NR612 DT R01 MARCH 2023

# RULES FOR THE CLASSIFICATION OF HARBOUR EQUIPMENT

## NR612 - MARCH 2023


RULE NOTE

BUREAU VERITAS

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NR612 DT R01 MARCH 2023 takes precedence over previous revision.

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



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BUREAU VERITAS

NR612

# RULES FOR THE CLASSIFICATION OF HARBOUR EQUIPMENT



March 2023

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# RULES FOR THE CLASSIFICATION OF HARBOUR EQUIPMENT

## Part A
## Classification and Surveys



March 2023

Part A
Classification and Surveys

# CHAPTER 1
# PRINCIPLES OF CLASSIFICATION

# Section 1 General Principles of Classification

## 1 Principles of classification

### 1.1 Purpose of the Rules

**1.1.1** This Rule Note gives the requirements for assignment and maintenance of class for harbour equipment, as defined in [1.2.5], operated in smooth stretches of water.

Harbour equipment intended to be operated on stretches of water where different conditions of water may be encountered are to comply with Ch 1, Sec 3, [1.2.4] and Pt D, Ch 8, Sec 4.

**1.1.2** The class assigned reflects the discretionary opinion of the Society that the harbour equipment, for declared conditions of use and within the relevant time frame, complies with the rules applicable at the time the service is rendered.

**1.1.3** The general conditions valid at the time of signing of the contract with the Owner or prospective Owner, the Building Yard or Other Interested party apply.

**1.1.4** The application criteria of the different parts of the present Rules are the following:

- Part A - Classification and Surveys, applies to all harbour equipment
- Part B - Hull Design and Construction, applies to all harbour equipment, but is to be complemented by applicable requirements of the Society's Rule Notes / Guidance Note:
  - NR561 Hull in Aluminium alloys, for harbour equipment assigned additional service feature **A**
  - NR546 Hull in Composite Materials and Plywood, for harbour equipment assigned additional service feature **C** or **W**
  - NI594 Design and Construction of Offshore Concrete Structures, for harbour equipment assigned additional service feature **CR**
- Part C - Machinery, Systems and Electricity, applies to all harbour equipment
- Part D - Additional Requirements for Notations, applies to specific harbour equipment types.

Where necessary, the extent of application is more precisely defined in each Chapter of these parts.

The classification of harbour equipment other than those dealt with in the above-mentioned Part B, Part C and Part D is covered by specific Rules published by the Society.

Classification according to this Rule Note applies primarily to new buildings constructed under survey of the Society. Classification may also be applied to existing harbour equipment by a survey for admission to class/classification after construction, if sufficient documentation is available. See Ch 2, Sec 4, [1.2].

**1.1.5** This Rule Note will be applied for structural elements of the hull and for components of the machinery and electrical installations of harbour equipment, subject to agreement between the Prospective Owner, the Other Interested party and the Building Yard for the classification order to the Society.

**1.1.6** A harbour equipment not covered by any of the service notation defined in Ch 1, Sec 3 will be dealt with on a case-by-case basis.

### 1.2 General definitions

#### 1.2.1 Administration

Administration means the competent authorities within the state where the harbour equipment is operated.

#### 1.2.2 Building specification

The building specification is part of the building contract between the Prospective Owner, Other Interested Party and the Building Yard which specifies the technical parameters and all other details for construction of the harbour equipment.

#### 1.2.3 Building Yard

The Building Yard is the contractual partner of the Prospective Owner or Other Interested Party, entrusted with managing the design, construction and equipment of the harbour equipment, generally together with a series of subcontractors and manufacturers.

#### 1.2.4 Date of contract for construction

The date of "contract for construction" of a harbour equipment is the date on which the contract to build the harbour equipment is signed between the Prospective Owner or the Other Interested Party and the Building Yard. This date is normally to be declared to the Society by the ordering client applying for the assignment of class to a new building.

The date of "contract for construction" of a series of harbour equipment, including specified optional harbour equipment for which the option is ultimately exercised, is the date on which the contract to build the series is signed between the Prospective Owner or Other Interested Party and the Building Yard.

For the purpose of this definition, harbour equipment built under a single "contract for construction" are considered a "series of harbour equipment" if they are built to the same reviewed plans for classification purposes. However, harbour equipment units within a series may have design alterations from the original design, provided:

- such alterations do not affect matters related to classification, or
- if the alterations are subject to classification requirements, these alterations are to comply with the classification requirements in effect on the date on which the alterations are contracted between the Prospective Owner or Other Interested Party and the Building Yard or, in the absence of the alteration contract, comply with the classification requirements in effect on the date on which the alterations are submitted to the Society for review.

The optional harbour equipment will be considered part of the same series of harbour equipment if the option is exercised not later than 1 year after the contract to build the series was signed.

If a "contract for construction" is later amended to include additional harbour equipment or additional options, the date of "contract for construction" for such harbour equipment is the date on which the amendment to the contract is signed between the Prospective Owner or Other Interested Party and the Building Yard. The amendment to the contract is to be considered as a "new contract" to which the above applies.

If a "contract for construction" is amended to change the harbour equipment type, the date of "contract for construction" of this modified harbour equipment is the date on which the revised contract or new contract is signed between the Prospective Owner, or Prospective Owners, and the Building Yard.

#### 1.2.5 Harbour equipment

Harbour equipment covers all non-propelled floating units equipped to provide facilities such as:

- cargo loading/unloading
- passengers embarking/disembarking
- vessels dry docking
- sealing or separation of water areas
- miscellaneous products supply or storage
- working surfaces, etc.

#### 1.2.6 Hull

The hull is the structural body of a harbour equipment including all strength components, i.e. shell plating, wall, framing, decks, bulkheads, etc. of the main hull, superstructures and deckhouses. The hull also includes:

- all portions of the harbour equipment extending beyond the main hull outline (appendages)
- river chests
- structures permanently connected by weld to the harbour equipment's hull such as guard rails, bitts, fixed parts of lifting appliances, machinery bedding, etc.
- tanks integrated to the hull structure
- independent storage tanks.

#### 1.2.7 Other Interested Party

Other Interested Party means other ordering subcontractors such as the broker, the Designer, the engine and components manufacturer, or the Supplier of parts to be tested, etc.

#### 1.2.8 Owner or Prospective Owner

Owner or Prospective Owner means the Registered Owner or the Disponent Owner or the Manager or any other party responsible for the definition, purchase and/or operation of the harbour equipment and having the responsibility to keep the harbour equipment in good condition, having particular regard to the provisions relating to the maintenance of class.

#### 1.2.9 Period of class

Period of class means the period starting either from the date of the initial classification or from the credited date of the last class renewal survey, and expiring at the limit date assigned for the next class renewal survey.

#### 1.2.10 Significant wave height

The significant wave height considered in the Rules corresponds to $H_{1/3}$ which means the average of 33% of the total number of waves having the greater heights between wave trough and wave crest, observed over a short period.

#### 1.2.11 Smooth stretches of water

Smooth stretches of water cover operation of harbour equipment on water stretches where the significant wave height does not exceed 0,3 m.

#### 1.2.12 Society

Society means the Classification Society with which the harbour equipment is classed.

#### 1.2.13 Statutory Rules

Statutory Rules are the national and international Rules and Regulations which apply to the harbour equipment but which are not covered by the classification.

#### 1.2.14 Survey

Survey means an intervention by the Surveyor for assignment or maintenance of class, or interventions by the Surveyor within the limits of the tasks delegated by the Administrations.

#### 1.2.15 Surveyor

Surveyor means technical staff acting on behalf of the Society to perform tasks in relation to classification and survey duties.

#### 1.2.16 Type approval

Type approval means an approval process for verifying compliance with the Rules of a product, a group of products or a system, and considered by the Society as representative of continuous production.

### 1.3 Essential service

**1.3.1** Essential service is intended to mean a service necessary for a harbour equipment to undertake activities connected with its operation and for the safety of life, as far as class is concerned. Essential service is subdivided in primary and secondary essential services according to [1.3.2] and [1.3.3] respectively.

#### 1.3.2 Primary essential services

Primary essential services are those which need to be in continuous operation to maintain safe operation of the harbour equipment.

Examples of equipment for primary essential services:

- scavenging air blowers, fuel oil supply pumps, lubricating oil pumps and cooling water pumps for auxiliary engines and turbines
- electric generators and associated power sources
- hydraulic pumps
- control, monitoring and safety devices/systems for equipment for primary essential services
- speed regulators dependent on electrical energy for auxiliary engines.

The main lighting system for those parts of the harbour equipment normally accessible to and used by personnel is also considered (included as) a primary essential service.

#### 1.3.3 Secondary essential services

Secondary essential services are those services which need not necessarily be in continuous operation.

Examples of equipment for secondary essential services:

- starting air and control air compressors
- bilge pumps
- fire pumps and other fire-extinguishing medium pumps
- ventilation fans for engine rooms
- services considered necessary to maintain dangerous products in a safe condition
- internal safety communication equipment
- fire detection and alarm systems
- electrical equipment for watertight closing appliances
- electric generators and associated power supplying the above equipment
- hydraulic pumps supplying the above equipment
- control, monitoring and safety for product containment systems
- control, monitoring and safety devices/systems for equipment for secondary essential services
- cooling system of environmentally controlled spaces
- windlasses.

Services for habitability are those intended for minimum comfort conditions for people on board.

Examples of equipment for maintaining conditions of habitability:

- cooking
- heating
- domestic refrigeration
- mechanical ventilation
- sanitary and fresh water
- electric generators and associated power sources supplying the above equipment.

### 1.4 Meaning of classification, scope and limits

**1.4.1** The classification process consists of:

- the development of Rules, guidance notes and other documents relevant to the harbour equipment, structure, material, equipment, machinery and other items covered by such documents
- the review of plans and calculations and the surveys, checks and tests intended to demonstrate that the harbour equipment meets the Rules (refer to Ch 2, Sec 1)
- the assignment of class (see Ch 2, Sec 1) and issue of a Certificate of Classification, where compliance with the above Rules is found
- the periodical, occasional and class renewal surveys performed to record that the harbour equipment in service meets the conditions for maintenance of class (see Ch 2, Sec 2).

**1.4.2** The Rules, surveys performed, reports, certificates and other documents issued by the Society, are in no way intended to replace or alleviate the duties and responsibilities of other parties, such as Administrations, Designers, Building Yard, Manufacturers, Repairers, Suppliers, Contractors or Subcontractors, actual or Prospective Owners or Operators and Underwriters.

The activities of such parties which fall outside the scope of the classification as set out in the Rules, such as design, engineering, manufacturing, operating alternatives, choice of type and power of machinery and equipment, number and qualification of operating personnel, remain therefore the responsibility of those parties, even if these matters may be given consideration for classification according to the service notation of the harbour equipment or additional class notation assigned.

**1.4.3** Unless otherwise specified, the Rules do not deal with structures, pressure vessels, machinery and equipment which are not permanently installed and used solely for operational activities, except for their effect on the classification-related matters, such as the harbour equipment's general strength.

During periods of construction, modification or repair, the harbour equipment is solely under the responsibility of the Builder or the Repair Yard. As an example, the Builder or Repair Yard is to ensure that the construction, modification or repair activities are compatible with the design strength of the harbour equipment and that no permanent deformations are sustained.

Note 1: Refer to [3.3] as regards the Owner's responsibility for maintenance and operation of the harbour equipment in relation to the maintenance of class.

**1.4.4** The class assigned to a harbour equipment by the Society following its interventions is embodied in a Certificate of Classification and noted in the Register.

At a certain date the class of a harbour equipment is maintained or regular when no surveys are overdue, when the conditions for suspension of class are not met and when the class is not withdrawn nor suspended. Otherwise the class is irregular. Attention is drawn on the fact that a harbour equipment holding a valid Certificate of Classification may be in an irregular class position.

### 1.5 Limitation of classification to hull only

**1.5.1** When it is agreed to limit the classification to the harbour equipment's hull only, the parts of the harbour equipment which are to comply with the Rules are those mentioned in [1.2.6]. In such a case, the applicable stability requirements are also to be complied with and the classification notations defined in Ch 1, Sec 2 will be assigned only to the hull. Machinery, systems and electrical installations which are normally matters for classification, are to be proven to be in compliance with the applicable relevant Regulations.

### 1.6 Request for service

**1.6.1** Requests for interventions by the Society, such as request for classification, surveys during construction, surveys of harbour equipment in service, tests, etc., are in principle to be submitted in writing and signed by the Other Interested Party, the Owner, the Prospective Owner or the Building Yard. Such request implies that the applicant will abide by all the relevant requirements of the Rules and the General Conditions of the Society.

## 2 Rules

### 2.1 Effective date

**2.1.1** The effective date of entry into force of any amendments to the Rules is indicated on the inside front page of the Rules or in the relevant Section.

### 2.2 Application

**2.2.1** In principle, the applicable Rules for assignment of class to a new harbour equipment are those in force at the date of contract for construction. In the case of admission to class after construction, the Rules in force at the date of the request for classification apply.

**2.2.2** Special consideration may be given to applying new or modified rule requirements which entered into force subsequent to the date of the contract for construction, at the discretion of the Society and in the following cases:

- when a justified written request is received from the party applying for classification
- when the keel is not yet laid and more than one year has elapsed since the contract was signed
- where it is intended to use existing previously reviewed plans for a new contract.

**2.2.3** The above procedures for application of the Rules are, in principle, also applicable to existing harbour equipment in the case of major conversions and, in the case of alterations, to the altered parts of the harbour equipment.

**2.2.4** The rule requirements related to assignment, maintenance and withdrawal of the class of harbour equipment already in operation are applicable from the date of their entry into force.

### 2.3 Equivalence

**2.3.1** The Society may consider the acceptance of alternatives to this Rule Note, provided that they are deemed to be equivalent, to the satisfaction to the Society.

**2.3.2** As a rule, certification of materials and equipment by the Society in compliance with NR467 Rule for Steel Ships is considered acceptable within the scope of this Rule Note.

### 2.4 Novel features

**2.4.1** The Society may consider the classification of harbour equipment based on or applying novel design principles or features, to which the Rule Note is not directly applicable, on the basis of experiments, calculations or other supporting information provided to the Society. The specific limitations will then be indicated on a memorandum.

### 2.5 Disagreement and appeal

**2.5.1** Any technical disagreement with the Surveyor in connection with the performance of his duties is to be raised by the Interested Party as soon as possible.

The Interested Party may appeal in writing to the Society, which will subsequently consider the matter and announce its decision according to its established procedure.

### 2.6 Other construction Rules and Regulations

**2.6.1** The appraisal of design and construction particulars by the Society will be exclusively based on Rules and Guidelines agreed upon in the specification of the classification contract between the Prospective Owner, the Other Interested Party or the Building Yard and the Society.

**2.6.2** In addition, statutory construction Rules for harbour equipment may be applied upon agreement with the relevant Authority and if defined in the specification of the classification contract between the Prospective Owner, the Other Interested Party or the Building Yard and the Society.

**2.6.3** The compliance to statutory Rules of the respective registry country is the responsibility of the Prospective Owner.

### 2.7 Industry Codes, Standards, etc

**2.7.1** Internationally recognised Standards and Codes published by relevant organisations, national industry organisations or standardisation institutions may be used upon agreement in particular cases as a design and construction basis.

Examples: ISO, IEC, EN, DIN, NF.

## 3 Duties of the Interested Parties

### 3.1 International and National Regulations

**3.1.1** The classification of a harbour equipment does not dispense the Owner, Other Interested Party and Building Yard from compliance with any requirements issued by Administrations.

### 3.2 Surveyor’s intervention

**3.2.1** Surveyors are to be given free access at all times to harbour equipment units which are classed or being classed, Building Yard and manufacturer works, to carry out their interventions within the scope of assignment or maintenance of class, or within the scope of interventions carried out on behalf of Administrations, when so delegated.

Free access is also to be given to experts or/and auditors accompanying the Surveyors of the Society within the scope of the audits as required in pursuance of the Society's internal Quality System or as required by external organizations.

**3.2.2** Owners, Other Interested Parties and Building Yard are to take the necessary measures for the Surveyor's inspections and testing to be carried out safely and efficiently under their full responsibility. Owners, Other Interested Parties and Building Yard, irrespective of the nature of the service provided by the Surveyors of the Society or others acting on its behalf, assume with respect to such Surveyors all the responsibility of an employer for his workforce such as to meet the provisions of applicable legislation. As a rule, the Surveyor is to be constantly accompanied during surveys by personnel of the Owner, Other Interested Party or Building Yards.

**3.2.3** The Certificate of Classification and/or other documents issued by the Society remain the property of the Society. All certificates and documents necessary to the Surveyor's interventions are to be made available by the Owner, Other Interested Party or Building Yard to the Surveyor on request

**3.2.4** During the phases of design and construction of the harbour equipment, due consideration is to be given to rule requirements in respect of all necessary arrangements for access to spaces and structures with a view to carrying out class surveys. Arrangements of a special nature are to be brought to the attention of the Society.

## 3.3 Operation and maintenance of harbour equipment

**3.3.1** The classification of a harbour equipment is based on the understanding that the harbour equipment is operated in a proper manner by competent and qualified operating personnel according to the environmental, loading, operating and other criteria on which classification is based.

**3.3.2** In particular, it will be assumed that the draught of the harbour equipment in operating conditions according to normal prudent conduct will not exceed that corresponding to the freeboard assigned or the maximum approved for the classification, that the harbour equipment will be properly loaded taking into account both its stability and the stresses imposed on its structures.

**3.3.3** Any document issued by the Society in relation to its interventions reflects the condition of the harbour equipment as found at the time and within the scope of the survey. It is the Interested Party's responsibility to ensure proper maintenance of the harbour equipment until the next survey required by the Rules. It is the duty of the Interested Party to inform the Surveyor when he boards the harbour equipment of any events or circumstances affecting the class.

## 3.4 Use of measuring equipment and of service suppliers

### 3.4.1 General

Firms providing services on behalf of the Interested Party, such as measurements, tests and servicing of safety systems and equipment, the results of which may form the basis for the Surveyor's decisions, are subject to the acceptance of the Society, as deemed necessary.

The equipment used during tests and inspections in workshops, shipyards and on board harbour equipment, the results of which may form the basis for the Surveyor's decisions, is to be customary for the checks to be performed. Firms are to individually identify and calibrate to a recognised national or international standard each piece of such equipment.

Note 1: Refer to Rule Note NR533 Approval of Service Suppliers.

### 3.4.2 Simple measuring equipment

The Surveyor may accept simple measuring equipment (e.g. rulers, tape measures, weld gauges, micrometers) without individual identification or confirmation of calibration, provided it is of standard commercial design, properly maintained and periodically compared with other similar equipment or test pieces.

### 3.4.3 On board measuring equipment

The Surveyor may accept measuring equipment fitted on board a harbour equipment (e.g. pressure, temperature or rpm gauges and meters) and used in examination of on board machinery and/or equipment based either on calibration records or comparison of readings with multiple instruments.

### 3.4.4 Other equipment

The Surveyor may request evidence that other equipment (e.g. tensile test machines, ultrasonic thickness measurement equipment, etc.) is calibrated to a recognised national or international standard.

## 3.5 Spare parts

**3.5.1** It is the Owner's responsibility to decide whether and which spare parts are to be stored on board.

**3.5.2** As spare parts are outside the scope of classification, the Surveyor will not check that they are kept on board, maintained in a satisfactory condition, or suitably protected and lashed.

However, in the case of repairs or replacement, the spare parts used are to meet the requirements of the Rules as far as practicable.

## 3.6 Quality system audits

**3.6.1** Attention is drawn to the possibility that auditors external to the Society may attend surveys and audits carried out by the Society and that this attendance shall not be obstructed.

# 4 Application of statutory Rules by the Society

## 4.1 International and national Regulations

**4.1.1** When authorised by the Administration concerned, the Society will act on its behalf within the limits of such authorisation. In this respect, the Society will take into account the relevant requirements, survey the harbour equipment, report and issue or contribute to the issue of the corresponding certificates.

**4.1.2** The above surveys do not fall within the scope of the classification of harbour equipment, even though their scope may overlap in part and may be carried out concurrently with surveys for assignment or maintenance of class.

In the case of a discrepancy between the provisions of the applicable international and national Regulations and those of the Rules, normally, the former take precedence. However, the Society reserves the right to call for the necessary adaptation to preserve the intention of the Rules.

# Section 2 Class Designation

## 1 General

### 1.1 Purpose of the classification notations

**1.1.1** The class of a harbour equipment complying with this Rule Note is expressed by its classification notations assigned for hull and machinery, including electrical installations.

**1.1.2** There are different kinds of classification notations, describing particular features, capabilities, service restrictions or special equipment and installations included in the classification.

