of TQ are the establishment of a team with stakeholders, the agreed definition of qualifica-tion basis for the fitness of service, the normative gap analy-sis, the risk assessment and the engineering activities (analysis and tests) to demonstrate the qualification criteria have been fulfilled.

Some generic guidance is provided in the following, but the actual process is to be developed in full according to the aforesaid Guide for TQ Processes.

a) To define the qualification basis, first of all the actual design, mission and safety criteria of the W2W need to be appraised, bearing in mind that the first and foremost goal is the safety of the personnel in all operating conditions.

   In this regulation, the W2W is assumed to be a gangway to transfer personnel from the OSV to offshore facilities such as wind farms, offshore platforms and the like, built using steel and/or aluminum alloys. It may be fitted on an OSV during her construction, or on an existing vessel, which obviously poses different problems.

   Other systems than a gangway may be employed, and this is to be appraised up front.

b) The OSV, gangway and facility are to be viewed as closely interrelated aspects and particular care is to be given to the physical and operational interfaces; the TQ of a gangway is valid on a specific combinations of such aspects (unless it is demonstrated that the same qualified gangway is used in more benign conditions). The aspects of integration onboard of the supporting OSV are to be appraised, e.g.:

   - physical layout of the W2W and its supporting structures and foundations;
   - the OSV motions and accelerations in the most severe environmental conditions;
   - stability issues during W2W operations in the most severe environmental conditions;
   - the station keeping system;
   - the power supply, which is at least to be sized to feed simultaneously the station keeping system, the W2W and its auxiliaries in the worst defined environmental conditions
   - the W2W auxiliaries fitted onboard
   - the actions on the W2W, in its various operating phases, initiated by the control and automation system in case of emergency scenarios affecting the OSV, the facility, or both.
   - the actions on the W2W in a transit loading condition, when W2W is stowed but subject to the most severe wind and ship motion loads.

   The studies need to include aspects like the OSV motion response characteristics in the operational sea area, the location of the gangway system on the OSV structures, the W2W system's ability to compensate for motions imposed on it by the OSV, the means of connection to the facility, the OSV station keeping system, the facility motions if it is not a fixed structures, etc.

c) The gangway scantlings are to consider the maximum number of personnel onboard expected to be involved in the gangway operation for their work, and whether their work includes the transfer of loads through it. Of course, this personnel will be additional to the OSV crew and this number will have to be consistent with the regulatory framework of the OSV.

d) Careful consideration is to be given to the combination of environmental forces affecting the OSV, the W2W and the facility, to find out the worst case and the maximum operational envelope that still allows safety of operations through the gangway.

e) Power supply, auxiliary systems, control/monitoring/alarm and communication system is to be designed taking into account all the scenarios that may affect safety in relation to the W2W mission, e.g. the environmental conditions, single failures, contingency scenarios among OSV, W2W and facility, transfer of stretched personnel etc. according to the basic philosophy of the applicable sections of Pt C, Ch 3 of Tasneef Rules for the Classification for ships.

f) Particular care needs to be applied to the means of connection to the facility and to the failure modes of its active components or to structural problems e.g. due to excessive motions of the W2W. This latter characteristic is to be taken into account when setting the alarms and the emergency disconnection.

g) Control stations are to be designed so as to avoid that a single realistic operator error causes the loss of control of the W2W or the unwanted disconnection of the gangway.

h) Since the W2W system and the OSV are to be seen as a whole, the risk assessment studies required for the TQ, among others, are to cover power supply and auxiliary systems; in this framework, particular care is to be taken to cover:

- Command systems (mechanical - electromechanical - electrohydraulic - electrical)
- Control systems (electrical/electronic/hydraulic)
- Safety systems (passive and active)
- Interfaces with other OSV systems (ESD - position reference system…)
- emergency scenarios (blackout, fire, flooding etc.)

The results of the risk assessment will then be used to complete the commissioning phase , to set up onboard verification tests to demonstrate that the W2W system is safe in the envisaged normal and abnormal operating conditions.

Part E
Service Notations

Chapter 33
WIND TURBINE INSTALLATION VESSEL

SECTION 1 GENERAL

1 General

1.1 Application

1.1.1 *(1/1/2022)*

Ships complying with the requirements of this Chapter are eligible for the assignment of the service notation **wind turbine installation vessel**, as defined in Pt A, Ch 1, Sec 2, [4.8.12].

Wind turbine installation vessel are specially intended for installation and/or maintenance of fixed and floating wind power equipment such as:

- foundations
- columns
- generator house
- blades.

1.1.2 *(1/1/2022)*

Ships dealt with in this Chapter are to comply with the requirements stipulated in Parts A, B, C and D of the Rules, as applicable, and with the requirements of this Chapter, which are specific for the assignment of the service feature **wind turbine Installation vessel**.

1.2 Summary table

1.2.1 *(1/1/2022)*

Tab 1 indicates, for ready reference, the Sections of this Chapter containing specific requirements applicable to wind turbine Installation vessel.

Table 1 *(1/1/2022)*

Main subject	Reference
Ship arrangement	(1)
Hull and stability	Sec 2
Machinery and systems	Sec 3
Electrical installations	(1)
Automation	(1)
Fire protection, detection and extinction	(1)

(1) No specific requirements for wind turbine Installation vessel are given in this Chapter.

2 Wind turbine installation vessel with additional service feature W2W

2.1 General

2.1.1 *(1/1/2022)*

Wind turbine installation vessels with the additional service feature **W2W** are to comply with applicable requirements in Ch 32.

SECTION 2 HULL AND STABILITY

1 Special design principles applied to self-elevating units

1.1

1.1.1 *(1/1/2022)*

For **wind turbine Installation vessel** equipped with a self-elevating system, the special design principles of Pt E, Ch 4, Sec 2, [1] and [7] of Tasneef Rules for the Classification of Floating Offshore Units at Fixed Locations and Mobile Offshore Drilling Units are to be applied.

2 Intact stability criteria

2.1

2.1.1 *(1/1/2022)*

Intact stability criteria are to be in compliance with Pt E, Ch 4, Sec 3, [4] of Tasneef Rules for the Classification of Floating Offshore Units at Fixed Locations and Mobile Offshore Drilling Units.

3 Subdivision and damage stability

3.1

3.1.1 *(1/1/2022)*

Subdivision and damage stability are to be in compliance with Pt E, Ch 4, Sec 3, [5.1] of Tasneef Rules for the Classification of Floating Offshore Units at Fixed Locations and Mobile Offshore Drilling Units.

4 Stability and watertight integrity

4.1

4.1.1 *(1/1/2022)*

Stability and watertight integrity are to be in compliance with Pt E, Ch 4, Sec 3, [6.2] and [7.1.6] of Tasneef Rules for the Classification of Floating Offshore Units at Fixed Locations and Mobile Offshore Drilling Units.

5 Freeboard

5.1

5.1.1 *(1/1/2022)*

Freeboard is to be in compliance with Pt E, Ch 4, Sec 3, [9.3] of Tasneef Rules for the Classification of Floating Offshore Units at Fixed Locations and Mobile Offshore Drilling Units.

SECTION 3 MACHINERY AND SYSTEMS

1 Machinery installations for self-elevating units

1.1 General

1.1.1 (1/1/2022)

The requirements of this item apply in lieu of those in Pt C, Ch 1, Sec 1, [2.4].