**1.1.3** The classification notations give the scope according to which the class of the harbour equipment 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 additional service features of the harbour equipment and other criteria which have been provided by the Owner, Building Yard or Other Interested Party, when applying for classification.

**1.1.4** 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 mission and any other criteria taken into account for classification.

Note 1: Reference is to be made to Ch 1, Sec 1, [1.4] on the limits of classification and its meaning.

**1.1.5** The classification notations assigned to a harbour equipment are indicated on the Certificate of Classification, as well as in the Register published by the Society.

It will be the decision of the Owner, Building Yard or Other Interested Party to have the notations, together with the whole class designation, included in the Register published by the Society or not.

**1.1.6** The classification notations applicable to existing harbour equipment conform to the Rules of the Society in force at the date of assignment of class. However, the classification notations of existing harbour equipment may be updated according to the current Rules, as far as applicable.

**1.1.7** At the request of the Owner and as far as applicable, the Society reserves the right to grant other class notations as defined in other Rules of the Society. The class maintenance surveys for such classification notations are to be performed to the corresponding requirements in the other Rules of the Society.

### 1.2 Types of notations assigned

**1.2.1** The types of classification notations assigned to a harbour equipment are the following:

a) Construction mark

b) Class symbol

c) Class period

d) Service notations with additional service features, as applicable

e) Additional class notations (optional).

The different classification notations and their conditions of assignment are defined in [2] to [7].

#### 1.2.2 Examples of class designation

Tab 1 shows examples of a class designation for hull and machinery of a harbour equipment covered by this Rule Note.

## 2 Construction mark for hull and machinery installation

### 2.1 General

**2.1.1** The construction mark identifies the procedure under which the harbour equipment and its main equipment or arrangements have been surveyed for initial assignment of the class (see Tab 2). However, the Society may change the construction mark where the harbour equipment is subjected to repairs, conversion or alterations.

The procedures under which the harbour equipment is assigned one of the construction marks are detailed in Ch 2, Sec 1.

### Table 1 : Examples of class designation

| Service notation | Class designation |
|---|---|
| Floating dock | **I ✠ HULL • MACH**<br>**5**<br>**Floating dock / Lifting capacity (4000 tons) / Self docking / Modular/ $H_S \leq 1$** |
| Floating landing dock | **I ✠ HULL**<br>**10**<br>**Floating landing dock / Modular / Green passport** |
| Floating door | **I ✠ HULL**<br>**10**<br>**Floating door**<br>**$H_S \leq 1,2$** |
| Floating bridge | **I ✠ HULL**<br>**10**<br>**Floating bridge / Capacity (5 tons) / Equipped for wheeled vehicles / Modular** |
| Worksite unit | **I ✠ HULL**<br>**10**<br>**Worksite unit / Green passport** |
| Floating storage | **I ✠ HULL ✠ MACH**<br>**10**<br>**Floating storage / Liquid products / DG-S** |
| Floating plant | **I ✠ HULL ✠ MACH**<br>**10**<br>**Floating plant / PowerProd /**<br>**LNGfuel dualfuel**<br>**Power (kw)**<br>**$H_S \leq 1,2$** |

### Table 2 : Hull and machinery - Mode of survey and certification

| Component | Symbol | Rule requirements |
|---|---|---|
| Hull | ✠ | Harbour equipment built under the supervision of the Society and with certification of components and materials in accordance with the Rules. |
| | $\underline{\text{✠}}$ | Harbour equipment built under the supervision of another classification Society and which have been assigned a class equivalent to the Society's Rules of classification. |
| | • | Harbour equipment built under the supervision of the Society in accordance with the Rules but, e.g., without inspection by the Society of components and materials which, however, are deemed to be acceptable.<br>It is the responsibility of the Building Yard, Owner or Other Interested Party to ascertain that the materials and equipment used in the harbour equipment's construction satisfactorily meet the Rules requirements.<br>Depending on particular conditions or harbour equipment notations, inspection of materials and components by the Society may be required for essential services. |
| | • | In the event of admission to class or classification after construction of not classed harbour equipment. |
| Machinery | ✠, etc. | Same symbols, followed by **MACH** |

**2.1.2** One of the construction marks defined below is assigned separately to the hull of the harbour equipment, to the machinery installation, and to some installations for which an additional class notation is assigned.

The construction mark is placed before the symbol **HULL** for the hull, before the symbol **MACH** for the machinery installations, and before the additional class notation granted, when such a notation is eligible for a construction mark (e.g. ✠ **Crane**).

If the harbour equipment has no machinery installations covered by classification, the symbol **MACH** is not granted and the construction mark will be only placed before the symbol **HULL**.

#### 2.1.3 Symbol ✠

The symbol ✠ will be assigned to the relevant part of the harbour equipment when it has been constructed:

- under the survey of and in accordance with the Rules of the Society at the Building Yard and/or at subcontractors supplying construction components/hull sections, as applicable
- with certification by the Society of components and materials requiring inspection subject to the Society's construction Rules.

#### 2.1.4 Symbol ✠

The symbol ✠ will be assigned to the relevant part of the harbour equipment when this latter has been designed and constructed in accordance with the Rules and under supervision of another classification Society and is subsequently, or at a later date, classed with the Society. See Tab 2.

#### 2.1.5 Symbol •

The symbol • will be assigned to the relevant part of the harbour equipment, where the procedure for the assignment of classification is other than those detailed in [2.1.3] and [2.1.4] but however deemed acceptable. See Tab 2.

# 3 Class symbol

## 3.1 General

**3.1.1** The class symbol expresses the degree of compliance of the harbour equipment with the rule requirements as regards its construction and maintenance. One class symbol is to be assigned to every classed harbour equipment.

**3.1.2** The class symbol **I** is assigned to harbour equipment built in accordance with the Society's Rules or other Rules recognised as equivalent, and maintained in a condition considered satisfactory by the Society.

**3.1.3** The class symbol **II** is assigned to harbour equipment which do not meet all requirements for class symbol **I**, but are deemed acceptable to be entered into the Register of harbour equipment. In this case, the class may be maintained for shorter class periods or with shorter survey intervals. See Tab 3.

**Table 3 : Class symbol and class period**

| Symbol | Description |
|---|---|
| | Class symbol |
| **I** | For harbour equipment found to meet the construction and scantling requirements. |
| **II** | For harbour equipment that do not meet in full some construction or scantling requirements, but, however, are deemed acceptable to be entered in the Register published by the Society. |
| | Class period (**p**) |
| **10**<br>**5** | These symbols indicate the duration of the class period in years. |

# 4 Class period

## 4.1 General

**4.1.1** The symbol **p** indicates the duration of the nominal class period in years

Normally:

- **p** = 5, for **Floating dock** and other harbour equipment assigned $\mathbf{H_S} \le \mathbf{x}$ if 1,2 m < x ≤ 2m
- **p** = 10, for other harbour equipment.

The nominal class period may be extended in compliance with Ch 2, Sec 2, [6.2.1].

The nominal class period can be reduced in exceptional cases and for a limited time, if the harbour equipment does not fully comply with the Rules but has been allowed to operate under restrictions.

# 5 Service notations

## 5.1 General

**5.1.1** The service notations define the type and/or the nature of operation of the harbour equipment which have been considered for its classification, according to the request for classification signed by the Prospective Owner, Building Yard or Other Interested Party. At least one service notation is to be assigned to every classed harbour equipment

**5.1.2** A harbour equipment may be assigned several different service notations. In such a case, the specific rule requirements applicable to each service notation are to be complied with. However, if there is any conflict in the application of the requirements applicable to different service notations, the Society reserves the right to apply the most appropriate requirements or to refuse the assignment of one of the requested service notation.

# 6 Additional service features

## 6.1 General

**6.1.1** The service notation may be completed by one or more additional service features, giving further precision regarding the type, service or capabilities of the harbour equipment, for which specific rule requirements are applied, e.g.:

- **Selfdocking**
- **DG-S**
- **Lifting capacity(4000 tons**)
- **$H_S \leq x$**

**6.1.2** The assignment and/or maintenance of such an additional service feature is subject to the compliance with additional rule requirements which are detailed in Part D, for assignment of the notation and/or in Ch 3, Sec 3, for its maintenance.

# 7 Additional class notations

## 7.1 General

**7.1.1** An additional class notation expresses the classification of additional equipment or specific arrangement, which has been requested by the interested party, e.g.:

- **Modular**
- **Equipped for wheeled vehicles**.

**7.1.2** The assignment of such an additional class notation is subject to the compliance with additional rule requirements, which are detailed in Part D.

# Section 3 Classification Notations

## 1 General

### 1.1 Service notations

**1.1.1** Generally the service notations will be assigned according to the indications or suggestions of the prospective harbour equipment owner, Building Yard or other interested party.

**1.1.2** The various service notations which may be assigned to a harbour equipment are defined in [2] to [9] according to the category to which they belong. These notations are also listed in Tab 1, together with corresponding additional service features.

**1.1.3** The Society reserves the right to grant other service notations.

### 1.2 Additional service features

#### 1.2.1 General

Additional service features are defined together with service notations in Tab 1.

The service notation may be also completed by the additional service features described in the following depending upon:

- mode of operation in relation with energy supply
- hull material
- operating area.

#### 1.2.2 Mode of operation

Where regarding energy supply (electrical power, water, compressed air, heating and air conditioning systems) and fire safety management, the harbour equipment is fully independent with respect to shore systems, it will be assigned the additional service feature **SSI** (Shore Systems Independent).

#### 1.2.3 Special consideration for hull materials

If harbour equipment is constructed of normal strength hull structural steel, this will not be specially indicated. If other materials are employed for the hull, this will be indicated in the notations in the Classification Certificate, e.g.:

- **HS** for higher strength hull structural steel
- **A** for aluminium
- **C** for composite materials such as fiber reinforced plastic (FRP)
- **W** for wood
- **CR** for concrete.

#### 1.2.4 Operating area

An additional service feature $\mathbf{H_S \leq x}$ will be assigned if the harbour equipment is intended to be operated in water stretches other than smooth stretches of water (see definition in Ch 1, Sec 1, [1.2.11]), where $0,3 < x \leq 2$, is the maximum significant wave height, in m, in the operating area.

e.g: $\mathbf{H_S \leq 1,2}$.

#### 1.2.5 Units using low flashpoint liquid or gas fuels

The service notation is to be completed by one of the following additional service features, as applicable:

- **LNGfuel**, for units fitted with machinery using natural gas as fuel, stored in liquefied form,
- **CNGfuel**, for units fitted with machinery using compressed natural gas as fuel,
- **LPGfuel**, for units fitted with machinery using petroleum gas as fuel, in liquefied or gaseous form,
- **Methanolfuel**, for units fitted with machinery using methanol as fuel,
- **LFPfuel**, for units fitted with machinery using a low flashpoint fuel different from the fuels mentioned above.

Note 1: Low flashpoint means a flashpoint (determined using the close cup test) less than 55°C.

Note 2: Natural gas means gaseous mixture consisting mainly of methane and which may also contain smaller amounts of ethane, propane and butane.

Note 3: Petroleum gas means gaseous mixture consisting mainly of propane and butane.

Each additional service feature is to be completed by one of the following notations:

- **singlefuel** for units fitted with machinery using only the fuel considered,
- **dualfuel** for units fitted with machinery using both the fuel considered and fuel oil.

The requirements for the assignment of these additional service features are given in:

- NR529 Gas-Fuelled Ships,
- NI647 LPG-fuelled Ships,
- NR670 Methyl/ethyl alcohol as fuel.

The additional requirements of Ch 3, Sec 3, [12] are applicable to these units.

The additional service feature **LFPfuel** is assigned to units fitted with machinery using a low flashpoint liquid fuel or gas different from the fuels mentioned above when this has been specially considered by the Society.

Examples:

**CNGfuel singlefuel**

**methanolfuel dualfuel**

**LNGfuel singlefuel**

### 1.2.6 Units fitted with a fuel cell

The service notation will be completed by the additional service feature **Fuelcell**, when the harbour equipment complies with NR547 Ships using Fuel Cells.

**Table 1 : Service notations and additional service features**

| Service notation [ref. in this Section] | Additional service feature [ref. in this Section] | Applicable Requirements |
|---|---|---|
| **Floating dock** [2] | **Lifting capacity (x tons)** [2.2.1]<br>**Self docking** [2.2.2]<br>**WB-LS** [2.2.3]<br>**LA-LS** [2.2.4]<br>**CA-LS** [2.2.5] | Part D, Chapter 1<br>Part D, Chapter 1<br>Part D, Chapter 1<br>Part D, Chapter 1<br>Part D, Chapter 1 |
| **Floating landing dock** [3] | | Part D, Chapter 2 |
| **Floating door** [4] | | Part D, Chapter 3 |
| **Floating bridge** [5] | **Capacity (x tons)** [5.2.1] | Part D, Chapter 4 |
| **Worksite unit** [6] | | Part D, Chapter 5 |
| **Floating storage** [7] | **Dry products** [7.2.1]<br>**Liquid products** [7.2.2]<br>**Gaseous products** [7.2.3] | Part D, Chap 6<br>Part D, Chap 6<br>Part D, Chap 6 |
| | **DG-S** [7.2.4] | NR 217, Part D, Chap 3 |
| | **Bunker station** [7.2.5]<br>**Wastes** [7.2.6] | Pt D, Ch 8, Sec 1<br>Pt D, Ch 8, Sec 1 |
| **Floating plant** [8] | **Type** [8.2.1]<br>**Capacity (x)** [8.2.2] | Part D, Chapter 7<br>Part D, Chapter 7 |
| **Special service** [9] | Particular service | Particular service to be considered on a case-by-case basis according to their additional service feature |
| OTHER ADDITIONAL SERVICE FEATURES | | |
| | **SSI** [1.2.2] | - |
| | **HS** [1.2.3] | Part B and Part D |
| | **A** [1.2.3] | Part B, Part D and NR561 |
| | **C** [1.2.3] | Part B, Part D and NR546 |
| | **W** [1.2.3] | Part B, Part D and NR546 (for plywood) |
| | **CR** [1.2.3] | Part B, Part D and NI594 |
| | $\mathbf{H_S \leq x}$ [1.2.4] | Pt D, Ch 8, Sec 4 |
| | **LNGfuel** [1.2.5] | NR529 |
| | **CNGfuel** [1.2.5] | NR529 |
| | **LPGfuel** [1.2.5] | NI647 |
| | **methanolfuel** [1.2.5] | NR670 |
| | **LFPfuel** [1.2.5] | NR529 |
| | **Fuelcell** [1.2.6] | NR547 |

**Table 2 : List of additional class notations**

| Additional class notation | Reference in this Section | Applicable rule requirements |
|---|---|---|
| **Auxiliary propulsion** | [10.1] | Part C |
| **Equipped for wheeled vehicles** | [10.2] | Pt D, Ch 8, Sec 2 |
| **Modular** | [10.3] | Pt D, Ch 8, Sec 3 |
| **Laid-up** | – | NR217, Pt A, Ch 2, Sec 2, [11] |
| **Green passport** | [10.4] | NR528 |
| **Battery system** | [10.5] | NR467, Pt F, Ch 14, Sec 1 |
| **Electric hybrid** | [10.6] | NR467, Pt F, Ch 14, Sec 2 |

### 1.3 Additional class notations

**1.3.1** The additional class notations which may be assigned to a harbour equipment are defined in [10] and listed in Tab 2.

**1.3.2** The Society reserves the right to grant other additional class notations.

## 2 Floating dock

### 2.1 Service notation

**2.1.1** The service notation **Floating dock** applies to harbour equipment intended to lift floating units, complying with the requirements stated in Part D, Chapter 1.

### 2.2 Additional service features

#### 2.2.1 Lifting capacity

The service notation **Floating dock** will be completed by the additional service feature **Lifting capacity (x tons)**, indicating the maximum weight **x**, in ton, of the vessel that the floating dock can lift.

#### 2.2.2 Self docking

The service notation **Floating dock** will be completed by the additional service feature **Self docking**, when the floating dock consists of two continuous wing walls and a pontoon deck composed of longitudinally independent transverse detachable members connected to the lower flange of the wing walls by bolting or any other similar device.

#### 2.2.3 Water ballast lifting system WB-LS

The service notation **Floating dock** will be completed by the additional service feature **WB-LS**, when the floating dock is designed to lift floating units using water ballast system.

#### 2.2.4 Liquid air lifting system LA-LS

The service notation **Floating dock** will be completed by the additional service feature **LA-LS**, when the floating dock is designed to lift floating units using liquid air system.

#### 2.2.5 Compressed air lifting system CA-LS

The service notation **Floating dock** will be completed by the additional service feature **CA-LS**, when the floating dock is designed to lift floating units using compressed air system.

## 3 Floating landing dock

### 3.1 Service notation

**3.1.1** The service notation **Floating landing dock** applies to harbour equipment intended for vessels mooring alongside allowing operations such as bunkering, cargo loading and unloading, embarking and disembarking of passengers, etc, complying with the requirements stated in Part D, Chapter 2.

## 4 Floating door

### 4.1 Service notation

**4.1.1** The service notation **Floating door** applies to a watertight box girder with flooding and dewatering system intended to be operated as movable gate to close dry dock or separate water areas complying with the requirements stated in Part D, Chapter 3.

# 5 Floating bridge

## 5.1 Service notation

**5.1.1** The service notation **Floating bridge** applies to harbour equipment intended to be used as a bridge supported by low flat-bottomed boats or pontoons complying with the requirements stated in Part D, Chapter 4.

## 5.2 Additional service feature

### 5.2.1 Capacity

The service notation **Floating bridge** will be completed by the additional service feature **Capacity (x tons)**, indicating the maximum weight **x**, in ton, of authorised vehicles.

# 6 Worksite unit

## 6.1 Service notation

**6.1.1** The service notation **Worksite unit** applies to harbour equipment appropriately built and equipped for use at worksites, complying with the requirements stated in Part D, Chapter 5.

# 7 Floating storage

## 7.1 Service notation

**7.1.1** The service notation **Floating storage** applies to harbour equipment appropriately built and equipped for storage of products in bulk or in package, complying with the requirements stated in Part D, Chapter 6.

## 7.2 Additional service features

### 7.2.1 Dry products

The service notation **Floating storage** will be completed by the additional service feature **Dry products** when the harbour equipment is intended for storage of packages or dry bulk products.

### 7.2.2 Liquid products

The service notation **Floating storage** will be completed by the additional service feature **Liquid products** when the harbour equipment is intended for storage of liquids in bulk.

### 7.2.3 Gaseous products

The service notation **Floating storage** will be completed by the additional service feature **Gaseous products** when the harbour equipment is intended for storage of liquefied gases in bulk.

### 7.2.4 Storage of dangerous products DG-S

The service notation **Floating storage** will be completed by the additional service feature **DG-S** when the harbour equipment is intended for the storage of liquid dangerous products in compliance with the applicable requirements of NR217, Part D, Chapter 3.

### 7.2.5 Bunker station

The additional service feature **Bunker station** will be affixed to **DG-S**, when the harbour equipment has a deadweight of up to 300 tons and is built and equipped for the storage of liquid dangerous products intended for vessel operation, in compliance with the requirements stated under Pt D, Ch 8, Sec 1.

Example

**DG-S/Bunker station**

### 7.2.6 Wastes

The additional service feature **Wastes** will be affixed to **DG-S**, when the harbour equipment has a deadweight of up to 300 tons and is built and equipped for the storage of waste dangerous products from vessel operation, in compliance with the requirements stated under Pt D, Ch 8, Sec 1.

Example

**DG-S/Wastes**

# 8 Floating plant

## 8.1 Service notation

**8.1.1** The service notation **Floating plant** applies to harbour equipment intended to be used as manufacturing or production site, complying with the requirements stated in Part D, Chapter 7.

### 8.2 Additional service features

#### 8.2.1 Plant type

The service notation **Floating plant** will be completed by an appropriate additional service feature defining the plant type, e.g:

a) Power production plant

- A floating plant intended for power production by means other than solar cells or wind turbines, will be completed by the additional service feature **POWERGEN** if the power plant complies with the applicable requirements of NR656 Power Generation Units.
- A floating plant intended for power production by means other than solar cells or wind turbines, will be completed by the additional service feature **PowerProd** if the power plant complies with the applicable requirements of the Society.

b) Acetylene generator plant

A floating plant intended for acetylene production will be completed by the additional service feature **Acetylene generator** if the plant complies with the applicable Society's Rules and/or recognised standards.

c) Oxygen generator plant

A floating plant intended for oxygen production will be completed by the additional service feature **Oxygen generator** if the plant complies with the applicable Society's Rules and/or recognised standards.