All machinery, components and systems essential to the safe operation of a unit are to be designed to operate under the following static condition of inclination: when self-elevating units are upright and inclined to an angle up to 10° in any direction.

The Society may permit or require deviations from these angles, taking into consideration the type, size and service conditions of the unit.

1.1.2 (1/1/2022)

Jacking mechanisms for self-elevating units are in general to be arranged with redundancy so that a single failure of any component does not cause an uncontrolled descent of the unit.

1.1.3 (1/1/2022)

Means are to be provided whereby normal operation of vital systems, such as ballast systems in semisubmersible units, jacking systems in self-elevating units or control of blow-out preventers, can be sustained or restored even though one of the essential auxiliaries becomes inoperable.

2 Cranes

2.1

2.1.1 (1/1/2022)

For **wind turbine Installation vessel** equipped with cranes intended to be operated offshore, the service notation **Lifting unit** is to be complied with, as defined in Pt A, Ch 1, Sec 2.

3 Seakeeping

3.1 General

3.1.1 (1/1/2022)

The ship is to be capable, within given environmental limit conditions, of maintaining the position during operation, either by means of anchoring arrangement or dynamic positioning system.

3.2 Dynamic positioning

3.2.1 (1/1/2022)

Dynamic positioning system, when used to maintain the vessel's position during operations, is to comply with the requirements for the additional class notation **DYNAPOS** (see Pt F, Ch 13, Sec 6).

SECTION 6 DYNAMIC POSITIONING (DYNAPOS)

1 General

1.1 Application

1.1.1 *(1/7/2017)*

The additional class notation **DYNAPOS** is assigned, in accordance with Pt A, Ch 1, Sec 2, [6.14.6], to ships fitted with dynamic positioning installations complying with the requirements of this Section, as follows:

- **DYNAPOS-SAM**
- **DYNAPOS-DP1**
- **DYNAPOS-DP2**
- **DYNAPOS-DP3**

For the purpose of this Section, these notations are indicated using the following abbreviations:

- **SAM** for **DYNAPOS-SAM**
- **DP1** for **DYNAPOS-DP1**
- **DP2** for **DYNAPOS-DP2**
- **DP3** for **DYNAPOS-DP3**

1.1.2 *(1/7/2017)*

SAM (semi-automatic control): the control system of the installation is to be achieved by automatic conversion of the instructions issued by the operator in thruster commands: the operator's manual intervention is necessary for position keeping.

1.1.3 *(1/7/2017)*

DP1 (automatic control): position keeping is automatically achieved and loss of position and/or heading may occur in the event of a single failure.

1.1.4 *(1/7/2017)*

DP2 (automatic control): position keeping is automatically achieved, but loss of position and/or heading is not to occur in the event of a single failure in any active component or system. Single failure criteria include:

- any active component or system (generators, thrusters, switchboards, communication network, remote controlled valves, etc.),
- any static component (cables, pipes, manual valves, fitting, junction, etc.) not properly protected from external damage. Static components will not be considered to fail where adequate protection from damage is demonstrated to the satisfaction of the Society.

1.1.5 *(1/1/2021)*

DP3 (automatic control): position keeping is automatically achieved, but loss of position and/or heading is not to occur in case of a single failure. Single failure criteria include:

- any active component or system (generators, thrusters, switchboards, communication network, remote controlled valves, etc.),
- any static component,
- all components in any one watertight compartment and any one fire sub-division, due to fire or flooding.

Note 1: It is assumed that all active and static components are subjected to proper maintenance.

1.1.6 *(1/1/2021)*

The additional class notation **DP PLUS** is assigned, in accordance with Pt A, Ch 1, Sec 2, [6.14.6], to ships having the additional class notation **DYNAPOS-DP2** or **DYNAPOS-DP3** and equipped with a dynamic positioning (DP) system complying with the requirements specified in [11]. An additional FMEA is needed to demonstrate the compliance with the requirements listed in [11].

1.1.7 *(1/7/2017)*

For **DP2** and **DP3**, a single inadvertent act is to be considered as a single failure if such an act is reasonably likely.

1.1.8 *(1/7/2019)*

Based on the single failure criteria in [1.1.4] and [1.1.5], the worst case failure is to be determined and used as the criterion for the consequence analysis.

1.1.9 *(1/7/2017)*

The notations may be completed by the feature **SKC (L, I1, I2, I3, I4)**, defined in [10].

1.1.10 *(1/7/2017)*

These requirements are additional to those applicable in other parts of the Rules.

1.1.11 *(1/7/2017)*

These Rules do not cover the association of the dynamic positioning system to a position mooring system. However, if a position mooring system is used to assist the main dynamic positioning system in special circumstances of operation, this system is to be at least designed in such a way to control the length and tension of individual anchor lines remotely. An analysis of the consequences of anchor line breaks or thruster failure, according to the operational mode of the installation, is to be carried out.

1.2 Definitions

1.2.1 Alarm devices: visual and audible signals enabling the operator to immediately identify any failure of the dynamic positioning system.

...OMISSIS...

7 Software

7.1

7.1.1 The software is to comply with Pt C, Ch 3, Sec 3, as applicable.

7.1.2 A back-up copy of the current release is to be available onboard.

7.1.3 *(1/7/2017)*

Modifications or updates of the software are to be carried out by authorized personnel, according to a specific management of change. A copy of the documentation that illustrates the modifications performed and the relevant management of change is to be kept onboard.

7.1.4 *(1/7/2019)*

Appropriate security measures are to be taken to avoid inadvertent or malicious misuse of the software. In particular, the following actions are deemed not acceptable by the Society:

- remote maintenance;
- onboard maintenance, or use of removable media/storage devices, by non-authorized personnel.

Note 1: software maintenance includes checking, updating, reconfiguring, or upgrading the software in order to prevent or correct failures, maintain regulatory compliance and/or improve performance.

Note 2: a malware check should be performed on the device to be used before the maintenance is carried out and confirmation that this check has been performed is to be recorded in the management of change.

7.1.5 A key figure responsible for the integration of the software of the DP-subsystems should be identified

7.1.6 The compatibility of individual equipment of the DP subsystems is to be demonstrated.

7.1.7 Data communication links are to comply with requirements of Pt C, Ch 3, Sec 3. For **DP2** and **DP3** notation, overloading of the data communication link in one system is never to be transferred to the other redundant system.

8 Operational requirements

8.1 General

8.1.1 Before every DP-operation, the DP-system is to be checked according to the vessel specific location checklist(s) to make sure that the DP-system is functioning correctly and that the system has been set up for the appropriate equipment class.

8.1.2 During DP-operations, the system is to be checked at regular intervals according to a vessel specific watch-keeping checklist.

8.1.3 *(1/7/2019)*

For **DP2** or **DP3** notation, DP operations are to terminate when the environmental conditions (e.g., wind, waves, current, etc.) are such that the DP-vessel will no longer be able to keep position if the single failure criterion applicable to the DP notation occurs. In this context, deterioration of environmental conditions and the necessary time to safely terminate the operation is also be taken into consideration. This is to be checked by way of environmental envelopes if operating in **DP1** and by way of an automatic means (e.g. consequence analysis) if operating in **DP2** or **DP3** notation.

8.1.4 The necessary DP-operating instructions are to be kept on board. In this context, deterioration of environmental conditions and the necessary time to safely terminate the operation and consequence of loss of position should also be taken into consideration.