#### 8.2.2 Capacity

The service notation **Floating plant** will be completed by the additional service feature **Capacity (x [unit])**, indicating the maximum capacity **x** of the plant, in kw, Ah, $Nm^3/h$, or $m^3/h$, depending on the plant type.

## 9 Special service

### 9.1 General

**9.1.1** The service notation **Special service** is assigned to harbour equipment which, due to the peculiar characteristics of their activity, are not covered by any of the service notations mentioned above. The classification requirements of such units are considered by the Society on a case by case basis.

**9.1.2** An additional service feature will be specified after the service notation, e.g. **Wave breaker**, to identify the particular service in which the harbour equipment is intended to trade. The scope of classification of such units is indicated into the certificate of classification.

## 10 Additional class notations

### 10.1 Auxiliary propulsion

**10.1.1** A service notation assigned to harbour equipment may be completed by the additional class notation **Auxiliary propulsion**, when the harbour equipment is equipped with an auxiliary propulsion system allowing short moves at a limited speed complying with the applicable requirements of Part C.

### 10.2 Equipped for wheeled vehicles

**10.2.1** A service notation assigned to harbour equipment may be completed with the additional class notation **Equipped for wheeled vehicles where the harbour equipment complies with the requirements stated under** Pt D, Ch 8, Sec 2.

### 10.3 Modular

**10.3.1** A service notation assigned to harbour equipment will be completed by the additional class notation **Modular** when the harbour equipment consists of several modules connected by adequate coupling devices and complies with the requirements stated under Pt D, Ch 8, Sec 3.

**10.3.2** Modular harbour equipment will be defined by:

- its main dimensions
- its geometrical configuration
- the main dimensions of each module
- the type of coupling system.

**10.3.3** When a harbour equipment consists of modules being part of a series of units, such units is to be assigned identification numbers to be indicated in the harbour equipment class certificate.

### 10.4 Green passport for harbour equipment recycling

**10.4.1** The additional class notation **Green passport** may be assigned to harbour equipment for which requirements intended to facilitate harbour equipment recycling have been applied, encompassing the identification, quantification and localization of materials which may cause harm to the environment and people when the fittings or equipment containing such materials are removed, or when the harbour equipment is recycled.

The requirements for the assignment and maintenance of this notation are given in NR528 Green passport.

### 10.5 Battery system

**10.5.1** The service notation may be completed by the additional service feature **Battery system** when batteries are used for electric power supply purpose during operation of the harbour equipment. This additional service feature is mandatory when the harbour equipment is only relying on batteries for electrical power supply for main sources.

The requirements for the assignment of this additional service feature are given in the Rules for the Classification of Steel Ships (NR467, Pt F, Ch 14, Sec 1).

Note 1: when a harbour equipment is assigned the additional service feature **Electric hybrid ( )**, it is not necessary to assign the additional service feature **Battery system**.

### 10.6 Electric hybrid

**10.6.1** The service notation may be completed by the additional service feature **Electric hybrid ( )** when harbour equipment are provided with an energy storage system (ESS) used to supply the main electrical power distribution system.

The additional service feature **Electric hybrid ( )** is to be completed, between brackets, by at least one of the following notation:

- **PM**, when at least one of the following power management mode is available: load smoothing mode, peak shaving mode, or enhanced dynamic mode
- **PB**, when power backup mode is available
- **ZE**, when zero emission mode is available.

Example:

**Electric hybrid (PM, ZE)**

The requirements for the assignment and maintenance of this additional service feature are given in the Rules for the Classification of Steel Ships (NR467, Pt F, Ch 14, Sec 2).

Part A
Classification and Surveys

# CHAPTER 2
# CLASSIFICATION

# Section 1 Assignment of Class

## 1 General

### 1.1

**1.1.1** Class is assigned to a harbour equipment upon a survey, with the associated operations, which is held in order to verify whether it is eligible to be classed on the basis of the Rules of the Society. See Ch 1, Sec 1, [1.4.2].

This may be achieved through:

- the completion of a new building, during which a survey has been performed
- a survey when the harbour equipment changes class between classification Societies, or
- a specific admission to class survey, in cases where a harbour equipment is not classed at all.

**1.1.2** The assignment of class is to comply with the procedure developed in NR217, Pt A, Ch 2, Sec 1, where the terminology “vessel” is to be replaced by “harbour equipment”.

# Section 2 Maintenance of Class

## 1 General principles of surveys

### 1.1 Survey types

**1.1.1** Classed harbour equipment are to be submitted to surveys for the maintenance of class. These surveys include the class renewal survey, intermediate and possible quarter term survey, bottom survey (either survey in dry condition or in-water survey) and surveys for the maintenance of additional class notations, where applicable. Such surveys are carried out at the intervals and under the conditions laid down in this Rule Note.

The different types of periodical surveys are summarized in Tab 1. The intervals at which the periodical surveys are carried out are given in the items referred to in the second column of Tab 1. The relevant extent and scope are given in Part A, Chapter 3 for all harbour equipment.

**Table 1 : Class renewal and periodical surveys**

| Type of survey | Ref. in this Section | Ref. to scope of survey |
|---|---|---|
| Class renewal | [4] | Ch 3, Sec 1 and Ch 3, Sec 3 |
| Quarter term | [5.2] | Ch 3, Sec 2 and Ch 3, Sec 3 |
| Intermediate | [5.3] | Ch 3, Sec 2 and Ch 3, Sec 3 |
| Bottom | [5.4] | Ch 3, Sec 4 |

Where there are no specific survey requirements for additional class notations assigned to a harbour equipment, equipment and/or arrangements related to these additional class notations are to be examined, as applicable, to the Society's satisfaction at each class intermediate or class renewal survey.

The surveys are to be carried out in accordance with the relevant requirements in order to confirm that the hull, machinery, equipment and appliances comply with the applicable Rules and will remain in satisfactory condition based on the understanding and assumptions mentioned in [9.2].

Where the conditions for the maintenance of service notation and additional class notations are not complied with, the service notation and/or the additional class notations, as appropriate, will be suspended and/or withdrawn in accordance with the applicable requirements given in Ch 2, Sec 3, [1].

It is understood that the requirements for surveys apply to those items that are required according to the Rules.

Unless otherwise specified, any survey other than bottom survey may be effected by carrying out partial surveys at different times to be agreed upon with the Society, provided that each partial survey is adequately extensive. The splitting of a survey into partial surveys is to be such as not to impair its effectiveness.

### 1.2 Change of periodicity, postponement or advance of surveys

**1.2.1** The Society reserves the right, after due consideration, to change the periodicity, postpone or advance surveys, taking into account particular circumstances.

When a survey becomes due, the requirements of [1.2.2] to [1.2.4] apply.

#### 1.2.2 Class renewal survey

In the case of a class renewal survey, the Society may grant an extension provided there is documented agreement to such an extension and class extension surveys are performed prior to the expiry date of the class certificate, and the Society is satisfied that there is justification for such an extension.

#### 1.2.3 Quarter term survey and intermediate survey

In the case of quarter term survey and intermediate survey, as a rule, no postponement is granted. The surveys are to be completed within their prescribed windows.

#### 1.2.4 All other periodical surveys and conditions of class

In the case of all other periodical surveys and conditions of class, extension or postponement may be granted, provided there is sufficient technical justification for such an extension or postponement.

#### 1.2.5 Extension of scope of survey

The Society may extend the scope of the provisions in Ch 3, Sec 1 to Ch 3, Sec 3 which set forth the technical requirement for surveys, whenever and so far as considered necessary, or modify them in the case of special harbour equipment or systems.

The extent of any survey also depends upon the condition of the harbour equipment and its equipment. Should the Surveyor have serious doubts as to the maintenance or condition of the harbour equipment or its equipment, or be advised of any deficiency or damage which may affect the class, then further examination and testing may be conducted as considered necessary.

#### 1.2.6 General procedure of survey

The general procedure of survey consists in:

- an overall examination of the parts of the harbour equipment covered by the Rules
- at random checking of the selected items covered by the Rules
- attending tests and trials, where applicable and deemed necessary by the surveyor.

**1.2.7** When a survey results in the identification of significant corrosion, structural defects or damage to hull, machinery and/or any piece of its equipment which, in the opinion of the Surveyor, affect the harbour equipment's class, remedial measures may be required to be implemented before the harbour equipment continues in service.

**1.2.8** The Society's survey requirements cannot be considered as a substitute for specification and acceptance of repairs and maintenance, which remain the responsibility of the Owner.

## 2 Definitions and procedures related to surveys

### 2.1 General

**2.1.1** For definitions and procedures related to surveys, refer to NR217, Pt A, Ch 2, Sec 2, [2], where the terminology “vessel” is to be replaced by “harbour equipment”.

## 3 Certificate of Classification: issue, validity, endorsement and renewal

### 3.1 Issue of Certificate of Classification

**3.1.1** A Certificate of Classification, bearing the class notations assigned to the harbour equipment and an expiry date, is issued to any classed harbour equipment.

**3.1.2** A Provisional Certificate of Classification may serve as a Certificate of Classification in some cases, such as after an admission to class survey, after a class renewal survey, or when the Society deems it necessary.

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

**3.1.3** The Certificate of Classification is to be made available to the Society’s Surveyors upon request.

### 3.2 Validity of Certificate of Classification, maintenance of class

**3.2.1** According to Ch 1, Sec 1, [2.5], the Society alone is qualified to confirm the class of the harbour equipment and the validity of its Certificate of Classification.

**3.2.2** During the class period, a Certificate of Classification is valid when it is not expired.

The class is maintained during a certain period or at a given date, when during the said period or at such date the conditions for suspension or withdrawal of class are not met.

Refer also to Ch 1, Sec 1, [1.4.4].

**3.2.3** At the request of the Owner, a statement confirming the maintenance of class may be issued by the Society based on the information in its records for that harbour equipment at the time.

This statement is issued on the assumption that the Owner has complied with the Rules, in particular with [6].

Should any information which would have prevented the Society from issuing the statement and which was not available at the time subsequently come to light, the statement may be cancelled.

Attention is drawn to Ch 2, Sec 3, whereby the Society, upon becoming aware of a breach of the Rules, is empowered to suspend class from the date of the breach, which may be prior to the date of the statement.

**3.2.4** According to the same conditions as in [3.2.2], a statement declaring that the class is maintained “clean and free from condition of class” may be issued by the Society when there is no pending recommendation at that date.

**3.2.5** Classification-related documents and information are liable to be invalidated by the Society whenever their object is found to differ from that on which they were based or to be contrary to the applicable requirements. The Owner is liable for any damage which may be caused to any third party from improper use of such documents and information.

### 3.3 Endorsement of Certificate of Classification

#### 3.3.1 Text of endorsement

When surveys are satisfactorily carried out, the Certificate of Classification is generally endorsed accordingly, with the relevant entries.

#### 3.3.2 Possible modifications to endorsements

The Society reserves the right to modify the endorsements made by Surveyors.

### 3.4 Status of surveys and conditions of class

**3.4.1** Information given in the Certificate of Classification, harbour equipment survey status, Rules and other harbour equipment specific documents made available to the Owner, enables the Owner to identify the status of surveys and conditions of class.

**3.4.2** The omission of such information does not absolve the Owner from ensuring that surveys are held by the limit dates and pending conditions of class are cleared to avoid any inconvenience which is liable to result from the suspension or withdrawal of class; see Ch 2, Sec 3.

## 4 Class renewal survey

### 4.1 General principles

**4.1.1** Class renewal survey - also called special survey - is to be carried out at the intervals **p** indicated by the class period symbol.

**4.1.2** In principle elements covered by the classification and submitted to a class renewal survey on a date different from the date of the periodical class renewal survey of the harbour equipment, are to be re-examined **p** years after the previous survey.

**4.1.3** Upon request, extension of the class period may be granted by the Society, see [6.2].

**4.1.4** Class renewals for hull are numbered in the sequence I, II, III, etc., depending upon the age of the habour equipment, in years, at time of class renewal survey:

I : Age ≤ 5

II : 5 < Age ≤ 10

III : 10 < Age ≤ 15

IV : 15 < Age

Regarding their scope, see Ch 3, Sec 1, [2].

**4.1.5** A class renewal survey may be carried out in several parts. The survey may be commenced at the last year during the class period. Considering [4.1.3], the total survey period of the class renewal survey must not exceed 12 months, except under special circumstances and by prior agreement from the Society.

**4.1.6** The new period of class will commence:

- with the following day, after which the previous class expires, provided that the class renewal survey has been completed within the 3 months preceding that date. In case of extension of validity of class certificate, the period of class will commence the following day after which the last classification certificate has expired. See also [1.2]
- with the date on which the class renewal survey has been completed, if this is the case more than 3 months before expiry of the previous class.

**4.1.7** The class renewal survey is in principle to be held, in addition to the inspections and checks to be carried out on occasion of the intermediate surveys, when the harbour equipment is in dry dock or on a slipway unless a dry docking survey has already been carried out within the admissible period, see [4.1.5] and Ch 3, Sec 3.

## 5 Periodical survey

### 5.1 General

**5.1.1** The periodical surveys listed in the following are to be conducted for the hull, machinery including electrical installations as well as special equipment and installations included in the classification of the harbour equipment.

If, for some obvious reason, e.g. a temporary out-of-service condition of certain equipment, parts included in the classification cannot be surveyed, this will be noted in the survey statement/certificate.

**5.1.2** Where applicable Regulations impose inspection intervals deviating from the class related intervals, the intervals will be harmonized in the individual case to reduce the number of single surveys, where possible.

### 5.2 Quarter term survey

**5.2.1** The quarter term survey falls due every **p**/4 years.

The survey has to be carried out within a time interval from 3 months before to 3 months after the date corresponding to **p**/4.

The quarter term survey does not apply to harbour equipment being assigned a period of class **p** ≤ 5.

### 5.3 Intermediate survey

**5.3.1** The intermediate survey falls due at half the nominal time interval between two class renewal survey, i.e. every **p**/2 years.

The survey has to be carried out within a time interval from 6 months before to 6 months after the date corresponding to **p**/2.

**5.3.2** Intermediate survey shall include all inspections and checks required for quarter term surveys

### 5.4 Bottom survey

**5.4.1** Bottom survey means the examination of the outside of the harbour equipment's bottom and related items. This examination may be carried out with the harbour equipment either in dry dock (or on a slipway) or afloat: the survey will be referred to as dry-docking survey in the former case and as in-water survey in the latter case.

The Owner is to notify the Society whenever the outside of the harbour equipment's bottom and related items can be examined in dry dock or on a slipway.

### 5.5 Links between anniversary dates and surveys

**5.5.1** The links between the anniversary dates, the class renewal survey (when carried out according to the normal system), and the intermediate surveys are given in Fig 1, for class period **p** = 5 and in Fig 2, for class period **p** = 10.

**Figure 1 : Links between anniversary dates and surveys - p = 5**

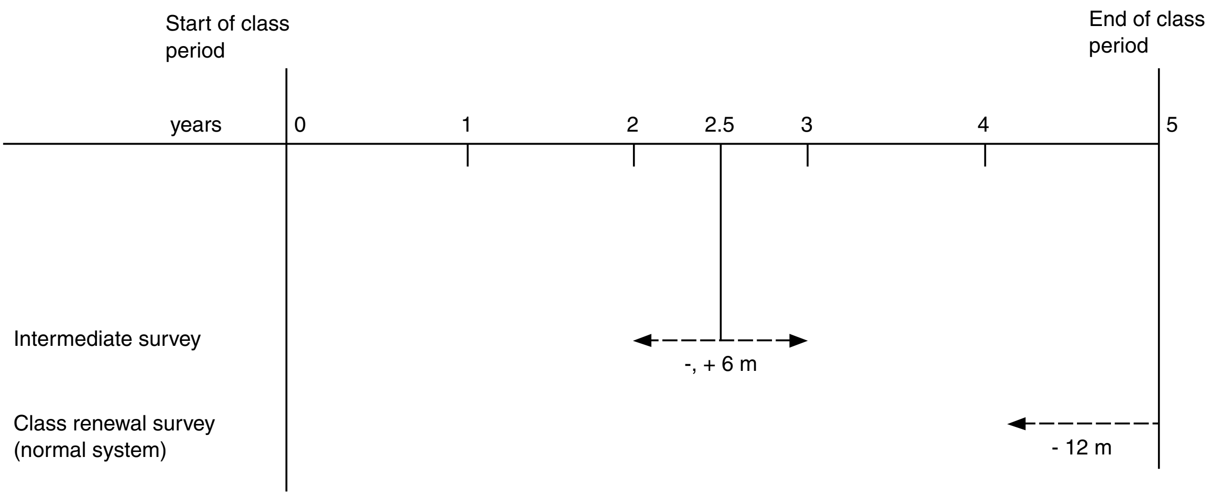
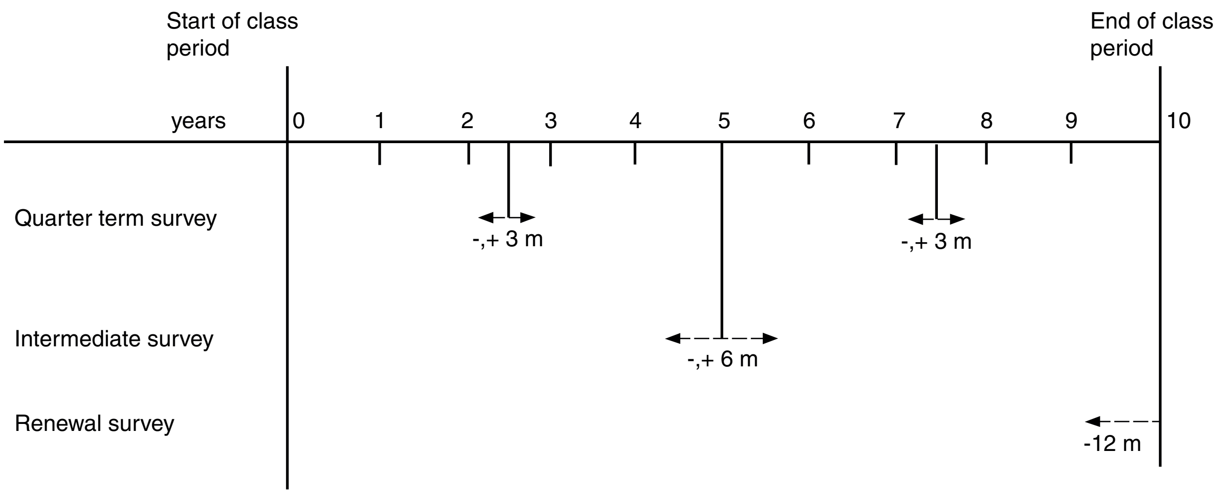



**Figure 2 : Links between anniversary dates and surveys - p = 10**



## 6 Occasional surveys

### 6.1 General

**6.1.1** An occasional survey is any survey which is not a periodical survey. The survey may be defined as an occasional survey of hull, machinery, boilers, refrigerating plants, etc., depending on the part of the harbour equipment concerned.

Where defects are found, the Surveyor may extend the scope of the survey as deemed necessary.

**6.1.2** Occasional surveys are carried out at the time of, for example:

- updating of classification documents, e.g. change of the Owner, name of the harbour equipment, flag
- damage or suspected damage
- repair or replacement work
- alterations or conversion
- quality system audits
- postponement of surveys or of recommendations.

### 6.2 Class extension surveys

**6.2.1** On Owner's special request and following surveys of hull and machinery afloat, the Society may extend the class by no more than 12 months in total, provided that the surveys in the scope of an intermediate survey at least, show that hull and machinery including electrical installations are in unobjectionable condition.

### 6.3 Damage and repair surveys

**6.3.1** Damage and repair surveys fall due whenever the harbour equipment's hull and machinery, including electrical installations, as well as special equipment and installations covered by the classification have suffered a damage which might affect validity of class, or if damage may be assumed to have occurred as a consequence of an average or some other unusual event, see also [9.1.2].

**6.3.2** Where damage has occurred to the harbour equipment's hull, machinery including electrical installations or special equipment and installations, the automatic/remote-control systems, etc., the damaged parts are to be made accessible for inspection in such a way that the kind and extent of the damage can be thoroughly examined and ascertained, see also [9.1.2].

In the case of grounding, dry docking, see Ch 3, Sec 4, [2] or, alternatively, in-water survey, see Ch 3, Sec 4, [3], is required.

**6.3.3** The repair measures are to be agreed with the Surveyor such as to render possible confirmation of the class without reservations upon completion of the repairs. In general, a class confirmation with conditions of class, e.g. in the case of a preliminary repair ("emergency repair"), requires to be approved by the Society's head office or Society's representative.