8.1.5 DP capability polar plots are to be produced to demonstrate position keeping capacity for fully operational and post worst case single failure conditions. The capability plots is to represent the environmental conditions at the area of operation and the mission specific operational condition of the ship.

8.1.6 *(1/1/2022)*

The following checklist, test procedures and instructions are to be incorporated into the vessel specific DP operati~~ng~~on manuals:

- location checklist
- watch-keeping checklist
- DP-operation instructions
- tests and procedures
- example of tests and procedures after modifications and non-conformities
- black-out recovery procedure
- list of critical components
- operating modes
- capability plot.

Reports of tests and record of modification or equivalent are to be kept on board and made available during periodical inspections.

9 Testing

9.1 General

9.1.1 Before a new installation, or any alteration or addition to an existing installation, is put into service, the DP system equipment is to be tested in accordance with [9.2] , [9.3].

9.1.2 When deemed necessary by the attending surveyor, tests additional to those listed above may be required.

9.2 Type approved components

9.2.1 The following components are to be type tested or type approved according to the tests listed in Pt C, Ch 3, Sec 6, Tab 1, as far as applicable:

- DP-control system
- Independent joystick control system with auto heading
- Sensors
- Thruster control system.

SECTION 15 HIGH VOLTAGE SHORE CONNECTION (HVSC)

1 General

1.1 Application

1.1.1

The additional class notation **HVSC** is assigned in accordance with Pt A, Ch 1, Sec 2, [6.14.18] to ships fitted with high voltage shore connection (HVSC) systems complying with the requirements of this Section.

1.1.2 *(1/1/2022)*

These requirements are additional to those applicable in other Parts of the Rules.

For specific requirements relevant to particular ship's types, annexes in IEC 80005 may be referred to.

1.1.3 *(1/1/2022)*

On shore equipment and ~~machinery~~installations (including shore-based transformers, circuit-breakers, cables, connectors and on shore alarm, control and safety systems) are not covered by these requirements.

1.1.4 *(1/1/2022)*

Assessment of the overall compatibility between ship and shore installation is necessary before connection and is not covered by this additional class notation. This assessment of compatibility is to be completed in advance, and relevant documentation is to be available, to prepare for a visit to a port where it is intended to connect to the ship to shore power supply.

Note 1: Where the requirements and recommendations of IEC/IEEE 80005-1~~:2019~~ are complied with, high voltage shore supply arrangements are likely to be compatible for visiting ships for connection.

1.2 ~~System description~~Definitions

1.2.1 *(1/1/2022)*

~~A typical HVSC system includes all hardware components necessary to electrically connect ship to shore such as plugs and sockets, transformers, switchboards, (static or rotating) frequency converters, alarm control and safety systems.~~Cable management system: all equipment designed to control, monitor and handle the HV-flexible and control cables and their connection devices.

1.2.2 *(1/1/2022)*

Equipotential bond monitoring device: device that monitors the equipotential bonding between two points.

1.2.3 *(1/1/2022)*

Pilot contact: contact of the plug and socket-outlet, which signals correct plug connection and is a safety-related component.

1.3 Documents to be submitted

1.3.1 *(1/1/2022)*

The documents in Tab 1 are required.

The Society reserves the right to request the submission of additional documents in the case of non-conventional design or when it is deemed necessary for the evaluation of the systems and components.

2 Requirements for both ship's and shore systems

2.1 General

2.1.1 *(1/1/2022)*

A typical HVSC system consists of all hardware components necessary to electrically connect ship to shore such as plugs and sockets, transformers (where applicable), switchboards, (static or rotating) frequency converters and alarm, control and safety systems.

2.1.2 *(1/1/2022)*

Protection and safety systems are to be designed based on the fail-safe principle and hard-wired.

2.1.~~1~~3

Electrical power supply from an HVSC system is not to adversely affect the availability of main, auxiliary or emergency machinery, including ship sources of electrical power to allow ship power to be restored.

2.2 Equipotential bonding

2.2.1 *(1/1/2022)*

An equipotential bonding ~~connection~~between the ship's hull and shore earthing system is to be foreseen~~ between ship and shore~~.

2.2.2 *(1/1/2022)*

Integrity of the equipotential bonding is to be continuously checked as a part of the ship shore safety ~~system~~circuit.

2.2.3 *(1/1/2022)*

Loss of continuity in the equipotential bonding is to result in the shutdown of the HVSC~~. T~~ and the ship system is to perform a standard restart after blackout.

Note 1: The adoption of special arrangements (e.g. detection of corrosion currents across the equipotential bonding circuit) against electrochemical corrosion is to be considered, especially in the case of aluminium ships.

2.2.4 *(1/1/2022)*

As an alternative to the continuous monitoring of the equipotential bonding, periodic testing and maintenance of the bonding connection may be accepted on a case-by-case basis, considering the operative profile of the ship. Documentation is to be made available onboard as a reference for the surveyor in charge for survey.

2.3 Compatibility

2.3.1

At least the following matters are to be considered when ship shore network compatibility is evaluated:

- nominal ratings of the shore supply, ship to shore connection and ship connection (power, alarm, control, safety and communication cables),
- maximum prospective short-circuit current (electrical system design, including short-circuit protective device rating, is to be suitable for the maximum prospective short-circuit current at the installation point),
- acceptable voltage variations at ship switchboards between no load and rated load (considering steady state and transient ship load demands),
- shore supply response to step changes in load,
- verification of ship equipment impulse withstand capability,
- configuration compatibility assessment of neutral point connection (where an on board transformer is not feasible, the neutral point treatment on the shore supply is to be able to adapt to various grounding philosophies),
- cable length,
- presence of hazardous areas.

Table 1 : Documents to be submitted *(1/1/2022)*

No.	**(1)**	Document
1	A	One line diagram of the HVSC system
2	A	Electrical Load Analysis (in shore supply condition)
3	~~A~~I	Short-circuit calculation
4	A	Selectivity and coordination of the electrical protection
5	A	Diagrams of converters and switchboards (including information about Manufacturer, type and characteristics of circuit-breakers and protection)
6	A	Diagrams of alarm, control and safety system (including information about Manufacturer, type and characteristics of electronic equipment and location of the ship's manned station during HVSC system operation)
(1) A = to be submitted for approval, in quadruplicate		

2.4 Failures

2.4.1

An alarm is to be given at the ship's manned station during HVSC system operation whenever a failure occurs on the HVSC system or in ship's systems required to maintain ready availability (for example preheating systems).

2.4.2

The failure effect is to be analysed and the consequences found acceptable from the safety point of view.

2.5 Location

2.5.1

HV equipment is to be located in access controlled spaces.

2.5.2 *(1/1/2022)*

In addition, at least the following matters are to be considered when ship shore equipment location is evaluated:

- the safe and efficient operation of the ship's bunkering, cargo handling and mooring systems
- interference with other ships' operations
- flow on the pier and to maintain open fire (or other emergency) lanes
- need for physical safeguards to prevent injuries (e.g. personnel falling from the shore or the ship because of HVSC system operations)
- all tidal conditions
- presence of hazardous areas.

2.6 Short-circuit calculation and electrical load analysis

2.6.1

In calculating the maximum prospective short-circuit current, the source of current is to include the maximum number of generators which can be simultaneously connected (as far as permitted by any interlocking arrangements), the shore supply contribution and the maximum number of motors which are normally simultaneously connected in the system.