**6.3.4** Surveys conducted in the course of repairs are to be based on the latest experience and instructions by the Society. In exceptional cases advice is to be obtained from the Society's head office or Society's representative, in particular where doubts exist as to the cause of damage.

**6.3.5** For older harbour equipment, in the case of repairs and/or replacement of parts subject to classification, as a matter of principle, the construction Rules in force during their period of construction continue to be applicable.

This does not apply in the case of modifications required to the structure in the light of new knowledge gained from damage analyses, with a view to avoiding recurrence of similar damages.

**6.3.6** Regarding the materials employed and certificates required, the requirements for new buildings are applicable. See [9.2].

**6.3.7** Regarding corrosion damages or excessive wastage beyond allowable limits that affect the harbour equipment's class, see NR217, Part A, Ch 2, App 1.

### 6.4 Conversion surveys

**6.4.1** In case of conversion and/or major changes of the harbour equipment's hull, machinery, as well as special equipment and installations with effect to the class designation including notations, the Society's approval is to be requested as in the case of new buildings and surveys are to be carried out, as described in [9.2].

A new or amended class designation will be assigned, where necessary.

### 6.5 Quality system audits

**6.5.1** The Society reserves the right to require extraordinary surveys to be held independently of any regular surveys. Such surveys may become necessary for examining the harbour equipment's technical condition and are understood to be a part of Society's quality assurance system.

### 6.6 Survey for towage or voyage over sea

**6.6.1** In compliance with the provisions of the General Conditions, a certificate regarding towage or voyage over sea may be issued upon satisfactory survey the scope of which is fixed in each particular case by the Society according to the towing or voyage over sea.

## 7 Surveys in accordance with flag state regulations

### 7.1 General

**7.1.1** All activities outlined in [7.2] and, where applicable, issuance of relevant certificates/attestations are likewise subject to the respective latest edition of Society's General Conditions.

### 7.2 Society intervention

**7.2.1** Where surveys are requested by the Owner on account of corresponding laws and Regulations, the Society will carry them out by order or within the framework of official order, acting on behalf of the Authorities concerned, based on the respective provisions.

Where possible, such surveys will be carried out simultaneously with the class surveys.

## 8 Change of ownership

### 8.1 General

**8.1.1** In the case of change of ownership, the harbour equipment retains its current class with the Society, provided that:

- the Society is informed of the change in due time and able to carry out any survey deemed appropriate, and
- the new Owner expressively requests to keep the current class, involving acceptance of the Society's General Conditions and Rules. This request covers inter alia the condition of the vessel when changing ownership.

**8.1.2** The harbour equipment's class is maintained without prejudice to those provisions in the Rules which are to be enforced in cases likely to cause suspension or withdrawal of the class such as particular damages or repairs to the harbour equipment of which the Society has not been advised by the former or, as the case may be, new Owner.

## 9 Validity of class

### 9.1 General

**9.1.1** The class continues to be valid, provided that the hull, machinery as well as special equipment and installations classed are subject to all surveys stipulated, see Part A, Chapter 3 and that any repairs required as a consequence of such a survey are carried out to the satisfaction of the Society.

If some special equipment classed is not subjected to the prescribed surveys or is no longer intended to be carried on board, the notation for that equipment only will be suspended or withdrawn.

**9.1.2** The Society's head office or one of its representations are to be immediately informed about any average, damage or deficiency to the hull, machinery or equipment classed, where these may be of relevance to the harbour equipment's class and safety. A survey will have to be arranged immediately.

If the survey reveals that the harbour equipment's class has been affected, it will be maintained only on condition that the repairs or modifications demanded by the Society are carried out within the period and under the operating conditions specified by the Surveyor. Until full settlement of these demands the class will be restricted.

**9.1.3** Any damage or excessive wastage beyond allowable limits to side shell frames, their end attachments and/or adjacent shell plating, the deck structure and deck plating, the bottom structure and bottom plating, the watertight or oiltight bulkheads and the hatch covers or coamings that affect a harbour equipment's class, is to be permanently repaired immediately.

**9.1.4** Where defects are found further to an inspection by an Administration in pursuance of Port State Control or similar programs, Owners are to:

- immediately report the outcome of this inspection to the Society, and
- ask the Society to perform a survey in order to verify the deficiencies, when related to the class of the harbour equipment.

**9.1.5** Apart from the class certificate, any other documentation of significance for classification, such as:

- reports on surveys previously performed
- maintenance schedules to be observed by harbour equipment owner, as agreed with the Society
- reviewed drawings and other documentation handed out to the harbour equipment owner and containing particulars or instructions of significance in respect of the classification requirements, e.g. use of special steel grades,

is to be kept on board and made available to the Surveyor on request.

**9.1.6** Systems for special use may be exempted from classification. However, any changes in such systems that may affect the safety of operations and hence validity of the harbour equipment's class, including its classified installations, shall be notified to the Society in due course. This applies particularly to cases, where system changes lead to structural conversions or important changes in the machinery and electrical installation.

**9.1.7** The Society provides a notification system to remind the harbour equipment owner of surveys becoming due, or of any other matters of interest or urgency in connection with the classification of the harbour equipment. However, it remains the responsibility of the harbour equipment Owner to comply with the class conditions and to observe the dates for the prescribed surveys.

### 9.2 Repairs, conversions

**9.2.1** Where parts or components are damaged or worn to such an extent that they no longer comply with the class requirements, they are to be repaired or replaced. The damaged parts shall be made accessible for inspection so that the kind and extent of the damage can be thoroughly examined.

During repairs or maintenance work, the Owner has to arrange so that any damage, defects or non-compliance with the rule requirements are reported to the Surveyor during his survey.

**9.2.2** Repairs and conversions of the harbour equipment's hull, machinery as well as special equipment and installations classed have to be carried out under the supervision of the Society to ensure compliance with the Rules and continued validity of class. The repair measures are to be agreed with the Surveyor such as to render possible confirmation of the class, without reservations and conditions of class, upon completion of the repairs.

Where necessary, documentation is to be submitted to the Society and/or made available to the attending Surveyor.

Generally, a confirmation of class with conditions of class, e.g. in case of temporary repairs, requires to be approved by the Society's head office.

**9.2.3** The areas affected by repairs or conversion shall be treated in the same way as for new buildings. However, experience and technical knowledge gathered since the harbour equipment was built are to be taken into account.

Materials and equipment used for conversions, alterations or repairs are generally to meet the requirements of the Rules for new vessels built under survey; see Ch 3, Sec 4.

**9.2.4** If, following major conversions, new classification notations are assigned so that the class certificate is to be reissued, commencement of a new period of class may be agreed upon.

## 10 Lay-up and recommissioning of laid-up harbour equipment

### 10.1 General

**10.1.1** Lay-up and recommissioning of laid-up harbour equipment are subject to the applicable requirements of NR217, Pt A, Ch 2, Sec 2, [11].

# Section 3 Suspension and Withdrawal of Class

## 1 General

### 1.1

**1.1.1** The class may be discontinued either temporarily or permanently. In the former case it is referred to as "suspension" of class, in the latter case as "withdrawal" of class. In both cases, the class is invalidated in all respects.

If, for some reason, the class has expired or has been withdrawn or suspended by the Society, this fact may be indicated in the Register.

**1.1.2** If the Owner is not interested in maintenance of class of the harbour equipment or any of its special equipment and installations classed, or if conditions are to be expected under which it will be difficult to maintain class, the Society will have to be informed accordingly. The Society will decide whether the certificate will have to be returned and class suspended or withdrawn. Where only special equipment and installations are concerned, the corresponding notation will be withdrawn and the certificate amended accordingly.

**1.1.3** Class may also be suspended if a harbour equipment is withdrawn from active service for a longer period.

**1.1.4** The discontinuance of class is to be governed by the procedure developed in NR217, Pt A, Ch 2, Sec 3, where the terminology "vessel" is to be replaced by "harbour equipment".

# Section 4 Classification Procedures

## 1 General

### 1.1 Classification of new building

**1.1.1** The written order for classification is to be submitted to the Society, if needed, by the Building Yard, the Other Interested Party or by the Prospective Owner, using the form provided by the Society. It is to be clearly agreed between the parties concerned, e.g. in the building contract, which party will be responsible for compliance with the Society's Rules and Guidelines and other Rules and Regulations to be applied.

Where orders for the production of components are placed with subcontractors, the Society will have to be advised accordingly indicating the scope of the subcontract. The Building Yard, Prospective Owner and Other Interested Party are responsible for observance of the Rules, Guidelines and Regulations by subcontractors.

When particulars already approved by the Society for previous harbour equipment built under supervision of the Society are incorporated in the design of the new building, this is to be specifically stated in the order for classification. Amendments to the construction Rules having been introduced meanwhile are to be taken into account.

**1.1.2** The classification procedures for new building is described in NR217, Pt A, Ch 2, Sec 4, where the terminology “vessel” is to be replaced by “harbour equipment”.

### 1.2 Classification after construction of existing harbour equipment

**1.2.1** Harbour equipment not originally built under supervision of the Society may be classed subsequently following the procedures described hereafter.

The Owner is to contact the Society for the necessary arrangements. The Society is to be informed about the previous class status and period, as well as about any conditions of class/recommendations imposed by the previous classification Society. The written order for admission to class of existing harbour equipment or special equipment including the required documents is to be formally addressed to the Society, if needed, using adequate forms.

**1.2.2** The procedures for classification after construction of existing harbour equipment is described in NR217, Pt A, Ch 2, Sec 4, where the terminology “vessel” is to be replaced by “harbour equipment”.

# Section 5 Hull Survey For New Construction

## 1 General

### 1.1

**1.1.1** In this Section, the Building Yard is understood as acting directly or on behalf of the party requesting classification.

**1.1.2** When a hull construction is surveyed by the Society, the Building Yard is to provide all appropriate evidence required by the Society that the hull is built in compliance with the Rules and Regulations, taking account of the relevant reviewed drawings.

**1.1.3** The hull survey for new construction is to comply with the requirements of NR217, Pt A, Ch 2, Sec 5, where the terminology "vessel" is to be replaced by "harbour equipment".

Part A
Classification and Surveys

# CHAPTER 3
# SURVEYS FOR MAINTENANCE OF CLASS

# Section 1 Class Renewal Survey

## 1 General

### 1.1 Application

**1.1.1** The requirements of this Section apply to class renewal surveys of all harbour equipment.

**1.1.2** A survey planning meeting is to be held prior to the commencement of the survey.

**1.1.3** In addition to the requirements of intermediate survey in Ch 3, Sec 2, the class renewal survey is to include sufficiently extensive examination and checks to show that the structures, machinery, systems, equipment and various arrangements of the harbour equipment are in satisfactory condition or restored to such condition as to allow the harbour equipment to operate for the new period of class of **p** years to be assigned, provided that the harbour equipment is properly maintained and operated and other surveys for maintenance of class are duly carried out during this period.

The examinations of the hull are to be supplemented by thickness measurements and testing as required in [2.4] and [2.5], to ensure that the structural integrity remains effective. The aim of the examination is to discover substantial corrosion, significant deformation, fractures, damages or other structural deformation that may be present.

## 2 Hull and hull equipment

### 2.1 Bottom survey in dry condition

**2.1.1** A bottom survey in dry condition is to be carried out, as detailed in Ch 3, Sec 4, [2], and in addition the requirements given in [2.1.3] to [2.1.4] are to be complied with.

**2.1.2** For harbour equipment of unusual characteristics or engaged on special services, means of underwater inspection equivalent to the bottom survey in dry condition may be considered as an alternative by the Society, particularly when a suitable high resistance paint is applied to the underwater portion of the hull.

**2.1.3** River valves and cocks are to be opened up for internal examination.

**2.1.4** Thickness measurements of the outer shell plating, as and if required within the scope of the related class renewal survey, are to be carried out (refer to [2.5]), if not already done within 12 months before the end of class period.

### 2.2 Decks, hatch covers and equipment

**2.2.1** Decks are to be examined, particular attention being given to the areas where stress concentration or increased corrosion are likely to develop, such as hatch corners and other discontinuities of structure.

Deck erections such as hatch coamings are to be examined.

The sheathing of wood-sheathed steel decks may be removed, at the Surveyor's discretion, in the case of doubt as to the condition of plating underneath.

**2.2.2** The hatch covers and coamings are to be surveyed by checking the effectiveness of sealing arrangements of all hatch covers by hose testing or equivalent.

**2.2.3** All bilge and ballast piping systems are to be examined and operationally tested to working pressure to attending Surveyor's satisfaction to ensure that tightness and condition remain satisfactory.

### 2.3 Holds and other dry compartments

**2.3.1** Holds, cofferdams, pipe tunnels and duct keels, void spaces and other dry compartments which are integral to the hull structure are to be internally examined, ascertaining the condition of the structure, bilges and drain wells, sounding, venting, pumping and drainage arrangements.

**2.3.2** Machinery spaces and pump rooms and other spaces containing machinery are to be internally examined, ascertaining the condition of the structure. Particular attention is to be given to tank tops, shell plating in way of tank tops, brackets connecting side shell frames and tank tops, and bulkheads in way of tank tops and bilge wells. Particular attention is to be given to the river suctions, river water cooling pipes and overboard discharge valves and their connections to the shell plating. Where wastage is evident or suspected, thickness measurements are to be carried out, and renewals or repairs effected when wastage exceeds allowable limits.

## 2.4 Tanks

**2.4.1** The type and number of tanks to be internally examined at each class renewal survey are detailed in Tab 1, according to the age of the harbour equipment.

This internal examination is to ascertain the condition of the structure, bilges and drain wells, sounding, venting, pumping and drainage arrangements, including piping systems and their fittings. Due attention is to be given to plating or double plates below the lower end of sounding and suction pipes.

Where the inner surface of the tanks is covered with cement or other compositions, the removal of coverings may be waived provided they are examined, found sound and adhering satisfactorily to the steel structures.

Note 1: Due attention is also to be given to fuel oil piping passing through ballast tanks, which is to be pressure tested when the harbour equipment is more than 10 years old.

**2.4.2** Tanks are to be tested by applying test pressure defined in Pt B, Ch 6, Sec 4 and in the relevant Chapter of Part D for each harbour equipment type.

**Table 1 : Requirements for internal examination of integral (structural) tanks at class renewal survey**

| Tank | Class renewal survey No. I | Class renewal survey No. II | Class renewal survey No. III | Class renewal survey Nos. IV and subsequent |
|---|---|---|---|---|
| Peaks (all use) | all | all | all | all |
| Water ballast tanks (all types) | all | all | all | all |
| Fresh water | none | one | all | all |
| Fuel and lubricating oil tanks | none | none | none | one |
| Storage tanks | all | all | all | all |

**Note 1:** Independent non-structural tanks located in machinery spaces are to be externally examined; the relevant fittings, with particular regard to the remote control shut-off valves under hydrostatic head, are to be externally examined to check the efficiency of manoeuvres and the absence of cracks or leakage.
**Note 2:** The extent of the survey of tanks dedicated to liquids other than those indicated in this table will be considered by the Society on a case by case basis according to the nature of the liquids.
**Note 3:** If a selection of tanks is accepted to be examined, then different tanks are to be examined at each class renewal survey, on a rotational basis. Tanks not internally examined may be examined externally from accessible boundaries.

## 2.5 Thickness measurements

### 2.5.1 General

Thickness measurements required for hull structural elements are to be carried out in compliance with NR217, Pt A, Ch 2, App 1 Requirements for Thickness Measurements.

### 2.5.2 Piping system

Where thickness measurements of piping system are carried out, they are to be checked against permissible tolerances according to NR217, Pt A, Ch 2, Sec 2, [2.4.3].

## 2.6 Additional inspection and check - Class renewal I

### 2.6.1 Hull structure

Thickness measurements are to be carried out in way of suspect areas, defined in Ch 2, Sec 2, [2].

### 2.6.2 Equipment, deck openings, etc.

The class renewal survey also covers other parts essential for the operation and safety of the harbour equipment, such as watertight doors, sluice valves, air and sounding pipes, and gas-freeing, companionways, hatches, scuppers and water drain pipes with their valves, fire protecting arrangements.

### 2.6.3 Machinery space structure

Particular attention is to be given to tank tops, shell plating in way of tank tops, brackets connecting side shell frames and tank tops, machinery space bulkheads in way of tank top and the bilge wells. Where wastage is evident or suspected, thickness measurements are to be carried out.

## 2.7 Additional inspection and check - Class renewal II

**2.7.1** The requirements for the second class renewal include those for class renewal I. Additionally the following investigations are to be carried out.

**2.7.2** The structural parts behind ceilings, floor coverings and insulation are to be examined, as required by the Surveyor and depending on the general condition of the harbour equipment.

Ceilings, linings and insulation including steel ceiling adjacent to the shell plating and the inner bottom are to be removed, as indicated by the Surveyor, to enable the structure to be examined in detail.

### 2.8 Additional inspection and check - Class renewal III and subsequent ones

**2.8.1** The requirements for the third and the subsequent class renewals include those for the class renewal II. Additionally, the following investigations are to be carried out.

**2.8.2** Ceilings, linings and insulation including steel ceiling adjacent to the shell plating and the inner bottom are to be removed, as indicated by the Surveyor, to enable the structure to be examined in detail.

For class renewals III and subsequent ones, the inner bottom ceilings may be partially removed at the Surveyor's discretion, to enable their assessment.

For class renewals IV and subsequent ones, the inner bottom ceilings are to be completely removed and the tank top is to be carefully cleaned, such as to enable proper assessment of the tank top's condition.

## 3 Machinery and electrical installations

### 3.1 General

**3.1.1** Except for individual machinery components as indicated in the following, the scope of all class renewal surveys related to the machinery including electrical installations is identical. The class renewal survey includes the surveys and checks required at intermediate survey according to Ch 3, Sec 2.

### 3.2 Surveys requiring dry docking

**3.2.1** While the harbour equipment is in dry dock, the river inlets and discharges are to be examined as to their condition and to be opened up and overhauled once within the class period.

### 3.3 Auxiliary machinery, equipment and piping, survey performance

**3.3.1** The following components are to be inspected and tested in dismantled condition, where deemed necessary by the Surveyor:

- all pumps of the essential systems
- air compressors, including safety devices
- separators, filters and valves
- coolers, pre-heaters
- piping, pipe connections, compensators and hoses
- emergency drain valves and bilge piping systems
- tank filling level indicators
- installations preventing the ingress of water into open spaces
- oil purifier and sewage systems
- additional systems and components, where deemed necessary by the Surveyor, as well as special equipment and installations if included in the scope of classification.

### 3.4 Electrical installations

**3.4.1** On main and emergency switchboards, after cleaning when necessary, feeder circuit breakers being open, busbar circuit closed, measuring and monitoring instruments disconnected, the resistance of insulation measured across each insulated busbar and hull, and across insulated busbars is not to be less than 1 megohm.

**3.4.2** For generators, the equipment and circuits normally connected between the generator and first circuit breaker being connected, preferably at working temperature whenever possible, the resistance of insulation, in ohms, is to be more than 1000 times the rated voltage, in volts. The insulation resistance of generators separate exciter gear is not to be less than 250000 ohms.

**3.4.3** With all circuit breakers and protective devices closed, except for the generators, the insulation resistance of the entire electrical system is to be checked.

In general, the resistance is not to be less than 100000 ohms. However, the variation of the resistance with time is to be checked by comparing the current figure with the previous readings. If insulation resistance drops suddenly or is insufficient, the defective circuits are to be traced by disconnecting the circuits as necessary.

**3.4.4** These measurements are subject to a report to be submitted to the Surveyor. In case the results are not satisfactory, supplementary investigation and necessary repairs have to be carried out to the Surveyor's satisfaction.

**3.4.5** The proper operation of the remote stopping systems of:

- transfer and fuel oil pumps
- forced draught fans and engine room ventilation fans,

are to be verified.

### 3.5 Pipes in tanks

**3.5.1** Where pipes are led through tanks, they are to be examined and, if required by the Surveyor, subjected to hydraulic tests, if for the respective tanks an internal examination is required. Depending on the results obtained, thickness measurements may be required.

### 3.6 Fire extinguishing and fire alarm systems

#### 3.6.1 General requirements

Proof is to be furnished to the Surveyor that the entire fire extinguishing equipment is ready for operation and in a satisfactory condition.

On the occasion of every class renewal survey, the installation must be subjected to a visual inspection and test, if deemed necessary by the Surveyor.

Equipment (cylinders, bottles, fire extinguishers, etc.) has to be inspected according to the manufacturer's instructions or applicable codes by an approved or recognized company. Reports of these inspections are to be provided to the Surveyor.

### 3.7 Trials

**3.7.1** Upon completion of the surveys for class renewal, the Surveyor is to be satisfied that the machinery installation including electrical installations, as well as special equipment and installations are operable without restrictions. In case of doubt, trials and/or operational tests may be necessary.

## 4 Pressure equipment

### 4.1 General

**4.1.1** For steam boiler installations, thermal oil plants and pressure vessels, see NR217, P, A, Ch 3, Sec 6.

# Section 2 Periodical Surveys

## 1 General

### 1.1

**1.1.1** The requirements of this Section apply to periodical surveys of all harbour equipment according to Tab 1.

**1.1.2** A survey planning meeting is to be held prior to the commencement of the survey.

**1.1.3** The quarter term survey and/or intermediate survey are to include examination and checks of a sufficiently extensive part of the structure to show that the structures of the harbour equipment are in satisfactory condition so that the harbour equipment is expected to operate until the end of the current period of class, provided that the harbour equipment is properly maintained and other surveys for maintenance of class are duly carried out during this period.

**Table 1 : Applicable requirements**

| Survey type | **p** ≤ 5 | **p** > 5 |
|---|---|---|
| Quarter term survey | NA | [2] |
| | | [3] |
| | | [4] |
| | | [5] |
| Intermediate survey | [2] | [6] |
| | [3] | |
| | [4] | |
| | [5] | |

**Note 1:**
**p** : Class period defined Ch 1, Sec 2, [4.1]
NA : Not applicable

## 2 Surveys performance

### 2.1 General

**2.1.1** The survey is to include the requirements stated under [3] to [6].

Note 1: More extensive applicable Regulations are to be observed.

**2.1.2** Additional requirements may have to be observed for particular harbour equipment types, due to the request of the Owner or in connection with manufacturer's recommendations for special equipment.

## 3 Hull and hull equipment

### 3.1 General

**3.1.1** The main structural elements of the hull are to be subjected to a general visual inspection, as far as accessible. If applicable, ballast tank, storage and machinery spaces are to be surveyed at random, depending on the harbour equipment type, age and general condition. Where damages or excessive wastage affecting the class are suspected, the Surveyor is entitled to carry out further investigations as well as thickness measurements, if required.

**3.1.2** The foundations and their substructure of special equipment, particularly on the deck, are to be inspected for damages.

**3.1.3** Compartments and rooms normally not accessible, or accessible only after special preparations, may be required to be opened for inspection, depending on the harbour equipment's age and available information about service conditions.

### 3.2 Ballast tanks

**3.2.1** Depending on the harbour equipment's age, the Surveyor may require opening of ballast tanks for visual inspection, particularly if deterioration of the coating or excessive wastage has already been observed at previous surveys.

If coating is to be partly or totally renewed, only approved coating is applicable in the case of a repair. The whole working procedure including the surface preparation is to be documented.

### 3.3 Hatches and covers

**3.3.1** Hatches and covers are to be surveyed regarding structural integrity as well as tightness and operability of all closures.

### 3.4 Dry dock survey

**3.4.1** Intermediate surveys have to be carried out in dry-dock in the following cases:

- the harbour equipment's shell is riveted, at the Surveyor's discretion
- the harbour equipment's age exceeds 4**p** years, at the Surveyor's discretion.
- the harbour equipment’s age exceeds 4**p** years and the service notation granted is floating storage for storing of liquid or gaseous dangerous products
- the harbour equipment is granted with the additional service feature $\mathbf{H_S(1{,}2 < x \le 2)}$, at the Society’s discretion.

For performance of dry dock surveys, see Ch 3, Sec 4, [2].

**3.4.2** Hull plates before protective application, appendages, discharge valves, river chests, etc. are to be examined. In case of doubt, thickness measurements can be requested by the Surveyor.

## 4 Machinery and electrical installations

### 4.1 General

**4.1.1** The machinery including electrical installations will be subjected to the following surveys and operational checks:

- general inspection of machinery and the auxiliary engines, possible fire and explosion sources, and checking of emergency exits as to their free passage
- external inspection of pressure vessels, with their appliances and safety devices.
- inspection and checking of the remote control, quick-closing/ stopping devices of pumps, valves, ventilators, etc.
- random checking of the remote control and automation equipment
- inspection and functional checking of control systems
- inspection of the bilge system, including remote control actuators and bilge filling level monitors
- survey of explosion-proof installations
- random inspection and checking of essential equipment to the Surveyor’s discretion.

### 4.2 Fire extinguishing systems

**4.2.1** The following items/systems are subject to inspection and/or testing, where applicable:

- fire mains system, including hoses and nozzles
- gas fire extinguishing system
- dry powder fire extinguishing system
- foam fire extinguishing system
- sprinkler system, including water mist sprinkler system
- water and/or foam drencher system
- any other fixed fire extinguishing system provided
- portable fire extinguishers, mobile fire extinguishers, including portable foam application units
- fire detection and alarm systems
- emergency stops for ventilation fans, boiler forced draft fans, fuel transfer pumps, fuel oil purifiers
- quick-closing fuel valves
- fire closures, fire dampers, etc.
- fireman’s outfits, if required.

The survey of fire extinguishing systems is to be performed according to NR217, Pt A, Ch 3, Sec 2, [4.2].

### 4.3 Machinery

**4.3.1** In addition to the requirements under [4.1.1], the components of essential systems onboard are to be subjected to operational tests.

### 4.4 Electrical installations and equipment

**4.4.1** The Surveyor will check the good condition, particularly the earthing of the electrical equipment, and the satisfactory operating condition of the entire electrical installation. If he judges it necessary, measurement of the insulation level of the electrical installation will be carried out.

## 5 Pressure equipment

### 5.1 General

**5.1.1** For steam boiler installations, thermal oil plants and pressure vessels, see NR217, Pt A, Ch 3, Sec 6.

## 6 Intermediate survey - p > 5

### 6.1 General

**6.1.1** The intermediate survey is to include all the inspections and checks required for quarter term surveys.

Note 1: More extensive Regulations of the country where the unit is operated are to be observed.

**6.1.2** The requirements of this Article apply to all harbour equipment. Additional requirements may have to be observed for particular harbour equipment types, at the request of the Owner or in connection with the manufacturer's recommendations for special equipment.

### 6.2 Hull

**6.2.1** The requirements given in Tab 2 for the survey and testing of water ballast spaces and other hull spaces are to be complied with.

**Table 2 : Intermediate survey of hull - p = 10 years**

| Space | Age of the harbour equipment (in year at time of intermediate survey) | | | |
|---|---|---|---|---|
| | Age ≤ 5 | 5 < Age ≤ 10 | 10 < Age ≤ 15 | 15 < Age |
| Water ballast tanks | Representative spaces internally examined | All spaces internally examined Thickness measurements if considered necessary by the surveyor **(1)(2)(3)** | All spaces internally examined Thickness measurements if considered necessary by the surveyor **(1)(3)** | All spaces internally examined Thickness measurements if considered necessary by the surveyor **(1)(3)** |
| Storage spaces | | | Selected storage spaces internally examined | Selected storage spaces internally examined |
| Storage tanks | | | Selected storage spaces internally examined | Selected storage spaces internally examined |

**(1)** If such examinations reveal no visible structural defects, the examination may be limited to a verification that the corrosion prevention system remains effective.

**(2)** If there is no hard protective coating, soft coating or poor coating condition, the examination is to be extended to other ballast spaces of the same type.

**(3)** For water ballast spaces, if there is no hard protective coating, soft coating or poor coating condition and it is not renewed, the spaces in question are to be internally examined at annual intervals.

**Note 1:** Due attention is also to be given to fuel oil piping passing through ballast tanks, which is to be pressure tested should doubts arise.

# Section 3 Additional Requirements for Notations

## 1 General

### 1.1 Application

**1.1.1** The purpose of this Section is to give details on the scope of surveys applicable to harbour equipment for which, due to the additional service feature or additional class notation assigned, specific requirements need to be verified for the maintenance of their class.

**1.1.2** These specific requirements either are additional to or supersede those stipulated in Ch 3, Sec 1 and Ch 3, Sec 2 which give general requirements for surveys applicable to all types of harbour equipment (see indication in each Article of this Section). 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. quarter term or intermediate or class renewal surveys, detailed in Ch 3, Sec 1 and Ch 3, Sec 2.

**1.1.3** Tab 1 indicates which additional service features and additional class notations are subject to specific requirements, and in which Article they are specified.

## 2 Liquid products /DG-S

### 2.1 General

**2.1.1** The requirements of this Article apply to **Floating storage** intended for the storage of liquid products assigned one of the following notations:

- **DG-S**
- **DG-S/Bunker station**
- **DG-S/Wastes**.

**Table 1 : Notations for which specific requirements are applicable**

| Notation | Article applicable in this Section | Surveys affected by these specific requirements |
|---|---|---|
| **Liquid products /**<br>**DG-S**<br>**DG-S/Bunker station**<br>**DG-S/Wastes** | [2] | class renewal and periodical surveys |
| **Gaseous products /**<br>**DG-S** | [3] | class renewal and periodical surveys |
| **Green passport** | [4] | class renewal |
| **Auxiliary propulsion** | [5] | class renewal and intermediate surveys |
| **A** | [6] | class renewal and bottom survey |
| **C** | [7] | class renewal and bottom survey |
| **W** | [8] | class renewal and bottom survey |
| **Floating plant** | [9] | class renewal and periodical surveys |
| **Battery system** | [10] | class renewal and periodical surveys |
| **Electric hybrid** | [11] | class renewal and periodical surveys |
| **LNGfuel**<br>**CNGfuel**<br>**LPGfuel**<br>**methanolfuel**<br>**LFPfuel** | [12] | class renewal and periodical surveys |
| **Fuelcell** | [13] | class renewal and periodical surveys |

## 2.2 Class renewal - Hull

**2.2.1** On harbour equipment which - as can be proved - have exclusively stored product not causing corrosion, the storage tanks are to be inspected at each alternate class renewal only, provided that it may be assumed on the basis of random checks that the component parts are still in satisfactory condition, and provided that no objections will result from the tightness and pressure tests according to Pt B, Ch 6, Sec 4.

**2.2.2** During each class renewal, the cofferdams are to be hydrostatically tested to the test pressure as defined in Pt B, Ch 6, Sec 4 and Pt D, Ch 6, Sec 2, [3.5].

**2.2.3** At each alternate class renewal only, the storage tanks, including gas collector if any, are to be tested by water and/or air pressure, to the test pressure stated in the Rules. In the case of air tightness and pressure test, the test has to be made according to Pt B, Ch 6, Sec 4. Where products are carried which cause corrosion in connection with water, the kind of testing is to be specified.

**2.2.4** At each class renewal, storage tanks intended for acids and lye solution will be subjected to an internal examination and, at each alternate class renewal, to a hydrostatic pressure test. The test pressure, to be determined in accordance with Pt D, Ch 6, Sec 2, [3.5], depends on the density of the cargo.

## 2.3 Class renewal - Machinery

### 2.3.1 Piping system

Product piping, including valves and fittings, pumps as well as gas-freeing and safety equipment is to be surveyed.

At each class renewal, the loading and discharge pipes of tankers are to be tested to 1,25 times the allowable working pressure.

The Surveyor may require dismantling and /or thickness measurements of piping.

Note 1: When components are replaced in the product handling installation, it is the responsibility of the Owner to verify their compatibility with the chemical characteristics of the products stored.

### 2.3.2 Inert gas system

Inert gas installations of the storage tanks are to be checked as to their operability.

### 2.3.3 Electrical installations

For harbour equipment intended for flammable products, the condition of safety electrical equipment in relation to explosive atmospheres is to be verified and particular attention is to be paid to cable runs and connecting terminals, especially in the storage area.

## 2.4 Periodical surveys - Machinery

### 2.4.1 Safety systems

The following installations and equipment are to be checked:

- level/overfill alarms
- level indicators
- tank venting systems
- flame arresters
- piping, valves and fittings, pumps
- pump room equipment, including ventilation system
- fire-extinguishing equipment
- pressure/vacuum relief valves.

### 2.4.2 Product piping system

a) Examination of the storage tank openings, including gaskets and covers
b) Examination of the storage tank pressure / vacuum relief valves or equilibrating devices
c) Examination of the flameproof devices and flame screens
d) Examination of the product piping and their auxiliaries
e) Testing of all storage tank alarms.

### 2.4.3 Inert gas system

Inert gas installations of the storage tanks are to be checked as to their operability.

### 2.4.4 Cofferdams

The cofferdams are to be inspected, if provided.

#### 2.4.5 Product pump room

For product pump rooms, the survey consists of the verification of the good condition of:

- access ladders
- sumps
- all bulkheads for signs of leakage or fractures and, in particular, the sealing arrangements of the bulkhead penetrations
- piping systems, their pumps and auxiliaries
- pump room ventilation system including ducting, dampers and screens.

#### 2.4.6 Electrical installations and equipment

The Surveyor will check that the insulation level of the electrical installation has been verified within the last three years and that the results are to his satisfaction, particularly in pump rooms and in the storage area. Furthermore, the good condition of the safety electrical equipment in respect to explosive atmosphere has to be checked. Special attention is to be paid to the cable runs and connecting terminals.

## 3 Gaseous products /DG-S

### 3.1 General

**3.1.1** The requirements of this Article apply to **Floating storage** intended for the storage of gaseous products assigned the additional service feature **DG-S**.

### 3.2 Class renewal survey - Hull

**3.2.1** On harbour equipment which - as can be proved - have exclusively stored products not causing corrosion, the storage tanks are to be inspected at each alternate class renewal only, provided that it may be assumed on the basis of random checks that the component parts are still in satisfactory condition, and provided that no objections will result from the tightness and pressure tests as per Pt B, Ch 6, Sec 4.

**3.2.2** During each class renewal, the cofferdams are to be hydrostatically tested to the test pressure as defined in Pt B, Ch 6, Sec 4, [2] and Pt D, Ch 6, Sec 2, [3.5].

**3.2.3** At each alternate class renewal only, the storage tanks, including gas collector if any, are to be tested by water and/or air pressure, to the test pressure stated in the Rules. In case of air tightness and pressure test, the test has to be made according to Pt B, Ch 6, Sec 4. Where products are stored which cause corrosion in connection with water, the kind of testing is to be specified.

**3.2.4** At each class renewal, storage tanks intended for acids and lye solution will be subjected to an internal examination and, at each alternate class renewal, to a hydrostatic pressure test. The test pressure, to be fixed in accordance with Pt D, Ch 6, Sec 2, [3.5], depends on the density of the product.

**3.2.5** The following examinations, measurements and testing are to be carried out:

a) Thickness measurements and non-destructive testing of storage tanks
   - thickness measurements of storage tanks may be required. During these examinations, the state of insulation is checked around the considered areas
   - during the internal survey of the tanks, a non destructive testing procedure supplements the examination of storage tanks, according to a programme and control means approved beforehand by the Society
   - when independent tanks (cylindrical under pressure) are concerned, in principle, 10% of the length of welded seams, in critical areas are tested: tank supports, reinforcement rings, attachment of hollow bulkheads, weldings of the fittings (domes, sumps) to the tank-plates, supports of pumps, ladders, pipe connections. It may be necessary to remove partially the tank insulation to perform these examinations
   - for tanks where anti-corrosion coatings are found to be in satisfactory condition, the extent of thickness measurements may be specially considered, at the discretion of the Surveyor.

b) Testing of storage tanks
   - tanks for the storage of pressurized liquefied gases are to be tested like pressure vessels. Deviating there from, storage tanks need to be subjected to an internal inspection on the occasion of each other subsequent class renewal only, if in these tanks only gases or gas mixtures have been stored, which have no corrosive effect upon their walls, and if random checks suggest that the tanks are in satisfactory condition
   - tightness of storage tanks and domes is to be verified. However, for a harbour equipment of less than fifteen years of age, a separate tightness test may not be required for each tank, provided the examination of the log book raises no doubts as to their tightness
   - where the results of tanks examination and testing, or the examination of the log book raise doubts as to the structural integrity or tightness of a storage tank, or when significant repairs have been carried out, hydraulic or hydropneumatic testing is to be carried out.

c) External examination of storage tanks

- all independent tanks are to be examined externally wherever practicable. Where the insulation of a storage tank or of the hull structure is accessible, the Surveyor examines the insulation externally including any vapour or protective barrier. If considered necessary by the Surveyor, insulation is to be removed in part or entirely so as to check the condition of the tank. Storage tank supports, chocks and keys and the adjacent hull structure are to be examined
- pressure relief valves of storage tanks are to be opened up for examination, adjusted, sealed and tested to the Surveyor's satisfaction
- pressure / vacuum relief valves or other pressure relief devices in the tank spaces, are to be examined to the Surveyor's satisfaction and, according to their design, opened up, adjusted and tested.

d) Examination of the storage area

- the venting system of storage tanks and storage spaces is to be checked. All gastight bulkheads are to be examined. Gastight bulkhead penetrations, including eventual gastight shaft sealings, are to be examined
- gas detection equipment, including indicators and alarms in operation, are to be verified to be in good working order
- the inert gas or dry air installation in operation, including the means for preventing backflow of product vapour to gas safe areas will be checked
- sealing arrangements of tanks/tank domes, penetrating decks / tank covers, of portable and permanent drip trays or insulation for deck protection in the event of product leakage are to be verified
- hose and spool pieces used for segregation of piping systems for product, inert gas and bilge are to be examined.

## 3.3 Class renewal survey - Machinery

### 3.3.1 Product handling installation

The product piping system including valves, their monitoring devices, etc. are to be opened up for examination and their insulation removed as the Surveyor deems necessary. The complete system is tested to 1,25 times the design pressure. If the maximum delivery pressure of pumps is less than the design pressure of the piping system, testing to the pumps maximum delivery pressure may be accepted. In such cases, selected expansion bellows are to be dismantled, examined internally and tested to their design pressure to the Surveyor's satisfaction.

All pressure relief valves are to be opened up for examination, adjusted, sealed and tested to the Surveyor's satisfaction.

The product pumps, compressors, heat exchangers and other machinery including their prime movers which are a part of the product handling installation are to be examined.

### 3.3.2 Product handling control and safety installations

The product handling control and safety installations, such as:

- emergency shut down valves at shore connections and tanks
- control, alarm and safety systems monitoring the pressure in storage tanks, product piping and storage spaces
- storage tanks level indicators including alarm and safety functions
- product temperature monitoring systems
- control, alarm and safety systems of product compressors and product pumps,

are to be verified on good working.

Note 1: When components are replaced in the product handling installation, it is the responsibility of the Owner to verify their compatibility with the chemical characteristics of the products transported.

### 3.3.3 Inert gas system

Inert gas installations of the storage tanks are to be checked as to their operability.

## 3.4 Periodical surveys - Machinery

### 3.4.1 Safety systems

The following installations and equipment are to be checked:

- level/overfill alarms
- level indicators
- tank venting systems
- piping, valves and fittings, pumps
- compressor / pump room equipment, including ventilation system
- fire-extinguishing equipment
- pressure/vacuum relief valves.

**3.4.2** Access to storage tanks and/or inerted storage spaces is not normally required.

**3.4.3** Recorded entries in the log book, if any, since the last survey are to be examined in order to check the past performance of the system and to establish if certain parts have shown any irregularities in operation or if the evaporation rate has been abnormally high.

**3.4.4** Spaces and areas such as product control rooms, air locks, compressor rooms are to be examined together with product handling piping and machinery including product and process piping, product heat exchangers, evaporators, compressors, during operation, whenever possible.

**3.4.5** Electric bonding of storage tanks and product piping systems is to be verified.

#### 3.4.6 Inert gas system

Inert gas installations of the storage tanks are to be checked as to their operability.

**3.4.7** Examination and checking of the following items:

a) Venting system of storage tanks and storage spaces
b) All gastight bulkhead penetrations including gastight shaft sealing, if provided
c) Product handling control and safety systems, if practicable, such as:
    - emergency shut down valves at shore connections and tanks
    - control, alarm and safety systems monitoring the pressure in storage tanks, product piping and storage spaces
    - storage tanks level gauging including alarm and safety functions
    - product temperature monitoring systems
    - control, alarm and safety systems of product compressors and product pumps.
d) Gas detection equipment including indicators and alarms in operation
e) Ventilation systems of all spaces in the storage area
f) Inert gas or dry air installations in operation, including the means for preventing backflow of product vapour to gas safe areas
g) Gastightness of control station doors and windows
h) Sealing arrangements of tank/tank domes, penetrating decks/tank covers, of portable and permanent drip trays or insulation for deck protection in the event of product leakage.

# 4 Green passport

## 4.1 General

**4.1.1** The requirements of this Article apply to harbour equipment which has been assigned the additional class notation **Green passport** related to unit recycling, as described in Ch 1, Sec 3, [10.4].