2.6.2

The calculations may take into account any arrangements that:

- prevent permanent parallel connection of high voltage shore supply with ship sources of electrical power and/or,
- restrict the number of ship generators operating during parallel connection to transfer load,
- restrict load to be connected.

2.6.3

The maximum number of generators or transformers may be evaluated without taking into consideration short-term parallel operation for load transfer, provided that suitable interlocks are foreseen.

2.7 Emergency shutdown and emergency stop

2.7.1

Emergency shutdown system is to be provided to open instantaneously all shore connection circuit-breakers, when activated.

2.7.2 *(1/1/2022)*

The high voltage power connections are to be:

a) automatically earthed (so that they are safe to touch) immediately following the isolation from ship and shore electrical supply or

b) arranged from manual earthing, ~~be~~ routed and located such that personnel are prevented from access to live connection cables and live connection points by barriers and/or adequate distance(s) (see Note 1) under normal operational conditions.

Note 1: barriers and/or adequate distance(s) may be satisfied with operational procedures established to:

- restrict un-authorized access to HVSC spaces,
- control personnel access to HVSC spaces and areas when the HV connection is live with locking arrangements, and
- arrangement for the safe discharge of HV conductors.

2.7.3 *(1/1/2022)*

~~If~~Where connection equipment ~~may~~can move into a potentially hazardous area, all electrical powered HVSC equipment that is not certified safe type is to be isolated and only alternative a) in [2.7.2] ~~the first of the two above-mentioned alternatives~~ is to be implemented.

2.7.4

Where earthing of shore equipment by ship equipment would not be permitted by the responsible shore authorities, alternative proposals for personnel protection and connection cable discharge may be considered.

2.7.5 *(1/1/2022)*

The emergency shutdown system is to be activated in the event of:

- loss of continuity in the equipotential bonding circuit, if applicable (see [2.2.4]),
- over~~voltage~~-tension on the flexible cable (mechanical stress),
- loss of any safety circuit,
- activation of any emergency stop buttons,
- activation of protection relays provided to detect faults on the HV connection cable or connectors and
- disengaging of power plugs from socket-outlets while HV connections are live.

2.7.6 *(1/1/2022)*

Emergency stop~~s~~ push buttons, ~~to~~ manually activat~~e~~ing the emergency shutdown system, are to be provided at least at the:

- ship's manned control station during HVSC system operation,
- active cable management system control locations; and
- shore and ship circuit-breaker locations.

Additional ~~manual activation~~emergency stop push buttons may also be provided at other locations, where considered necessary.

2.7.7

The emergency stop devices are to be clearly visible, protected against inadvertent operation. They are to require a manual action to reset.

2.7.8

An alarm is to be given at the ship's manned station during HVSC system operation, upon emergency shutdown activation. The alarm is to indicate the cause of the activation of the emergency shutdown system.

3 Ship ~~R~~requirements ~~for both ship's and shore systems~~

3.1 Power connection from shore

3.1.1

A shore connection switchboard for the reception of the ship to shore connection is to be provided at a suitable location, near the supply point.

3.1.2

The shore connection switchboard is to comply with IEC 62271-200.

3.1.3

The switchboard is to include a circuit-breaker to protect the shipboard fixed electrical cables.

3.1.4

The following interlocks are required for correct system operation (isolation before earthing):

- circuit-breaker and disconnector are to be interlocked and
- disconnector and earthing switches are to be interlocked.

3.1.5

An automatic operated circuit-breaker and remote operated or manually operated earthing switch are to be provided.

3.2 Instrumentation and protection

3.2.1 *(1/1/2022)*

The shore connection switchboard is to be equipped with:

- a voltmeter, all three phases,
- short-circuit devices: tripping and alarm,
- overcurrent devices: tripping and alarm,
- earth fault indicator: alarm
- unbalanced protection for systems with more than one ship inlet,
- battery backup adequate for at least 30 min. operation of all auxiliary circuits,

3.2.2

Alarms and indications are to be provided at the ship's manned station during HVSC system operation and at any other appropriate location for safe and effective operation.

3.2.3

Arrangements are to be provided to check the insulation between HVSC system conductors, and between the conductors and earth prior to the connection of the power supply.

3.3 System separation

3.3.1

Galvanic separation is to be provided between the on-shore and on-board systems.

3.3.2

If necessary, means are to be provided to reduce transformer current in-rush and/or to prevent the starting of large motors, or the connection of other large loads, when an HV supply system is connected.

3.4 Ship's power switchboard

3.4.1

An additional panel is to be provided in the ship's receiving switchboard (in general a section of the main switchboard).

3.4.2

Where parallel operation of the HV-shore supply and ship sources of electrical power for load transfer is possible, necessary instruments and synchronising devices are to be provided.

3.4.3

The shore connection circuit breaker is to be suitable for short time parallel operation and is to be an automatic circuit-breaker.

3.4.4

~~If the main switchboard is an HV switchboard, an earthing switch is to be provided.~~

3.5 Instrumentation

3.5.1

When parallel operation for load transfer is implemented, the following instruments are to be available:

- two voltmeters,
- two frequency meters,
- one ammeter (with an ammeter switch to read the current in each phase), or an ammeter in each phase,
- phase sequence indicator or lamps, and
- one synchronising device.

Means are to be provided to ensure that power supply can be connected to other live parts only when synchronised.

3.5.2

When transfer of supply from ship to shore and vice-versa is made passing through blackout condition, the following instruments are to be available:

- two voltmeters,
- two frequency meters,
- one ammeter (with an ammeter switch to read the current in each phase), or an ammeter in each phase,
- phase sequence indicator or lamps.

3.6 Protection

3.6.1

The following alarms and circuit-breaker trips are to be implemented in the event of:

- short-circuit: tripping with alarm,
- overcurrent: in two steps - alarm, and trip with alarm,
- earth fault: alarm (tripping if required by the type of distribution system used),
- over-under voltage: in two steps - alarm, and trip with alarm,
- over-under frequency: in two steps - alarm, and trip with alarm,
- reverse power: tripping with alarm,
- overcurrent (directional overcurrent protection): tripping with alarm, and
- wrong phase sequence: protection with alarm and interlock.

3.6.2

At least the following protective devices, or equivalent protective devices, are to be provided to satisfy the requirements of [3.6.1] (see Note 1):

- synchronising device (25)
- undervoltage (27)
- directional power (reverse power) (32)
- phase sequence voltage (47)
- overload (49)
- instantaneous overcurrent (50)
- overcurrent (51)
- earth fault (51G)
- overvoltage (59)
- directional overcurrent (67)
- frequency (under and over) (81)

Note 1: ANSI standard device designation numbers are shown in brackets.

3.6.3 *(1/1/2022)*

Load shedding of unessential consumers and restoration of ship power ~~are~~is to be considered where these measures could prevent complete power loss.

3.7 Shore connection circuit-breaker

3.7.1 *(1/1/2022)*

Interlocks are to be provided to ensure that the shore connection circuit-breakers cannot be ~~operated~~closed when:

- one of the earthing switches is closed (shoreside/shipside),
- the ~~pilot contact~~safety circuit is not established,
- the emergency shutdown system is activated,
- failure that would affect the safety of the connection is detected in ship or shore control, alarm or safety system
- the data communication link between shore and ship is not operational (where applicable),
- the high voltage supply is not present, ~~or~~
- equipotential bonding is not established, if applicable (see [2.2.4]).
- an earth fault on ship distribution system is detected.

3.8 Communication

3.8.1

An independent means of voice communication is to be provided between the ship and the shore.