**4.1.2** The class renewal survey is to be carried out in compliance with the requirements of NR528 Green Passport.

# 5 Auxiliary propulsion

## 5.1 General

**5.1.1** The requirements of this Article apply to harbour equipment which has been assigned the additional class notation **Auxiliary propulsion**, as described in Ch 1, Sec 3, [10.1].

#### 5.1.2 Class renewal survey

The class renewal survey is to be carried out in compliance with the applicable requirements of NR 217, Pt A, Ch 3, Sec 3, [3] and NR 217.

#### 5.1.3 Periodical surveys

Periodical surveys are to be carried out in compliance with the applicable requirements of NR 217, Pt A, Ch 3, Sec 2, [4].

# 6 Additional service feature A

## 6.1 General

**6.1.1** The requirements of this Article are applicable to harbour equipment assigned with the additional service feature **A**.

**6.1.2** These requirements are additional to those given in other Sections of Part A, Chapter 3, according to the relevant surveys.

### 6.2 Class renewal survey

**6.2.1** For harbour equipment assigned the additional service feature **A**, the highly stressed areas are to be externally examined and dye penetrant checks are to be carried out, as found necessary by the Surveyor.

Thickness measurements are to be carried out, in areas where chaffing or corrosion may have developed, as found necessary by the Surveyor.

### 6.3 Bottom survey

**6.3.1** For harbour equipment built in aluminium alloy, the appendages of the hull are to be examined as found necessary by the Surveyor, with particular attention to their fixation to the hull and to the surrounding area specially where deterioration of the hull protection is found.

## 7 Additional service feature C

### 7.1 General

**7.1.1** The requirements of this Article are applicable to harbour equipment assigned with the additional service feature **C**.

**7.1.2** These requirements are additional to those laid down in other Sections of Part A, Chapter 3, according to the relevant surveys.

### 7.2 Class renewal survey

**7.2.1** For harbour equipment assigned the additional service feature **C**, an external examination of the coating condition is to be carried out. This examination is to be directed at discovering significant alteration of the coating or contact damages.

## 8 Additional service feature W

### 8.1 General

**8.1.1** The requirements of this Article are applicable to harbour equipment assigned with the additional service feature **W**.

**8.1.2** These requirements are additional to those laid down in Part A, Chapter 3, according to the relevant surveys.

### 8.2 Class renewal survey

**8.2.1** For harbour equipment built with laminate wood and provided with coating, an external examination of the protection of edges against water ingress is to be carried out.

**8.2.2** For harbour equipment built with plank seams and butts, the condition of plank seams, butts and caulking is to be externally examined and renewal is to be carried out as found necessary by the Surveyor.

Where applicable, the timber of the main structural items is to be tapped specially in place where ventilation is poor.

When traces of worm or rot are found, the damaged pieces are to be added to sound wood or renewed as found necessary by the Surveyor.

### 8.3 Bottom survey

**8.3.1** The seams and butts of the garboard and bilges at midship, the keel scarphs and rabbets are to be examined. The same applies to caulking of the underwater parts specially butts and rabbets. The Surveyor may require caulking to be renewed or the hull to be recaulked as found necessary.

**8.3.2** For hulls built with planks, a particular attention is to be given to the tightness of the junctions between planks.

The condition of the bolting and fastening and, in general, of metal parts, is to be examined.

If decay or rot is found or if the wood is worn, it is to be renewed as found necessary by the Surveyor.

Where the planking is sheeted with composite material, such as fibre reinforced plastic, the edges of planks are to be examined as found necessary by the Surveyor, in order to ascertain that no ingress of water has occurred along them.

# 9 Floating plant

## 9.1 General

**9.1.1** The requirements of this Article apply to class renewal survey and periodical surveys of plant installations on harbour equipment assigned with the service notation **Floating plant**, as defined in Ch 1, Sec 3, [8.1].

**9.1.2** A scope of survey including at least the requirements stipulated under [9.2] and [9.3] is to be agreed upon with the Surveyor, depending on the plant type and the manufacturer's instructions.

## 9.2 Power production

**9.2.1** In addition to the requirements stipulated in Ch 3, Sec 1 and Ch 3, Sec 2:
- Power plant using low flashpoint liquid gas as fuel are to comply with the requirements of [12].
- When batteries are used as power source, the power plant is to comply with the requirements of [10].
- Power plants using solar cells are to comply with the manufacturer's instructions.

## 9.3 Other plant types

### 9.3.1 Safety system

The following installations and equipment are to be checked, as far as applicable:
- level/overfill alarms
- level indicators
- tank venting systems
- piping, valves and fittings, pumps
- compressor / pump room equipment, including ventilation system
- fire-extinguishing equipment
- pressure/vacuum relief valves.

### 9.3.2 Piping system

Piping, including valves and fittings, compressors, pumps as well as gas-freeing and safety equipment is to be surveyed.

### 9.3.3 Electrical installations and equipment

The Surveyor will check that the insulation level of the electrical installation in the plant area has been verified within the last three years and that the results are to his satisfaction.

Where flammable products are involved in the production process, the condition of safety electrical equipment in relation to explosive atmospheres has to be verified and particular attention is to be paid to cable runs and connecting terminals, especially in the storage area.

# 10 Battery system

## 10.1 General

**10.1.1** The requirements of this Article apply to units which have been assigned the additional class notation **Battery system** as defined in Ch 1, Sec 3, [10.5].

## 10.2 Periodical survey

**10.2.1** The periodical survey (quarter term or intermediate) is to include:
- general examination of the battery pack(s)
- general examination of the battery monitoring system
- general examination of the battery support system
- general examination of the battery compartment, including visual check of the safety measures and functions related to battery spaces, i.e. battery installation, ventilation, fire safety measures and alarms
- check of the electrolyte level and pH level
- check of State of health (SOH) of battery system according to the Manufacturer's specification and verification that the battery capacity has been regularly recorded and complies with the parameters specified by the Manufacturer
- test of sensor and alarm associated to the battery at random
- undertaking of measurement of insulation of battery packs
- additional checks when some specific part of battery is or has been replaced (e.g. battery cells, BMS) according to the Manufacturer specification and to the satisfaction of the Surveyor.

### 10.3 Class renewal survey

**10.3.1** The requirements given in [10.2.1] for periodical survey are to be complied with.

In addition:

- a comprehensive test of indication and alarms is to be carried out
- the traceability of cells replacement is to be checked
- the traceability of software modification is to be checked
- a battery capacity (State of Health - SOH) test is to be witnessed when:
  - release of flammable or toxic gases during battery operation was identified (e.g. hydrogen for lead-acid batteries)
  - loss of battery might jeopardize operability of the harbour equipment.

## 11 Electric hybrid

### 11.1 General

**11.1.1** The requirements of this Article apply to units which have been assigned the additional class notation **Electric hybrid** as defined in Ch 1, Sec 3, [10.6].

### 11.2 Periodical survey

**11.2.1** The periodical survey (quarter term or intermediate) survey is to include:

- verification of proper working of monitoring systems
- verification of proper working of alarms and defaults and related functions and/or interfacing to the other harbour equipment systems
- disconnection of the ESS in different operating modes, and automatic start of stand by source, as necessary
- test of the fire detection of the battery compartment
- test of the gas detection system of the battery compartment
- examination of the fire-extinguishing system of the battery compartment as applicable in accordance with the relevant requirements given in Ch 3, Sec 2, [4.2]
- verification that accessibility for common maintenance and devices for battery overhaul, if any, are maintained.

**11.2.2** In addition to the requirements [11.2.1], for **PM** mode, the survey is to include:

- increasing load steps, as far as practicable. The ESS is to deliver power to the grid, to compensate for the load steps. In case of continuous load, the load is to be gradually transferred to the running diesel engine. The load is to be shared equally between the diesel engines (see NR217, Pt C, Ch 2, Sec 3, [2.6.3])
- additional increasing load steps, with load dependent start of a stand-by main generating set activated, as far as practicable.

**11.2.3** In addition to the requirements of [11.2.1], for **PB** mode, the survey is to include:

- failure of one generator and automatic connection of the ESS
- failure of one generator and ESS autonomy measurement (starting of the stand by generator is blocked)
- automatic start of a stand by source in case of failure of the ESS or low state of charge of the ESS.

**11.2.4** In addition to the requirements of [11.2.1], for **ZE** mode, the survey is to include:

automatic start of a stand by source in case of failure of the ESS or low state of charge of the ESS.

### 11.3 Class renewal survey

**11.3.1** In addition to the requirements given in [11.2.1] for annual survey the following requirements are to be complied with:

- verification of the quality of the power supply in the different modes
- examination of the fire-extinguishing system as applicable in accordance with the relevant requirements given in Ch 3, Sec 1, [3.6].

**11.3.2** In addition to the requirements of [11.3.1], for **PM** mode, the survey is to include:

confirmation of the capacity of the batteries by verification of the proper operation of the ESS during 6 hours at least in normal working condition; however, where proper record is maintained, consideration may be given to accepting recent records effected by the harbour equipment's personnel. The ESS state of charge is not to be less than 80% at the end of the 6 hours period. A load analysis curve corresponding to this period is to be submitted for information. This document is to detail the total electrical production on board, the main generating sets electrical production and the ESS electrical production (with charging and discharging cycles).

**11.3.3** In addition to the requirements of [11.3.1], for **ZE** mode, the survey is to include:

load discharge test with ESS autonomy measurement up to ESS state of charge low level.

**11.3.4** In addition to the requirements of [11.3.1], for **PB** and **ZE** modes, the survey is to include:

ESS charging test, with evaluation of charging current and time for complete charging of the batteries (to reach full charge, just after a full discharge, in the conditions defined by the load balance).

# 12 Units using low flashpoint liquid or gas fuels

## 12.1 General

**12.1.1** The requirements of this Article apply to all harbour equipment, which utilize gas or other low flashpoint fuels as a fuel for power generation arrangements and associated systems, or which have been assigned one of the following additional service features:

- **LNGfuel**
- **CNGfuel**
- **LPG fuel**
- **methanolfueL**, or
- **LFPfuel**

Note 1: these additional service features are always completed by **singlefuel** of **dualfuel** as defined in Ch 1, Sec 3, [1.2.5].

**12.1.2** These requirements apply in addition to those laid down in Ch 3, Sec 1 and Ch 3, Sec 2 as applicable.

These survey requirements do not cover fire protection, fire-fighting installation, and personnel protection equipment.

## 12.2 Periodical surveys - hull items

### 12.2.1 General

The following requirements are to be verified during the periodical survey (quarter term or intermediate) of the fuel storage, fuel bunkering system and fuel supply system.

The logbooks and operating records are to be examined with regard to correct functioning of the gas detection systems, fuel supply/gas systems, etc. The hours per day of the reliquefaction plant, gas combustion unit, as applicable, the boil-off rate, and nitrogen consumption (for membrane containment systems) are to be considered together with gas detection records.

The manufacturer/builder instructions and manuals covering the operations, safety and maintenance requirements and occupational health hazards relevant to fuel storage, fuel bunkering, and fuel supply and associated systems for the used of the fuel, are to be confirmed as being aboard the harbour equipment.

### 12.2.2 Gas related spaces, fuel preparation and handling rooms and piping

The periodical survey (quarter term or intermediate) is to include:

- examination of portable and fixed drip trays and insulation for the protection of the harbour equipment’s structure in the event of a leakage
- examination of electrical bonding arrangements in hazardous areas, including bonded straps where fitted.

### 12.2.3 Fuel storage, bunkering and supply systems

The following requirements are to be examined, so far as applicable. Insulation need not to be removed, but any deterioration or evidence of dampness is to be investigated.

For fuel storage, the survey is to include:

- external examination of the storage tanks including secondary barrier if fitted and accessible
- general examination of the fuel storage hold place
- internal examination of tank connection space
- external examination of tank and relief valves
- verification of satisfactory operation of tank monitoring system
- examination and testing of installed bilge alarms and means of drainage of the compartment
- testing of the remote and local closing of the installed main tank valve.

For fuel bunkering system, the survey is to include:

- examination of bunkering stations and the fuel bunkering system
- verification of the satisfactory operation of the fuel bunkering control, monitoring and shutdown systems.

For fuel supply system, during working condition as far as practicable, the survey is to include:

- verification of the satisfactory operation of the fuel supply system control, monitoring and shutdown systems
- testing of the remote and local closing of the master fuel valve for each engine compartment.

## 12.3 Periodical surveys - Gas fuel machinery items

### 12.3.1 Control, monitoring and safety systems

The periodical survey (quarter term or intermediate) is to include:

- confirmation that gas detection and other leakage detection equipment in compartments containing fuel storage, fuel bunkering, and fuel supply equipment or components or associated systems, including indicators and alarms are in satisfactory operating condition
- verification that recalibration of the gas detection systems is done in accordance with the manufacturer's recommendations.
- verification of the satisfactory operation of the control, monitoring and automatic shutdown systems as far as practicable of the fuel supply and bunkering systems
- operational test, as far as practicable, of the shutdown of ESD protected machinery spaces.

### 12.3.2 Fuel handling piping, machinery and equipment

The periodical survey (quarter term or intermediate) is to include:

- examination, as far as practicable, of piping, hoses, emergency shutdown valves, relief valves, machinery and equipment for fuel storage, fuel bunkering, and fuel supply such as venting, compressing, refrigerating, liquefying, heating, cooling or otherwise handling the fuel
- examination of the means for inerting
- confirmation, as far as practicable, of the stopping of pumps and compressors upon emergency shutdown of the system.

### 12.3.3 Venting systems

The periodical survey (quarter term or intermediate) is to include:

- examination of the ventilation system, including portable ventilating equipment where fitted, is to be made for spaces containing fuel storage, fuel bunkering, and fuel supply units or components or associated systems, including air locks, pump rooms, compressor rooms, fuel preparation rooms, fuel valve rooms, control rooms and spaces containing gas burning equipment
- operational test, as far as practicable, of alarms, such as differential pressure and loss of pressure, where fitted.

### 12.3.4 Hazardous areas

The periodical survey (quater term or intermediate) is to include:

- examination of electrical equipment and bulkhead/deck penetrations including access openings in hazardous areas, for continued suitability for their intended service and installation area.

## 12.4 Intermediate survey

**12.4.1** In addition to the applicable requirements in [12.2] and [12.3], the intermediate survey is also to include:

- random test of gas detectors, temperature sensors, pressure sensors, level indicators, and other equipment providing input to the fuel safety system, to confirm their satisfactory operating condition
- verification of the proper response of the fuel safety system upon fault conditions.

## 12.5 Class renewal survey - hull

### 12.5.1 General

The class renewal survey is to include, in addition to the survey requirements in [12.2], examinations, tests and checks of sufficient extent to ensure that the fuel installations are in satisfactory condition and fit for intended purpose for the new period of class to be assigned, subject to proper maintenance and operation and to periodical surveys being carried out at the due dates.

### 12.5.2 Fuel handling and piping

All piping for fuel storage, fuel bunkering, and fuel supply such as venting, compressing, refrigerating, liquefying, heating, storing, burning or otherwise handling the fuel and liquid nitrogen installations are to be examined.

Removal of insulation from the piping and opening for examination may be required.

Where deemed suspect, a hydrostatic test to 1,25 times the maximum allowable relief valve setting (MARVS) for the pipeline is to be carried out.

After reassembly, the complete piping is to be tested for leaks.

Where water cannot be tolerated and the piping cannot be dried prior to putting the system into service, the surveyor may accept alternative fluids or alternative means of testing.

### 12.5.3 Fuel valves

All emergency shutdown valves, check valves, block and bleed valves, master gas valves, remote operating valves, isolating valves for pressure relief valves in the fuel storage, fuel bunkering, and fuel supply piping systems are to be examined and proven operable.

A random selection of valves is to be opened for examination.

#### 12.5.4 Pressure relief valves

a) Fuel storage tank pressure relief valves

The survey is to include:

- opening for examination, adjustment and function test of the pressure relief valves for the fuel storage tanks
- if the tanks are equipped with relief valves with non-metallic membranes in the main or pilot valves, replacement of such non-metallic membranes.

b) Fuel supply and bunkering piping pressure relief valves

The survey is to include:

- opening for examination, adjustment and function test of pressure relief valves for the fuel supply and bunkering piping
- where a proper record of continuous overhaul and retesting of individually identifiable relief valves is maintained, consideration will be given to acceptance on the basis of opening, internal examination, and testing of a representative sampling of valves, including each size and type of liquefied gas or vapor relief valve in use, provided there is logbook evidence that the remaining valves have been overhauled and tested since crediting the previous class renewal survey.

c) Pressure/vacuum relief valves

The survey is to include:

- opening, examination, test and readjustment as necessary, depending on their design, of the pressure/vacuum relief valves, rupture disc and other pressure relief devices for interbarrier spaces and hold spaces.

#### 12.5.5 Fuel storage tanks

Fuel storage tanks are to be examined in accordance with an approved survey plan.

Liquefied gas fuel storage tanks are to be examined based on a survey/inspection plan, in which requirements for the survey of liquefied gas fuel containment systems are to be in accordance with the requirements laid down in [3.2], except as noted below:

- the tank insulation and tank support arrangements shall be visually examined. Non-destructive testing may be required if conditions raise doubt to the structural integrity
- vacuum insulated independent fuel storage tanks of simple geometric shape where fatigue and crack propagation is considered not to be critical, without access openings need not be examined internally. Where fitted, the vacuum monitoring system shall be examined and records should be reviewed.

### 12.6 Class renewal survey - Gas fuel machinery items

#### 12.6.1 Fuel handling equipment

Fuel pumps, compressors, process pressure vessels, inert gas generators, heat exchangers and other components used in connection with fuel handling are to be examined according to the requirement of Ch 3, Sec 1 and Ch 3, Sec 2, as applicable.

#### 12.6.2 Electrical equipment

The survey is to include:

- examination of electrical equipment to include the physical condition of electrical cables and supports, intrinsically safe, explosion proof, or increased features of electrical equipment
- function testing of pressurized equipment and associated alarms
- testing of systems for de-energizing electrical equipment which is not certified for use in hazardous areas
- electrical insulation resistance test of the circuit terminating in, or passing through, the hazardous zones and spaces is to be carried out.

#### 12.6.3 Safety systems

Gas detectors, temperature sensors, pressure sensors, level indicators, and other equipment providing input to the fuel safety system are to be tested to confirm satisfactory operating condition.

Proper response of the fuel safety system upon fault conditions is to be verified.

Pressure, temperature and level indicating equipment are to be calibrated in accordance with the manufacturer’s requirements.

## 13 Units using fuel cells

### 13.1 General

#### 13.1.1 Application

The requirements of this Article apply to harbour equipment which has been assigned the additional service feature **Fuelcell**.

These requirements apply in addition to the requirements applicable to the remainder of the harbour equipment given in [12] and other Sections of this Chapter.

## 13.2 Periodical surveys

### 13.2.1 General

The logbooks and operating records are to be examined with regard to correct functioning of the gas detection systems, fuel systems, etc. The hours per day of the gas combustion unit, as applicable, and the fuel cell operation are to be considered together with gas detection records.

The manufacturer/builder instructions and manuals covering the operations, safety and maintenance requirements and occupational health hazards relevant to systems for the use of fuel, are to be confirmed as being available onboard the harbour equipment.

### 13.2.2 Fuel cell spaces

The following requirements are to be examined, so far as applicable. Insulation need not to be removed, but any deterioration or evidence of dampness is to be investigated.

The periodical survey (quarter term or intermediate) is to include:

- confirmation of satisfactory operating condition of gas detection and other leakage detection equipment in fuel cell spaces or associated systems, including indicators and alarms as applicable
- verification of calibration of the gas detection systems in accordance with the manufacturers' recommendations
- operational test, as far as practicable, of the emergency shutdown system
- examination of the ventilation system, including portable ventilating equipment where fitted, for fuel cell spaces and associated air locks. Where alarms, such as differential pressure and loss of pressure alarms, are fitted, these are be operationally tested as far as practicable
- examination of means for inerting
- examination of the required fire protection and fire extinguishing system contained in fuel cell spaces and operational test, as far as practicable
- examination of electrical equipment and bulkhead/deck penetrations including access openings in hazardous areas for continued suitability for their intended service and installation area
- examination of portable and fixed drip trays and insulation for the protection of the harbour equipment's structure in the event of leakage
- examination of electrical bonding arrangements in hazardous areas, including bonding straps where fitted
- examination and testing of installed bilge alarms and means of drainage of the fuel cell space
- testing of the remote and local closing of the master fuel valve for each fuel cell space.

### 13.2.3 Fuel cell installation system

The periodical survey (quarter term or intermediate) is to include:

- examination of the fuel cell system installation during working condition as far as practicable
- verification of satisfactory operation of the fuel cell system installation control, monitoring and shut-down systems
- examination of piping, hoses, emergency shut-down valves, remote operating valves, relief valves, machinery and equipment for handling the fuel, as far as practicable
- examination of means for inerting
- verification of stopping of reformer, pumps and compressors upon emergency shutdown of the system, as far as practicable.

## 13.3 Intermediate surveys

### 13.3.1 General

In addition to the applicable requirements in [13.2], the intermediate survey is also to include:

- random test of gas detectors, temperature sensors, pressure sensors, level indicators, and other equipment providing input to the fuel safety system, to confirm their satisfactory operating condition
- verification of the proper response of the fuel safety system upon fault conditions.

## 13.4 Class renewal surveys

**13.4.1** The class renewal survey is to include, in addition to the requirements of the periodical surveys, examinations, tests and checks of sufficient extent to ensure that the fuel installations are in satisfactory condition and fit for intended purpose for the new period of class to be assigned, subject to proper maintenance and operation and to periodical surveys being carried out at the due dates.

**13.4.2** All fuel cell installation system piping are to be examined. Removal of insulation from the piping and opening for examination may be required. Where deemed suspect, a hydrostatic test to 1,25 times the Maximum Allowable Relief Valve Setting (MARVS) for the pipeline is to be carried out. After reassembly, the complete piping is to be tested for leaks. Where water cannot be tolerated and the piping cannot be dried prior to putting the system into service, the Surveyor may accept alternative testing fluids or alternative means of testing.

**13.4.3** All emergency shut-down valves, check valves, block and bleed valves, master gas valves, remote operating valves, isolating valves for pressure relief valves in the fuel cell installation system are to be examined and proven operable. A random selection of valves is to be opened for examination.

**13.4.4** The survey is to include:

- examination of electrical equipment to include the physical condition of electrical cables and supports, intrinsically safe, explosion proof, or increased safety features of electrical equipment
- functional testing of pressurized equipment and associated alarms
- testing of systems for de-energizing electrical equipment which is not certified for use in hazardous areas
- an electrical insulation resistance test of the circuits terminating in, or passing through, the hazardous zones and spaces.

**13.4.5** Gas detectors, temperature sensors, pressure sensors, level indicators, and other equipment providing input to the fuel safety system are to be tested to confirm satisfactory operating condition.

**13.4.6** Proper response of the fuel safety system upon fault conditions is to be verified.

**13.4.7** Pressure, temperature and level indicating equipment are to be calibrated in accordance with the manufacturer's requirements.

**13.4.8** Fuel pumps, compressors, process pressure vessels, inert gas generators, heat exchangers and other components used in connection with fuel handling and parts of the fuel cell installation systems are to be examined according to the requirement defined in other Sections of this Chapter, as applicable.

In addition to the inspections required at the periodical surveys, the following is to be carried out:

a) an internal examination of:
   - the inert gas generator, where fitted
   - the scrubber
   - the deck water seal including the non-return valve
   - the pressure/vacuum breaking device
   - the cooling water systems including overboard discharge from the scrubber
   - all valves

b) a test to verify the proper operation of the system upon completion of all survey checks.

# Section 4 Bottom Survey

## 1 General

### 1.1

**1.1.1** Examinations of the outside of harbour equipment's bottom and related items of harbour equipment is normally to be carried out with the harbour equipment in dry-dock or on a slipway. However, consideration may be given to alternate examination while the harbour equipment is afloat as an in-water survey, subject to provisions of Ch 2, Sec 2, [5.4] and Article [3].

## 2 Dry dock survey

### 2.1 General

**2.1.1** Harbour equipment are generally to be subjected to a bottom survey once during the class period. As a matter of principle, class renewal includes a bottom survey in dry-dock.

**2.1.2** Intermediate surveys are to be carried out in dry-dock in the following cases:

- the harbour equipment's shell is riveted, at the Surveyor's discretion
- the harbour equipment's age exceeds 4**p** years, at the Surveyor's discretion.
- the harbour equipment's age exceeds 4**p** years and the service notation granted is floating storage for storing of liquid or gaseous dangerous products
- the harbour equipment is granted with the additional service feature $\mathbf{H_S(1{,}2 < x \le 2)}$, at the Society's discretion.

Moreover, for each bottom survey performed in addition to the bottom surveys stipulated by the classification requirements a Society's Surveyor is to be called to attend.

### 2.2 Performance of dry dock survey

#### 2.2.1 General

For the survey, the harbour equipment is to be placed on sufficiently high and secure blocks, so that all necessary examinations can be carried out in a satisfactory manner. It may be necessary to clean the bottom and outer shell and/or remove rust from some areas to the Surveyor's satisfaction.

#### 2.2.2 Hull bottom survey

The survey covers an examination of the bottom and side plates of the shell plating, including any attachments, the scuppers and water drain pipes, including their closures.

## 3 In-water survey

### 3.1 General

**3.1.1** In particular circumstances, in-water survey, the extent of which is subject to preliminary agreement of the Society, may be performed under the conditions set out in [3.2] to [3.4].

### 3.2 Approval

**3.2.1** The diving firm assisting to in-water surveys must be approved by the Society for this purpose according to the Society's procedures.

### 3.3 Performance of survey

**3.3.1** Unless accessible from outside with the aid of the harbour equipment's trim and/or heel, underwater parts are to be surveyed and/or relevant maintenance work is to be carried out with assistance by a diver whose performance is controlled by a Surveyor, using an underwater camera with monitor, communication and recording systems.

**3.3.2** Surveys of the underwater body are to be carried out in sufficiently clear and calm waters.

The harbour equipment is to be in light weight condition.

The shell sides below the waterline and the bottom are to be free from fouling.

**3.3.3** The underwater pictures on the surface monitor screen are to offer reliable technical information such as to enable the Surveyor to judge the parts and/ or the areas surveyed.

**3.3.4** Documentation suited for video reproduction including voice is to be made available to Society.

### 3.4 Additional examinations

**3.4.1** Where, for instance, grounding is assumed to have taken place, the Surveyor may demand individual parts of the underwater body to be additionally inspected from inside.

If during the in-water survey damages are found which can be assessed reliably only in dry-dock or require immediate repair, the harbour equipment is to be dry docked. If the coating of the underwater body is in a condition which may cause corrosion damages affecting harbour equipment's class to occur before the next dry docking, the harbour equipment is to be dry docked.

NR612

# RULES FOR THE CLASSIFICATION OF HARBOUR EQUIPMENT

## Part B
## Hull Design and Construction



March 2023

Part B
Hull Design and Construction

# CHAPTER 1
# GENERAL

# Section 1 Application

## 1 General

### 1.1 Structural requirements

**1.1.1** Part B contains the requirements for the determination of the minimum hull scantlings, applicable to all harbour equipment operated in smooth stretches of water (see Pt A, Ch 1, Sec 1, [1.2.11] for definition).

These requirements are to be integrated with those specified in Part D, for any individual harbour equipment type, depending on the class notations assigned to the harbour equipment.

**1.1.2** The requirements of Part B and Part D are to be complemented by applicable requirements of the Society's Rule Notes/ Guidance Note:

- NR561 Hull in Aluminium alloys, for harbour equipment assigned additional service feature **A**
- NR546 Hull in Composite Materials and Plywood, for harbour equipment assigned additional service feature **C** or **W**
- NI594 Design and Construction of Offshore Concrete Structures, for harbour equipment assigned additional service feature **CR**.

**1.1.3** Harbour equipment operated on water stretches with conditions different from those mentioned in [1.1.1], are to be assigned a corresponding operating area-related additional service feature in compliance with the requirements set out in Pt A, Ch 1, Sec 3, [1.2.4] and Pt D, Ch 8, Sec 4.

**1.1.4** Harbour equipment with novel features or unusual hull design is to be individually considered by the Society, on the basis of the principles and criteria adopted in this Rule Note.

**1.1.5** The harbour equipment's structure is to be checked by the Designer to make sure that it withstands the loads resulting from the towing.

**1.1.6** The strength of the harbour equipment constructed and maintained according to this Rule Note is sufficient for the scantling draught considered when applying the Rules.

### 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 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 harbour equipment's structure are considered as fixed parts.

**1.2.2** The fixed parts of lifting appliances and their connections to the harbour equipment's structure are covered by the Rules, even when the certification of lifting appliances is not required.

## 2 Rule application

### 2.1 Harbour equipment parts

#### 2.1.1 General

For the purpose of application of this Rule Note, the harbour equipment is considered as divided into the following parts:

- central part
- end parts.

#### 2.1.2 Central part

The central part includes the structures within the region extending over 0,5 L through the midship section.

#### 2.1.3 End parts

The end parts include the structures of the peaks and those located in the part extending over 0,1 L beyond the end bulkheads.

# 3 Rounding off of scantlings - Metallic hulls

## 3.1 Plate thicknesses

**3.1.1** The rounding off of plate thicknesses is to be obtained from the following procedure:

a) The net thickness (see Ch 2, Sec 4, [2]) is calculated in accordance with the rule requirements

b) Corrosion addition $t_C$ (see Ch 2, Sec 4, [3]) is added to the calculated net thickness, and the gross thickness obtained is rounded off to the nearest half-millimetre

c) The rounded net thickness is taken equal to the rounded gross thickness obtained in item b), minus the corrosion additions $t_C$.

## 3.2 Stiffener section moduli

**3.2.1** Stiffener section moduli as calculated in accordance with the rule requirements are to be rounded off to the nearest standard values; however, no reduction may exceed 3%.

# Section 2 Symbols and Definitions

## 1 Units

### 1.1

**1.1.1** Unless otherwise specified, the units used in the Rules are as indicated in Tab 1.

**Table 1 : Units**

| Designation | Usual symbol | Units |
|---|---|---|
| Unit's dimensions | see [2] | m |
| Hull girder section modulus | Z | $cm^3$ |
| Density | ρ | $t/m^3$ |
| Concentrated loads | P | kN |
| Linearly distributed loads | q | kN/m |
| Surface distributed loads (pressure) | p | $kN/m^2$ |
| Thickness | t | mm |
| Span of ordinary stiffeners and primary supporting members | $\ell$ | m |
| Spacing of ordinary stiffeners and primary supporting members | s, S | m |
| Bending moment | M | kN.m |
| Shear force | Q | kN |
| Stresses | σ, τ | $N/mm^2$ |
| Section modulus of ordinary stiffeners and primary supporting members | w | $cm^3$ |
| Sectional area of ordinary stiffeners and primary supporting members | A | $cm^2$ |

## 2 Symbols

### 2.1

**2.1.1**

L : Rule length, in m, defined in [3.1]

B : Breadth, in m, defined in [3.3]

D : Depth, in m, defined in [3.4]

T : Draught, in m, defined in [3.5]

$L_{OA}$ : Length overall, in m, defined in [3.6]

$L_{WL}$ : Length of waterline, in m, defined in [3.7]

Δ : Displacement, in ton, at draught T

r : Water density, in $t/m^3$

- $\rho = 1,025\ t/m^3$, for sea water
- $\rho = 1\ t/m^3$, for other water areas

$C_B$ : Block coefficient:

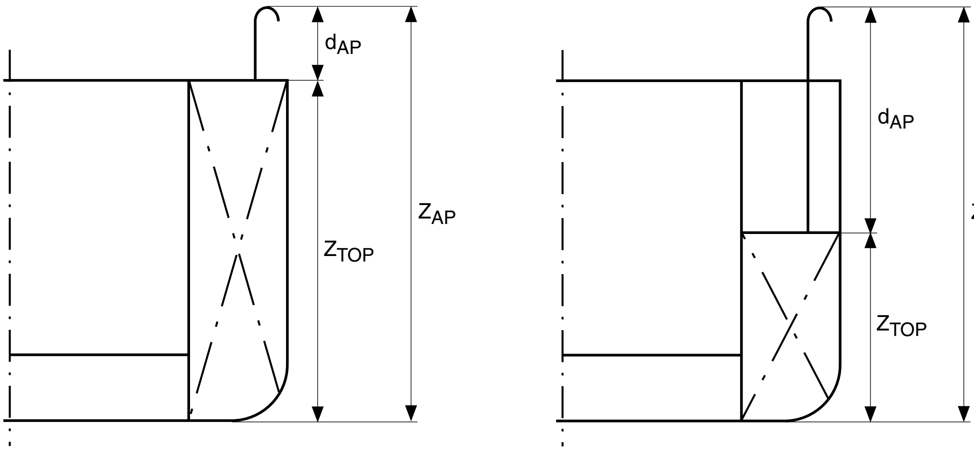
$$C_B = \frac{\Delta}{\rho L \cdot B \cdot T}$$

$d_{AP}$ : Distance from the top of the air pipe of the top of the tank, in m, see Fig 1

$z_{TOP}$ : Z co-ordinate, in m, of the highest point of the tank or compartment, see Fig 1

$z_{AP}$ : Z co-ordinate, in m, of the top of air pipe, see Fig 1.

**Figure 1 : Definitions**




## 3 Definitions

### 3.1 Rule length

**3.1.1** The rule length L is the distance, in m, taken equal to the length at the load waterline.

For harbour equipment with unusual end arrangements, the rule length L will be considered by the Society on a case-by-case basis.

### 3.2 Ends of rule length and midship

**3.2.1** The end perpendiculars are the perpendiculars to the load waterline at the ends of the distance L.

The midship corresponds to the perpendicular to the waterline at a distance 0,5L from end perpendiculars.

### 3.3 Breadth

**3.3.1** The breadth B is the greatest moulded breadth, in m, measured amidships below the upper deck.

### 3.4 Depth

**3.4.1** The depth D is the distance, in m, measured vertically at the midship transverse section, from the moulded base line to the top of the deck beam at side on the upper most continuous deck.

In the case of a harbour equipment with a solid bar keel, the moulded base line is to be taken at the intersection between the upper face of the bottom plating and the solid bar keel.

### 3.5 Scantling draught

**3.5.1** The scantling draught T is the distance, in m, measured vertically at the midship transverse section, from the moulded base line to the waterline at which the strength requirements for the scantling of the harbour equipment are met. It represents the full load condition and is to be not less than that corresponding to the assigned freeboard.

In the case of a harbour equipment with a solid bar keel, the moulded base line is to be taken as defined in [3.4].

### 3.6 Length overall

**3.6.1** The length overall $L_{OA}$ is the extreme length of the harbour equipment, in m.

### 3.7 Length of waterline

**3.7.1** The length of waterline $L_{WL}$ is the length of the hull, in m, measured at the maximum draught.

### 3.8 Superstructure

**3.8.1** A superstructure is a decked structure connected to the strength deck defined in [3.10], extending from side to side of the harbour equipment or with the side plating not being inboard of the shell plating more than 0,04 B.

### 3.9 Deckhouse

**3.9.1** A deckhouse is a decked structure other than a superstructure, located on the strength deck defined in [3.10] or above.

### 3.10 Strength deck

**3.10.1** The strength deck (main deck) is the uppermost continuous deck contributing to the hull girder longitudinal strength.

### 3.11 Weather deck

**3.11.1** The weather deck is the uppermost continuous exposed deck.

### 3.12 Bulkhead deck

**3.12.1** The bulkhead deck is the uppermost deck up to which the transverse watertight bulkheads and the shell are carried.

### 3.13 Cofferdam

**3.13.1** A cofferdam means an empty space arranged so that compartments on each side have no common boundary; a cofferdam may be located vertically or horizontally. As a rule, a cofferdam is to be properly ventilated and of a sufficient size to allow for inspection.

### 3.14 Weathertight

**3.14.1** "Weathertight" is the term used to a closure or a structure which prevents water from penetrating into the harbour equipment under any service conditions. Weathertight designates structural elements or devices which are so designed that the penetration of water inside the harbour equipment is prevented:

- for one minute when they are subjected to pressure corresponding to a 1 m head of water, or
- for ten minutes when they are exposed to the action of jet of water with a minimum pressure of 1 bar in all directions over their entire area.

The following constructions are regarded as weathertight:

- weathertight doors complying with ISO 6042
- ventilation flaps complying with ISO 5778
- air pipe heads of automatic type and of approved design.

Weathertightness is to be proven by hose tests or equivalent tests accepted by the Society before installing.

### 3.15 Watertight

**3.15.1** "Watertight" designates structural elements or devices which meet all the conditions stated for weathertightness and also remain tight at the anticipated internal and external pressures.

Watertightness is to be proven by workshop testing and, where applicable, by type approvals in combination with construction drawings (e.g. watertight sliding doors, cable penetrations through watertight bulkheads).

## 4 Reference co-ordinates

### 4.1 General

**4.1.1** The harbour equipment's geometry, motions, accelerations and loads are defined with respect to the following right-hand co-ordinate system:

- Origin: intersection point of the longitudinal plane of symmetry of the harbour equipment, one end of L and the baseline
- X-axis: longitudinal axis, positive towards the other end
- Y-axis: transverse axis, positive towards portside
- Z-axis: vertical axis, positive upwards.

**4.1.2** Positive rotations are oriented in anti-clockwise direction about the X, Y and Z axes.

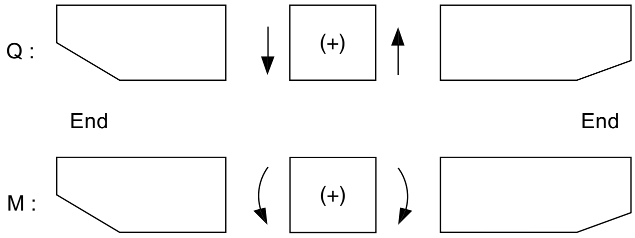
## 5 Sign conventions for vertical hull girder loads

### 5.1 General

**5.1.1** The sign conventions of vertical bending moments and shear forces at any harbour equipment transverse section are as shown in Fig 2, 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 transverse section under consideration; it is negative in the opposite case.

**Figure 2 : Sign conventions for shear forces Q and bending moments M**



Part B
Hull Design and Construction

# CHAPTER 2
# HULL STRUCTURAL PRINCIPLES

# Section 1 General Arrangement Design

## 1 Subdivision arrangement

### 1.1 General

**1.1.1** Harbour equipment is to be provided with appropriate subdivisions ensuring safe operations, stability and global structural strength.

Harbour equipment is to have at least the following transverse watertight bulkheads:

- two end bulkheads
- two bulkheads forming the boundaries of the machinery space, if fitted.

### 1.2 Height of transverse watertight bulkheads

**1.2.1** Transverse watertight bulkheads are to extend up to the bulkhead deck.

### 1.3 Openings in watertight bulkheads

**1.3.1** Certain openings below the bulkhead deck are permitted in bulkheads other than the end bulkheads, but these are to be:

- kept to a minimum compatible with the design and proper working of the harbour equipment, and
- provided with watertight doors having strength such as to withstand the head of water to which they may be subjected.

### 1.4 Watertight doors

**1.4.1** Doors cut out in watertight bulkheads are to be fitted with watertight closing appliances. The arrangements to be made concerning these appliances are to be approved by the Society.

**1.4.2** Thickness of the watertight doors is to be not less than that of the adjacent bulkhead plating, taking account of their actual framing spacing.

**1.4.3** Where vertical stiffeners are cut in way of watertight doors, reinforced stiffeners are to be fitted on each side of the door and suitably overlapped; cross-bars are to be provided to support the interrupted stiffeners.

## 2 Compartment arrangement

### 2.1 Cofferdams

**2.1.1** Cofferdams are to be provided between:

- fuel oil tanks and lubricating oil tanks
- compartments intended for liquid hydrocarbons (fuel oil, lubricating oil) and compartments intended for fresh water (drinking water, water for auxiliary machinery and boilers)
- compartments intended for liquid hydrocarbons (fuel oil, lubricating oil) and tanks intended for the carriage of liquid foam for fire extinguishing.

**2.1.2** Cofferdams separating:

- fuel oil tanks from lubricating oil tanks
- lubricating oil tanks from compartments intended for fresh water or boiler feed water
- lubricating oil tanks from those intended for the carriage of liquid foam for fire extinguishing.

may not be required when deemed impracticable or unreasonable by the Society in relation to the characteristics and dimensions of the spaces containing such tanks, provided that:

- the thickness of common boundary plates of adjacent tanks is increased, with respect to the thickness obtained according to Ch 4, Sec 2 by 2 mm in the case of tanks carrying fresh water or boiler feed water, and by 1 mm in all other cases
- the sum of the throats of the weld fillets at the edges of these plates is not less than the thickness of the plates themselves
- the structural test is carried out with a head increased by 1 m with respect to Ch 6, Sec 4.