3.9 HVSC behaviour in case of failure

3.9.1

If any failure occurs on the HVSC supply, all shore connection circuit-breakers are to automatically open.

Failures include loss of HV power and disconnection (including activation of emergency shutdown or electrical system protective device activation).

3.9.2

An alarm is to be given at the ship's manned station during HVSC system operation to indicate activation of the automatic circuit-breaker opening required in [3.9.1].

The alarm is to indicate the failure that caused the activation.

3.10 Load transfer via blackout

3.10.1

When load transfer is via blackout, interlocking means are to be provided to ensure that the shore supply can only be connected to a dead switchboard.

3.10.2

The simultaneous connection of an HVSC and a ship source of electrical power to the same dead section of the ship's electrical system is to be prevented.

3.10.3

The interlocking system is to be fault tolerant, i.e. also in the event of a single failure, improper connection is not to be possible.

3.11 Load transfer via temporary parallel operation

3.11.1

When parallel operation for load transfer is foreseen, loads are to be transferred between the HV shore supply and ship source(s) of electrical power after their connection in parallel.

3.11.2

The load transfer is to be completed in as short a time as practicable without causing machinery or equipment failure or intervention of protective devices and this time is to be used as the basis for defining the transfer time limit.

3.11.3

When the HVSC system is not connected, systems or functions used for paralleling or controlling the shore connection load transfer are not to affect the ship's electrical system.

3.11.4 *(1/1/2022)*

When the defined transfer time limit for transferring of load between HV shore supply and ship source(s) of electrical power has elapsed, one of the sources is to be automatically disconnected and an alarm is to be given at the ship's manned station during HVSC system operation.

3.11.5

When load reductions are required to transfer load, this is not to result in the loss of essential or emergency services.

4 Ship to shore connection

4.1 Standardisation

4.1.1

Standardised HVSC systems, including cables and their accessories, socket-outlets, data and communication links between ship and shore and earthing, are to be used.

4.2 Cable installation

4.2.1

The ship to shore connection cable installation and operation are to be arranged to provide adequate movement compensation, cable guidance, anchoring and positioning of the cable during normal planned ship to shore connection conditions.

4.2.2 *(1/1/2022)*

Ship to shore connection cable extension is not to be permitted.

4.3 ~~Plugs and socket-outlets~~Connectors

4.3.1 *(1/1/2022)*

Connectors are to comply with IEC 62613-1 and the following.

4.3.~~1~~2 *(1/1/2022)*

The shore-side of the connection cable is to be fitted with ~~by~~ plug(s). ~~The plug body is to protect all contacts.~~ Cable connections may be permanently connected on shore to suitable terminations.

4.3.~~2~~3

The shipside of the connection cable is to be fitted with connector(s). Cable connections may be permanently connected on board to suitable terminations.

~~4.3.4~~

~~Cable extensions are not permitted.~~

~~4.3.5~~

~~The plug and socket-outlet arrangement is to be fitted with a mechanical securing device that locks the connection in engaged position.~~

~~4.3.6~~

~~The plugs and socket-outlets are to be designed so that an incorrect connection cannot be made.~~

4.3.~~7~~4

Socket-outlets and inlets are to be interlocked with the earth switch so that plugs or connectors cannot be inserted or withdrawn without the earthing switch in closed position.

4.3.~~8~~5 *(1/1/2022)*

~~Access to plug and socket-outlets~~Handling of connectors are to be possible only when the associated earthing switch is closed.

4.3.~~9~~6

The earthing contacts are to make contact before the live contact pins do when inserting a plug.

4.3.10

~~Plugs are to be designed so that no strain is transmitted to the terminals and contacts.~~

~~4.3.11~~

~~The contacts are only to be subjected to the mechanical load which is necessary to ensure satisfactory contact pressure, also when connecting and disconnecting.~~

4.3.~~12~~7 *(1/1/2022)*

Each ~~plug~~connector is to be fitted with ~~two~~ pilot contacts to ensure continuity verification of the safety loop.

4.3.~~13~~8

Contact sequence is to be the following:

a) connection
- earth contact,
- power contacts, and
- pilot contacts;

b) disconnection
- pilot contacts
- power contacts, and
- earth contact.

4.3.~~14~~9

Each plug and socket-outlet is to have a permanent, durable and readable nameplate with the following information:

- Manufacturer's name and trademark,
- type designation, and
- applicable rated values.

4.3.~~15~~

The nameplates are to be readable during normal service.

4.3.~~16~~10 *(1/1/2022)*

Support arrangements are to be foreseen so ~~ensure~~ that the weight of connected cable is not borne by any plug or ~~socket~~ ship connector termination or connection.

4.3.~~17~~11 *(1/1/2022)*

Pilot contact connections are to open before the necessary degree of protection is no longer achieved during the removal of an HV plug or connector. Pilot contacts are to be part of the safety circuit.

4.3.~~18~~12 *(1/1/2022)*

Interlocking with earthing switches is to be arranged to ensure that the HV power contacts remain earthed until:

- all connections are made,
- no emergency stop is activated,
- the communication link is operational,
- self-monitoring properties of ship or shore alarm, control and safety systems detect that no failure would affect safe connections, and
- the permission from ship and shore is activated.

Interlocking are to be hardwired.

4.3.~~19~~13

The current carrying capacity of the earth contact is to be at least equal to the rated current of the other main contacts.

4.4 Cables

4.4.1

Cables are to be at least of a flame-retardant type in accordance with the requirements given in IEC 60332-1-2.

4.4.2

The outer sheath is to be oil-resistant, resistant to sea air, sea water, solar radiation (UV) and non-hygroscopic.

4.4.3

The insulation temperature class is to be at least 85°C.

4.5 Protection

4.5.1

If unbalanced damaging (above the rated cable current) current among multiple phase conductors (parallel power cables and connectors) occurs, the ship and shore HV circuit-breakers are to trip opening all insulated poles.

4.5.2 *(1/1/2022)*

~~At least the following protective devices, or equivalent protective devices, are to be provided to satisfy the requirements of [4.4.1] (see Note 1):~~

- ~~phase balance current relay (between multiple plug systems) (46),~~
- ~~-directional overcurrent (to detect current flow to earth fault from a parallel connection cable) (67N).~~

Protective ~~relays~~devices to satisfy th~~is~~e requirement of [4.5.1] are to~~may~~ be installed ~~on board and/or~~ ashore to~~provided the connection is~~ isolate~~d~~ the connection in the event of damaging unbalance~~d~~ detection.

Note 1: ~~ANSI standard device designation numbers are shown in brackets.~~

4.6 Data communication

4.6.1

At least the following data are to be communicated at the ship's manned station during HVSC system operation:

- shore transformer high temperature alarm,
- HV shore supply circuit-breaker protection activation,
- permission to operate HV circuit-breakers for HV ship to shore connection,
- alarm given by self-monitoring facilities of the ship or shore alarm, control or safety systems, when an error that would affect safe connection is detected,
- emergency stop activation,
- where provided, shore control functions,
- emergency disconnection of the shore supply.

4.6.2 -

~~When the communication between ship and shore is safety related, IEC 60092-504 is to be observed.~~

4.7 Storage

4.7.1

When not in use, shipboard equipment is to be stored in dry spaces in such a way that it does not present a hazard during normal ship operation.

4.7.2

Parts dismantled after use of the communication link are to be provided with stowage arrangements.

4.7.3

When stored, plugs, socket-outlets, inlets and connectors are to maintain their IP ratings.

4.7.4

Temporary coverings are not considered to satisfy [4.7.1], [4.7.2] or [4.7.3].

4.8 Equipotential bond monitoring

4.8.1 *(1/1/2022)*

The equipotential bond monitoring device, where provided, is to be installed either ashore or onboard where the cable management system is installed. Equipotential bond monitoring termination device, where provided, is to be installed on the other side.

5 Testing

5.1 Rule application

5.1.1

Before a new installation or any alteration or addition to an existing installation is put into service, the electrical equipment is to be tested in accordance with the following to the satisfaction of the Surveyor in charge.

5.2 Type approved components

5.2.1 *(1/1/2022)*

~~The following components~~Plugs, connectors and socket-outlets, in addition to the components listed in Pt C, Ch 2, Sec 15 [2.1.1], are to be type tested or type approved or provided with manufacturer's statement of conformity to ~~in accordance with~~ the applicable IEC product standard.~~:~~

- ~~plugs, connectors and socket-outlets.~~

5.2.2

Case-by-case approval based on submission of adequate documentation and execution of tests may also be granted at the discretion of the Society.

5.3 Component testing

5.3.1

HV system components are to be type and routine tested according to the relevant applicable requirements.

5.3.2

Tests are to be carried out to demonstrate that the electrical system and its alarm, control and safety systems have been correctly installed and are in good working order.

5.4 Initial tests of shipside installation

5.4.1

Tests are to be carried out on the ship's HVCS system, including alarm, control and safety equipment, according to a prescriptive test program to be agreed with the Society, to verify that the shipside installation complies with the requirements of this Section.

5.4.2

Tests are to be carried out in the presence of a Surveyor of the Society after completion of the installation.

5.4.3 *(1/1/2022)*

The following tests are to be carried out:

- visual inspection,
- HV test,
- insulation resistance measurement,
- ~~measurement of the earthing resistance~~ship-side bonding connection resistance measurement,
- functional tests including correct settings of the protection devices,
- functional tests of the interlocking system,
- functional tests of the control equipment,

- earth fault monitoring test,
- phase sequence test,
- functional tests of the cable management system, where applicable,
- integration tests to demonstrate that the shipside installations such as the power management system, integrated alarm, control and safety systems, etc. work properly.

5.4.4 *(1/1/2022)*

The tests required in [5.4.3] do not exempt Interested Parties from the requirement to carry out at least the following tests at the first call at a shore supply point:

- visual inspection,
- HV test,
- insulation resistance measurement,
- measurement of the earthing resistance,
- functional tests of the protection devices,
- functional tests of the interlocking system,
- functional tests of the control equipment,
- ~~earth fault~~equipotential bond monitoring test, if applicable (see [2.2.4]),
- phase sequence test,
- functional tests of the cable management system, where applicable,and
- integration tests to demonstrate that the shore and shipside installations work properly together.

SECTION 25 DOLPHIN QUIET SHIP AND DOLPHIN TRANSIT SHIP

1 General

1.1 Application

1.1.1 *(1/3/2017)*

The rules in this Section apply to underwater noise radiation from ships to ensure a low environmental impact.

The additional class notations **DOLPHIN QUIET SHIP** or **DOLPHIN TRANSIT SHIP** are assigned, in accordance with PtA, Ch1, Sec2, [6.14.40] to ships complying with the requirements in this Section.

A Certificate of Compliance may be issued to ships not classed with the Society, fulfilling the requirements of this Section.

1.2 Terms and Definitions

1.2.1 *(1/3/2017)*

For terms and definitions, reference is made to ISO PAS 17208-1 "Quantities and procedures for description and measurement of underwater sound from ships - Part 1: General requirements for measurements in deep water".

1.2.2 Acoustic Centre *(1/3/2017)*

Position at which it is assumed that all of the noise sources are co-located as a single point source.

For the purposes of this section, the position is on a ship.

1.2.3 Background Noise *(1/3/2017)*

Noise from all acoustical and non-acoustical sources when the source under test is not present.

For the purposes of this section, the source under test is a ship.

1.2.4 Beam Aspect *(1/3/2017)*

Direction to either side of the ship under test.

Beam aspect is in reference to the location of the hydrophones.

Another approach for hydrophone measurement (not applied in this section) is bottom aspect, where the hydrophone(s) are mounted at or near the sea floor.

1.2.5 Closest Point of Approach (CPA) *(1/3/2017)*

Point at which the horizontal distance (during a test run) from the acoustic center of ship under test is the closest to the hydrophone(s).

The distance at the closest point of approach is defined by the symbol d_{CPA}.

1.2.6 Commence Exercise (COMEX) *(1/3/2017)*

Start test range location, position of the ship under test when twice (2x) the "start data" distance ahead of the CPA.

1.2.7 Data Window Angle *(1/3/2017)*

Angle subtended at the hydrophone, between the start data location and the end data location.

1.2.8 Data Window Length (DWL) *(1/3/2017)*

Distance between the start data location and end data location.

The DWL is defined as 1,5x ship length (see [4.1]) and shown in Fig 3.

1.2.9 Data Window Period (DWP) *(1/3/2017)*

Time taken by the ship under test to travel the data window length at a certain speed.

1.2.10 End Data Location *(1/3/2017)*

Position of the acoustic center of the ship under test where data recording is ended.

End data location is one data window length after the start data location. See Fig 3.

1.2.11 Finish exercise (FINEX) *(1/3/2017)*

End test range location, position of the ship under test when twice (2x) the "start data" distance past the CPA.

1.2.12 Field Calibration *(1/3/2017)*

Method of using known inputs, if possible using physical stimuli (such as a known and calibrated/traceable acoustic or vibration source) or electrical input (charge or voltage signal injection) at the input (or other stage) of a measurement system in order to ascertain that the system is responding properly (i.e. within its stated uncertainty) to the known stimulus.

1.2.13 Frequency Response *(1/3/2017)*

Frequency range a system is able to measure, for a given uncertainty and repeatability, from the lowest frequency to the highest stated frequency.

1.2.14 Geometric far field *(1/3/2017)*

Horizontal distance from the ship under test at which the assumption of source co-location causes less than 1 dB of error when adjusting to the reference distance.

1.2.15 Hydrophone cable drift angle *(1/3/2017)*

Angle between the vertical axis and the line created between the fixed support of the hydrophone cable and the hydrophone.

1.2.16 Insert voltage calibration *(1/3/2017)*

Known, calibrated and traceable input stimulus in the form of an electrical input injected at the input (or other stage) of a measurement system in order to ascertain that the system is, in fact, responding properly (i.e. within the system's stated uncertainty and repeatability) to a known stimulus.

1.2.17 Lloyd's mirror surface image coherence effects *(1/3/2017)*

Alteration of radiated-noise levels caused by the presence of a free (pressure release) surface.

Radiation from the "surface image" constructively and destructively influences the source's direct radiation. For the purposes of this section, these effects are considered as part of the source's radiation, causing it to exhibit a vertical directivity.

1.2.18 Measurement uncertainty *(1/3/2017)*

Maximum difference between the measured resulting signature radiated noise level and the true signature radiated noise level stated in decibels for a given measurement system, for one-third-octave bands using a given measurement method (averaging time, bandwidth-time product, etc.).

Reference can be made to ISO/IEC Guide 98-3:2008.

1.2.19 Measurement repeatability *(1/3/2017)*

Expected difference between signature-radiated noise levels resulting from successive measurements on the same ship at the same operating condition, carried out under the same conditions of measurement with the same equipment at the same location, stated in decibels and in one-third-octave bands.

Reference can be made to ISO 3534-1.

1.2.20 Measurement system *(1/3/2017)*

Data acquisition system consisting of, but not limited to, one or more transducer(s), conditioning amplifier(s), analogue-to-digital converter(s), digital signal processing computer and ancillary peripherals.

1.2.21 Omni-directional hydrophone *(1/3/2017)*

Underwater sound pressure transducer that responds equally to sound from all directions.

1.2.22 Slant range *(1/3/2017)*

Distance from the acoustic center of the ship under test to each hydrophone.

1.2.23 Overall ship length *(1/3/2017)*

Longitudinal distance between the forward-most and aft-most perpendicular of a ship.

1.2.24 Radiated noise level *(1/3/2017)*

Measure of the underwater noise radiated by a surface ship, obtained from the root mean square sound pressure level and scaling this quantity according to spherical spreading to a standard reference distance of one meter from the acoustic center of the source.

1.2.25 Sound speed profile *(1/3/2017)*

Measure of the speed of sound in seawater as a function of depth, measured vertically through the water column (only if measurements are carried out in water depth < 100m)

1.2.26 Start data location *(1/3/2017)*

Position of the acoustic center of ship under test where data recording is started.

1.2.27 Test site *(1/3/2017)*

Location at which the underwater noise measurements are performed.

1.2.28 Sound pressure level *(1/3/2017)*

Defined as twenty times the logarithm to the base 10 of the ratio of the root-mean-square pressure of an underwater sound over a stated time interval to the reference value for sound pressure, P_{ref}, is 1 μPa.

$$L_p = 20\log_{10}\left(\frac{P_{rms}}{P_{ref}}\right)[dB re 1 \mu Pa]$$

2 Instrumentation, Measurements, Procedures, Reporting

2.1 General

2.1.1 *(1/3/2017)*

In order to quantify the underwater sound from a marine ship, three main instrumentation components are required:

- hydrophones and signal conditioning;
- data acquisition, recording, processing, and display system; and
- distance measurement system.

Detailed specifications of each of the measurement systems are given below. A summary of the attributes is given in Tab 1.

2.2 Hydrophone and signal conditioning

2.2.1 *(1/3/2017)*

The term "hydrophone" includes any signal conditioning electronics either within or exterior to the hydrophone. The hydrophone(s) are to have sensitivity, bandwidth, and dynamic range necessary to measure the ship under test and meet the performance noted in Tab 1.

Dolphin Class Notations require three hydrophones which are to be omni-directional across the required frequency range of 10 - 50 000 Hz. However, directional hydrophones may be used, as long as the directional characteristics are accounted for in the final data processing. The hydrophones may or may not have integral cable. However, the required performance is to be obtained with the full cable length to be used during the test.

When portable hydrophones are used, they are to be laboratory calibrated every 12 months according to IEC 60565 (or equivalent standard) for all required one-third octave bands. When fixed (i.e., permanently installed underwater) hydrophones are used, they are to be laboratory calibrated before installation to IEC 60565 (or equivalent standard) for all required one-third octave bands. It is advised to confirm the fixed hydrophone calibration by a comparative measurement utilizing a calibrated underwater sound source or reference hydrophone every 12 months.

The sensitivity and directivity of the hydrophones is to be determined to within ± 1 dB.

2.3 Data acquisition, recording, processing and display

2.3.1 *(1/3/2017)*

The data acquisition, recording, processing, and display system is to be capable of accurately acquiring, recording, processing, and displaying data from the hydrophones. Such systems may comprise tape recorders, computer-based data acquisition systems, or hardware-specific devices (such as spectrum analyzers) or combinations of such. The data acquisition system is to have an appropriate sampling rate and anti-aliasing filers following Nyquist requirements and appropriate dynamic range for either analogue or digital systems. All frequency-domain averaging is to be linear with sampling consistent with the Data Window Period.

The time domain signal from each hydrophone is to be acquired and recorded simultaneously and be sampled accurately for all channels. Tracking and time stamp data are to be recorded synchronously with the acoustic data to enable reconstruction of the track and data processing.

The broadband processing is to cover the one-third-octave bands whose centers are from 10 Hz to 50 000 Hz. Narrowband processing is to be in appropriate bandwidths relative to the frequencies to be determined up to 5,000 Hz, or higher as needed.

Effective narrowband processing bandwidth is to be reported in the measurement report.

2.4 Distance measurement

2.4.1 *(1/3/2017)*

Distance measurement is required to determine continuously the actual distance between the hydrophones and the acoustic center of the ship under test.

For measurement with surface-suspended hydrophones, the distance measurement systems only need to determine the horizontal distance from the sea surface position above the hydrophone(s) (i.e. the device or buoy used to suspend the cable) to the acoustic center of the ship under test. The distance measurement device may utilize any method (e.g. optical, acoustical, GPS, radar) as long as the required accuracy is achieved. The distance measurement system is to be accurate to 5% of the distance at CPA. The slant range from the ship under test to the hydrophone(s) may be computed during post-processing of the data. It is not necessary to take into account any drift that the hydrophones could experience after they are deployed, provided the hydrophone cable drift does not exceed 5°. If the drift angle does exceed 5°, then it is to either be reduced or the drift angle is to be taken into account when determining the slant range.

For measurement, with bottom-suspended hydrophones, the distance range-finding instrumentation is only to determine the horizontal distance from the sea surface position above the hydrophone(s) (corresponding to the point of attachment of the cable on sea bottom) to the acoustic center of the ship under test. The distance measurement system is to be accurate to 5% of the distance at CPA. The slant range from the ship under test to the hydrophone(s) may be computed during post-processing of the data. It is not necessary to take into account any drift that the hydrophones could experience after they are deployed, provided the hydrophone cable drift does not exceed 5°. If the drift angle does exceed 5°, then it is either to be reduced or the drift angle is to be taken into account when determining the slant range.

The hydrophone cable drift angle may be estimated by the use of depth gages that indicate the difference in depth with hydrophones.

Other means than the cable drift angle can be used to determine accurately the actual distance between the hydrophones and the acoustic center of the ship under test.

2.5 Acoustic center

2.5.1 *(1/3/2017)*

It must be possible to control the status of the shell openings from the bridge and/or other location which may be used to continuously monitor security.

Table 1 : Summary of measurement parameters *(1/1/2022)*

Achievable measurement uncertainty (averaged over all one third octave band frequencies)	±2.0 dB
Measurement repeatability	±2.0 dB
Bandwidth	One third octave band
Frequency range, lower one third octave band	10 Hz
Frequency range, upper one third octave band	~~4~~50 000 Hz (see [2.2])
Narrowband measurements	Optional, up to 5 000Hz
Number of hydrophones	Three
Hydrophone geometry	Figure 1
Nominal hydrophone depth	15°, 30°, 45°
Minimum water depth	Greater of 150m **(1)**

(1) Measurements in shallow water can be accepted if an adequate procedure for the estimation of the actual trasmission loss has been agreed with the Society (e.g. actual measurement of site TL, validated propagation models, etc).

(2) As an alternative, insert voltage calibration or physical stimuli calibration by pistonphone may be accepted by the Society.

Minimum distance at closest point of approach (CPA)	Greater of 100m
Distance ranging uncertainty (at CPA)	2%
Acoustic center location	Centerline, see definition
Data Window Length, meters	1.5x ship length (see [4.1])
Data Window Time, seconds	DWL/ship speed
Data window average time	One overall sample or ≤ 1 second
Minimum number of runs per ship conditions	4 Total, 2 port, 2 starboard
Recommended weather/sea conditions	Sea State Douglass ≤ 3; Wind Speed ≤ 10 knots
Portable hydrophone calibration	Laboratory calibration every 12 months Field calibration as below daily during measurements for a number of discrete frequencies **(2)**
Fixed hydrophone calibration	Laboratory calibration prior to installation Confirmation using calibrated sound source or reference hydrophone every 12 months Field calibration as below daily during measurements
System field calibration	Insert voltage calibration
Auxiliary data to be reported	Engine shaft speed, wind speed and direction

(1) Measurements in shallow water can be accepted if an adequate procedure for the estimation of the actual trasmission loss has been agreed with the Society (e.g. actual measurement of site TL, validated propagation models, etc).
(2) As an alternative, insert voltage calibration or physical stimuli calibration by pistonphone may be accepted by the Society.

3 Measurement requirements and procedure

3.1 Introduction

3.1.1 *(1/7/2017)*

In order to perform an accurate measurement of a ship's underwater sound, several factors have to be addressed correctly, e.g., selection of an appropriate test site, proper deployment of hydrophones, and proper operation of the ship under test, etc.

3.2 Test site requirements

3.2.1 *(1/1/2022)*

Dolphin Class Notations do not require the use of a specific ocean location for the measurement test site. It is up to the test organization to determine the suitability of the proposed test site for the intended measurements taking into consideration the specific requirement for water depth of a minimum of ~~20~~150 m.

Some of the other factors to consider are ambient noise, traffic, oceanography, bottom type, local weather, ship maneuverability and safety.

The background noise is to be low enough to permit measurement of the underwater sound of the ship under test over the frequency range of interest. Where the background noise limits the measurements, corrections are to be applied.

There will be circumstances where the problem of background noise limiting the measurable frequencies is insurmountable. In such cases where measured levels are background limited and no correction is possible.

3.3 Sea surface conditions

3.3.1 *(1/7/2017)*

The sea surface conditions during testing are of concern.

The recommended sea state 3 (Douglass scale) and wind speed limitation of ≤ 10 knots (5,4 m/s) provides a nominal value for yachts greater than 100 m.

As a generality, smaller length yachts will require lower wave heights to attain consistent radiated noise level measurements. Smaller yachts may require more benign surface conditions while larger yachts may tolerate larger surface conditions.

3.4 Hydrophone deployment

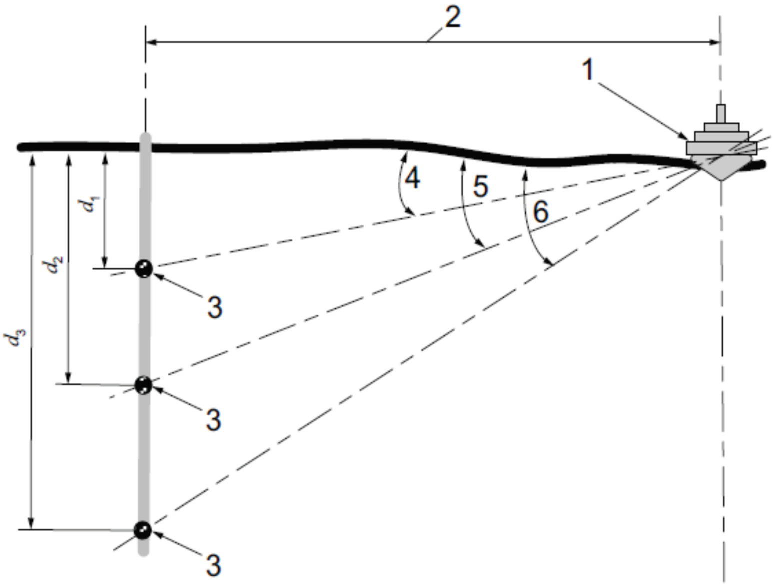
3.4.1 *(1/7/2017)*

The three hydrophones are to be arranged vertically in the water column. The hydrophones are to be located to measure the beam aspect of the ship under test.

The hydrophones are to be positioned vertically in the water column at depths which result from nominal 15°, 30° and 45° angles from the sea surface at a distance equal to the nominal distance at CPA (Fig 1).

Provisions are to be taken to mitigate the effects of cable strum and sea surface effects on the measurements. Fig 2 shows potential deployment approaches, but other solutions are allowed as long as the physical locations of Fig 1 and requirements with respect to the measurement uncertainty are fulfilled.

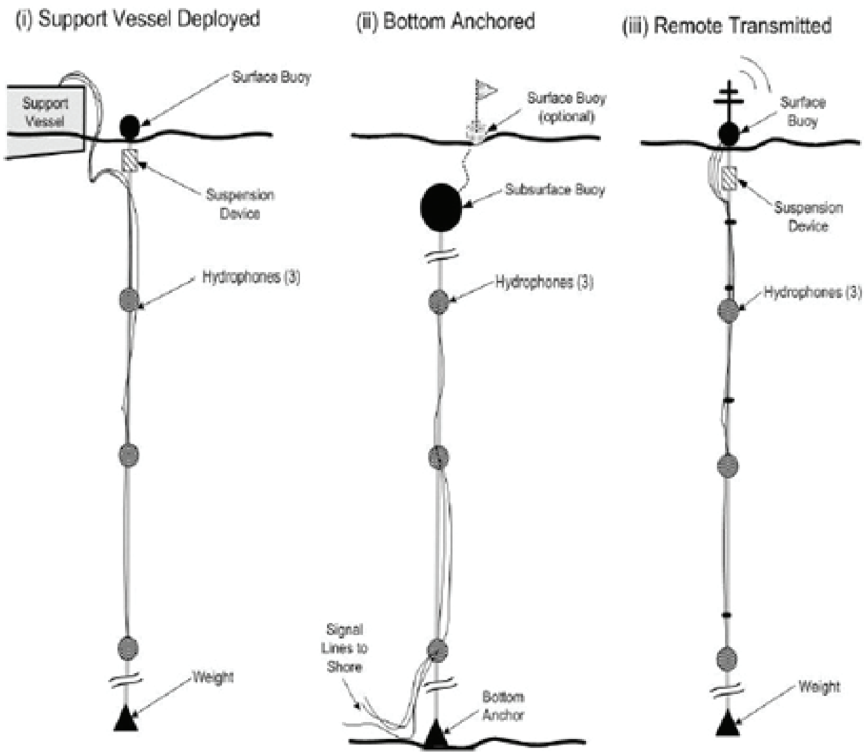
Figure 1 : Hydrophones geometry *(1/1/2022)*



1: ship under test
2: distance, dCPA, at closest point of approach
3: hydrophone
4: 15° angle between surface and shallowest hydrophone
5: 30° angle between surface and middle hydrophone
6: 45° angle between surface and deepest hydrophone

d1 = dCPA tan(15°)
d2 = dCPA tan(30°)
d3 = dCPA tan(45°)
dCPA = greater than 1~~5~~00 m

Figure 2 : Typical hydrophones deployment configurations (not to scale)



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