**2.1.3** Spaces intended for the carriage of flammable liquids are to be separated from accommodation and service spaces by means of a cofferdam. Where accommodation and service spaces are arranged immediately above such spaces, the cofferdam may be omitted only where the deck is not provided with access openings and is coated with a layer of material recognized as suitable by the Society.

The cofferdam may also be omitted where such spaces are adjacent to a passageway, subject to the conditions stated in [2.1.2] for fuel oil or lubricating oil tanks.

**2.1.4** Where a corner to corner situation occurs, tanks are not be considered to be adjacent.

Adjacent tanks not separated by cofferdams are to have adequate dimensions to ensure easy inspection.

### 2.2 Compartments located beyond the end bulkheads

**2.2.1** The peaks and other compartments located beyond the end bulkheads cannot be used for the carriage of fuel oil or other flammable products.

## 3 Access arrangement

### 3.1 Double bottom

#### 3.1.1 Inner bottom manholes

Inner bottom manholes are to be not less than 0,40 m x 0,40 m. Their number and location are to be so arranged as to provide convenient access to any part of the double bottom.

Inner bottom manholes are to be closed by watertight plate covers.

Doubling plates are to be fitted on the covers, where secured by bolts.

Where no ceiling is fitted, covers are to be adequately protected from damage.

#### 3.1.2 Floor and girder manholes

Manholes are to be provided in floors and girders so as to provide convenient access to all parts of the double bottom.

The size of manholes and lightening holes in floors and girders is, in general, to be less than 50 per cent of the local height of the double bottom.

Where manholes of greater sizes are needed, edge reinforcement by means of flat bar rings or other suitable stiffeners may be required.

Manholes may not be cut in the continuous centreline girder or in floors and girders below pillars, except where allowed by the Society, on a case-by-case basis.

### 3.2 Access to tanks

**3.2.1** Tanks and subdivisions of tanks having lengths of 35 m and above are to be fitted with at least two access hatchways and ladders, as far apart as practicable longitudinally.

Tanks less than 35 m in length are to be served by at least one access hatchway and ladder.

**3.2.2** The dimensions of any access hatchway are to be sufficient to allow a person wearing a self-contained breathing apparatus to ascend or descend the ladder without obstruction and also to provide a clear opening to facilitate the hoisting of an injured person from the bottom of the tank. In no case is the clear opening to be less than 0,36 $m^2$ and its length 0,50 m.

### 3.3 Access within tanks

#### 3.3.1 Manholes

Where manholes are fitted, access is to be facilitated by means of steps and hand grips with platform landings on each side.

### 3.4 Access to side tanks

**3.4.1** Where openings allowing access to side tanks are cut in the stringer plate, they are to be arranged clear of the hatch corners and to be of even-deck design, without obstacles causing stumbling. In order to assure the continuity of the strength, they are to be cut smooth along a well rounded design and are to be strengthened by thick plates, by doubling plates or by other equivalent structure.

# Section 2 Materials

## 1 General

### 1.1 Characteristics of materials

**1.1.1** The characteristics of the materials to be used in the construction of harbour equipment are to comply with the applicable requirements of NR216 Materials and Welding.

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 NR216 Materials and Welding.

### 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 NR216 Materials and Welding. In particular:

- parent material and welding processes are to be 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.

### 1.4 Dimensional tolerances

#### 1.4.1 Plates and wide flats

For plates and wide flats, an under thickness tolerance of 0,3 mm is permitted.

#### 1.4.2 Sections and bars

For sections and bars, the under thickness tolerance is to be in accordance with the requirements of a recognized international or national standard.

## 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 floating harbour equipment.

**2.1.2** High 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 yield stress $R_{eH}$ greater than 235 N/mm$^2$ are used, hull scantlings are to be determined taking into account the material factor k defined in [2.3.1].

**2.1.4** When no other information is available, the minimum yield stress $R_{eH}$ and the Young's modulus E of steels used at temperatures between 90°C and 300°C may be taken respectively equal to:

$$R_{eH} = R_{eH0}\left(1,04 - \frac{0,75}{1000}\theta\right)$$

$$E = E_0\left(1,03 - \frac{0,5}{1000}\theta\right)$$

where:

$R_{eH0}$ : Value of the minimum yield stress at ambient temperature

$E_0$ : Value of the Young's modulus at ambient temperature

$\theta$ : Service temperature, in °C.

**2.1.5** Characteristics of steels with specified through thickness properties are given in NR216 Materials and Welding, Ch 2, Sec 1, [9].

**Table 1 : Mechanical properties of hull steels**

| Steel grades ($t \leq 100$ mm) | Minimum yield stress $R_{eH}$, in N/mm² | Ultimate minimum tensile strength $R_m$, in N/mm² |
|---|---|---|
| A - B - D | 235 | 400 - 520 |
| A32 - D32 | 315 | 440 - 570 |
| A36 - D36 | 355 | 490 - 630 |
| A40 - D40 **(1)** | 390 | 510 - 660 |
| **(1)** $t \leq 50$ mm | | |

## 2.2 Information to be kept on board

**2.2.1** It is advised to keep on board a plan indicating the steel types and grades adopted for the hull structure. 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.

## 2.3 Material factor k

**2.3.1** Unless otherwise specified, the material factor k is defined in Tab 2 as a function of the minimum yield stress $R_{eH}$.

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

Steel with a yield stress lower than 235 N/mm² or greater than 390 N/mm² are considered by the Society on a case-by-case basis.

**Table 2 : Material factor k**

| $R_{eH}$, in N/mm² | k |
|---|---|
| 235 | 1,00 |
| 315 | 0,78 |
| 355 | 0,72 |
| 390 | 0,68 |

## 2.4 Grades of steels

### 2.4.1 Normal strength steel grades A, B and D

The distribution of the normal strength steel grades used in the central part is indicated in Tab 3.

Steel of grade D may be required for members consisting in plates more than 20 mm thick in highly stressed areas.

**Table 3 : Distribution of steel grades in the central part - Normal strength steels**

| | $t \leq 15$ | $15 < t \leq 20$ | $t > 20$ |
|---|---|---|---|
| Bilge and topside structure **(1)** | A | B | D |
| Side shell | A | A | A |
| Deck and bottom | A | A | B |
| Deck plates at the hatch corners | A | B | D |
| **(1)** Sheerstrake and stringer plate as well as longitudinal hatch coaming and trunk longitudinal bulkhead, if fitted.<br>**Note 1:**<br>t : Structural member gross thickness, in mm. | | | |

### 2.4.2 High tensile strength structural steel grades AH and DH

The distribution of the high tensile strength steel grades used in the central part is given in Tab 4.

Outside the central part, the thickness of high tensile strength steel is to be kept unchanged until the region where the thickness of ordinary steel is the same for the harbour equipment considered.

**Table 4 : Distribution of steel grades in the central part - High tensile strength steels**

| | t ≤ 20 | t > 20 |
|---|---|---|
| Bilge and topside structure **(1)** | AH | DH |
| Side shell | AH | AH |
| Deck and bottom | AH | DH |
| Deck plates at the corners of long hatches | AH | DH |
| **(1)** Sheerstrake and stringer plate as well as longitudinal hatch coaming and trunk longitudinal bulkhead, if fitted.<br>**Note 1:**<br>t : Structural member gross thickness, in mm. | | |

**2.4.3** For strength members not mentioned in Tab 3 and Tab 4, grade A/AH may generally be used.

**2.4.4** The steel grade is to correspond to the as-fitted gross thickness when this one is greater than the gross thickness obtained from the net thickness required by the Rules according to Ch 2, Sec 4, [1].

#### 2.4.5 Grades of steel for structures exposed to low temperatures

The selection of steel grades to be used for the structural members exposed to low temperatures (–20°C or below) is to be in compliance with the applicable requirements of NR216 Materials and Welding.

## 3 Aluminium alloys for hull structure

### 3.1 General

**3.1.1** The characteristics of aluminium alloys are to comply with the requirements of NR216 Materials and Welding, Ch 3, Sec 2.

Series 5000 aluminium-magnesium alloys or series 6000 aluminium-magnesium-silicon alloys are generally to be used (see NR216 Materials and Welding, Ch 3, Sec 2, [2]).

**3.1.2** In the case of structures subjected to low service temperatures or intended for other specific applications, the alloys to be employed are to be agreed by the Society.

**3.1.3** Unless otherwise agreed, the Young's modulus for aluminium alloys is equal to 70000 N/mm$^2$ and the Poisson's ratio equal to 0,33.

### 3.2 Extruded plating

**3.2.1** Extrusions with built-in plating and stiffeners, referred to as extruded plating, may be used.

**3.2.2** In general, the application is limited to decks, bulkheads, superstructures and deckhouses. Other uses may be permitted by the Society on a case by case basis.

**3.2.3** Extruded plating is preferably to be oriented so that the stiffeners are parallel to the direction of main stresses.

**3.2.4** Connections between extruded plating and primary members are to be given special attention.

### 3.3 Mechanical properties of weld joints

**3.3.1** Welding heat input lowers locally the mechanical strength of aluminium alloys hardened by work hardening (series 5000 other than condition 0 or H111) or by heat treatment (series 6000).

**3.3.2** The as-welded properties of aluminium alloys of series 5000 are in general those of condition 0 or H111.

Higher mechanical characteristics may be taken into account, provided they are duly justified.

**3.3.3** The as-welded properties of aluminium alloys of series 6000 are to be agreed by the Society.

### 3.4 Minimum yield stress

**3.4.1** The minimum yield stress of aluminium $R_y$, in N/mm$^2$, used for the scantling criteria of the hull structure is to be taken, unless otherwise specified, equal to:

$$R_y = R'_{lim}$$

where:

$R'_{lim}$ : Minimum specified yield stress of the parent metal in welded condition $R'_{p0,2}$, in N/mm², but not to be taken greater than 70% of the minimum specified tensile strength of the parent metal in welded condition $R'_m$, in N/mm².

$R'_{p0,2} = \eta_1 R_{p0,2}$

$R'_m = \eta_2 R_m$

$R_{p0,2}$ : Minimum specified yield stress, in N/mm², of the parent metal in delivery condition

$R_m$ : Minimum specified tensile stress, in N/mm², of the parent metal in delivery condition

$\eta_1$ , $\eta_2$ : Coefficients defined in Tab 5.

### 3.5 Material factor

**3.5.1** The material factor k for aluminium alloys is to be obtained from the following formula:

$$k = \frac{100}{R'_{lim}}$$

**3.5.2** In the case of welding of two different aluminium alloys, the material factor k to be considered for the scantlings of welds is to be the greater material factor of the aluminium alloys of the assembly.

**3.5.3** For welded constructions in hardened aluminium alloys (series 5000 other than condition 0 or H111 and series 6000), greater characteristics than those in welded condition may be considered, provided that welded connections are located in areas where stress levels are acceptable for the alloy considered in annealed or welded condition.

**Table 5 : Aluminium alloys for welded construction**

| Aluminium alloy | $\eta_1$ | $\eta_2$ |
|---|---|---|
| Alloys without work-hardening treatment (series 5000 in annealed condition 0 or annealed flattened condition H111) | 1 | 1 |
| Alloys hardened by work hardening (series 5000 other than condition 0 or H111) | $R'_{p0,2}/R_{p0,2}$ | $R'_m / R_m$ |
| Alloys hardened by heat treatment (series 6000) **(1)** | $R'_{p0,2}/R_{p0,2}$ | 0,6 |

**(1)** When no information is available, coefficient $\eta_1$ is to be taken equal to the metallurgical efficiency coefficient β defined in Tab 6.

**Note 1:**

$R'_{p0,2}$ : Minimum specified yield stress, in N/mm², of material in welded condition (see [3.3])

$R'_m$ : Minimum specified tensile stress, in N/mm², of material in welded condition (see [3.3]).

**Table 6 : Aluminium alloys Metallurgical efficiency coefficient β**

| Aluminium alloy | Temper condition | Gross thickness, in mm | β |
|---|---|---|---|
| 6005 A (Open sections) | T5 or T6 | t ≤ 6 | 0,45 |
| | | t > 6 | 0,40 |
| 6005 A (Closed sections) | T5 or T6 | All | 0,50 |
| 6061 (Sections) | T6 | All | 0,53 |
| 6082 (Sections) | T6 | All | 0,45 |

## 4 Composite materials and plywood for hull structure

### 4.1 Characteristics and testing

**4.1.1** The characteristics of the composite materials and plywood and their testing and manufacturing process are to comply with the applicable requirements of NR546 Composite Ships, in particular for the:

- raw materials
- laminating process
- mechanical tests and raw material homologation.

### 4.2 Application

**4.2.1** Attention is drawn to the use of composite and/or plywood materials from the point of view of structural fire protection. Regulations of the harbour equipment flag may entail in some cases a limitation in the use of composite and/or plywood materials.

# 5 Other materials

## 5.1 General

**5.1.1** Other materials and products such as parts made of iron castings, where allowed, products made of copper and copper alloys, rivets, cranes, masts, derricks, accessories and wire ropes are generally to comply with the applicable requirements of NR216 Materials and Welding.

**5.1.2** Materials used in welding processes are to comply with the applicable requirements of NR216 Materials and Welding.

# Section 3 Structural Detail Principles

## Symbols

$b_f$ : Face plate width, in mm, of an ordinary stiffener or a primary supporting member, as the case may be

$h_w$ : Web height, in mm, of an ordinary stiffener or a primary supporting member, as the case may be

k : Material factor defined in:

- Ch 2, Sec 2, [2.3.1] for steel
- Ch 2, Sec 2, [3.5.1] for aluminium alloys

$k_0$ : Coefficient to be taken equal to:

- $k_0 = 1$ for steel
- $k_0 = 2,35$ for aluminium alloys

$\ell$ : Span, in m, of an ordinary stiffener or a primary supporting member, as the case may be, measured between the supporting members

I : Moment of inertia, in $cm^4$, of an ordinary stiffener or a primary supporting member, as the case may be, without attached plating, around its neutral axis parallel to the plating

$I_B$ : Moment of inertia, in $cm^4$, of an ordinary stiffener or a primary supporting member, as the case may be, with bracket and without attached plating, around its neutral axis parallel to the plating, calculated at mid-length of the bracket

$R_y$ : Minimum yield stress, in $N/mm^2$, of the material to be taken equal to:

- $R_y = 235/k$ $N/mm^2$ for steel
- $R_y = 100/k$ $N/mm^2$ for aluminium alloys

unless otherwise specified

$R_{eH}$ :

- for hull structural steels:
  Minimum yield stress, in $N/mm^2$
- for aluminium alloys:
  - in general
    Minimum yield stress of the parent metal in delivery condition $R_{P0,2}$, in $N/mm^2$
  - for buckling of pillars
    Minimum yield stress of the parent metal in welded condition $R'_{P0,2}$, in $N/mm^2$

S : Spacing, in m, of primary supporting members

s : Spacing, in m, of ordinary stiffeners

$t_w$ : Web thickness, in mm, of an ordinary stiffener or a primary supporting member, as the case may be

$t_f$ : Face plate thickness, in mm, of an ordinary stiffener or a primary supporting member, as the case may be

$t_p$ : Thickness, in mm, of the plating attached to an ordinary stiffener or a primary supporting member, as the case may be

w : Section modulus, in $cm^3$, of an ordinary stiffener or primary supporting member, as the case may be, with an attached plating of width $b_p$

## 1 General

### 1.1 Application

#### 1.1.1 Metallic structures

The requirements of the present Section apply to longitudinally or transversely framed structure arrangement of hulls built in metallic materials.

Any other arrangement may be considered, on a case-by-case basis.

Additional structure design principles in relation to specific notations are defined in Part D.

#### 1.1.2 Composite and plywood structure

Equivalent arrangement for hulls built in composite materials and/or plywood is defined in NR546 Composite Ships.

## 2 General strength principles

### 2.1 Structural continuity

**2.1.1** The variation in scantlings between the midship region and the end parts is to be gradual.

**2.1.2** The structural continuity is to be ensured:

- in way of changes in the framing system
- at the connections of primary or ordinary stiffeners
- in way of ends of end parts and machinery space
- in way of ends of superstructures.

**2.1.3** Longitudinal members contributing to the hull girder longitudinal strength are to extend continuously for a sufficient distance towards the ends of the harbour equipment.

Ordinary stiffeners contributing to the hull girder longitudinal strength are generally to be continuous when crossing primary supporting members. Otherwise, the detail of connections is considered by the Society on a case-by-case basis.

Longitudinals of the bottom, bilge, sheerstrake, deck, upper and lower longitudinal bulkhead and inner side strakes, as well as the latter strakes themselves, the lower strake of the centreline bottom girder and the upper strake of the centreline deck girder, where fitted, are to be continuous through the transverse bulkheads of the central part and cofferdams. Alternative solutions may be examined by the Society on a case-by-case basis, provided they are equally effective.

**2.1.4** Where stress concentrations may occur in way of structural discontinuities, adequate compensation and reinforcements are to be provided.

**2.1.5** Openings are to be avoided, as far as practicable, in way of highly stressed areas.

Where necessary, the shape of openings is to be specially designed to reduce the stress concentration factors.

Openings are to be generally well rounded with smooth edges.

Generally, the radius of openings corners is to be not less than 50 mm. In way of highly stressed areas, the radius is to be taken as the greater of 50 mm and 8% of the opening width.

**2.1.6** Primary supporting members are to be arranged in such a way that they ensure adequate continuity of strength.

Abrupt changes in height or in cross-section are to be avoided.

### 2.2 Structural continuity - Multihull platform

**2.2.1** Attention is to be paid to the structural continuity of the primary transverse cross structure of the platform ensuring the global transverse resistance of the multihull.

The primary transverse cross structure of catamaran is generally to be continuous when crossing float structures.

The general continuity principles defined in [2.1] apply also

to the primary transverse cross structure of the platform.

### 2.3 Connections with higher strength steel

**2.3.1** Outside the higher strength steel area, scantlings of longitudinal elements in normal strength steel are to be calculated assuming that the midship area is made in normal strength steel.

**2.3.2** Regarding welding of higher strength hull structural steel, see applicable requirements of NR216 Materials and Welding.

### 2.4 Connections between steel and aluminium

**2.4.1** Any direct contact between steel and aluminium alloy is to be avoided (e.g. by means of zinc or cadmium plating of the steel parts and application of a suitable coating on the corresponding light alloy parts).

**2.4.2** Any heterogeneous jointing system is considered by the Society on case-by-case basis.

**2.4.3** The use of transition joints made of aluminium/steel clad plates or profiles is considered by the Society on a case-by-case basis.

# 3 Plating

## 3.1 Insert plates and doublers

**3.1.1** A local increase in plating thickness is generally to be achieved through insert plates. Local doublers, which are normally only allowed for temporary repair, may however be accepted by the Society on a case-by-case basis.

In any case, doublers and insert plates are to be made of materials of a quality at least equal to that of the plates on which they are welded.

**3.1.2** Doublers having width, in mm, greater than:

- 20 times their thickness, for thicknesses equal to or less than 15 mm
- 25 times their thickness, for thicknesses greater than 15 mm,

are to be fitted with slot welds, in accordance with the Rules.

**3.1.3** When doublers fitted on the outer shell and strength deck within 0,5 L amidships are accepted by the Society, their width and thickness are to be such that slot welds are not necessary according to the requirements in [3.1.2]. Outside this area, the possibility of fitting doublers requiring slot welds will be considered by the Society on a case-by-case basis.

# 4 Ordinary stiffeners

## 4.1 General

### 4.1.1 Stiffener non-perpendicular to the attached plating

Where the stiffener is not perpendicular to the attached plating, the actual net section modulus w, net shear area $A_{sh}$, and net moment of inertia I are to be obtained, from the following formulae:

$$w = w_0 \sin \varphi_w$$

$$A_{sh} = A_0 \sin \varphi_w$$

$$I = I_0 \sin^2 \varphi_w$$

where:

$w_0$ : Actual net section modulus, in $cm^3$, of the stiffener assumed to be perpendicular to the plating

$A_0$ : Actual net shear area, in $cm^2$, of the stiffener assumed to be perpendicular to the plating

$I_0$ : Net moment of inertia, in $cm^4$, of the stiffener assumed to be perpendicular to the attached plating

$\varphi_w$ : Angle, in degree, between the attached plating and the web of the stiffener, measured at midspan of the stiffener.

### 4.1.2 Bulb section: equivalent angle profile

A bulb section may be taken as equivalent to an angle profile.

The dimensions of the equivalent angle profile are to be obtained, in mm, from the following formulae:

$$h_w = h'_w - \frac{h'_w}{9,2} + 2$$

$$t_w = t'_w$$

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

$$t_f = \frac{h'_w}{9,2} - 2$$

where:

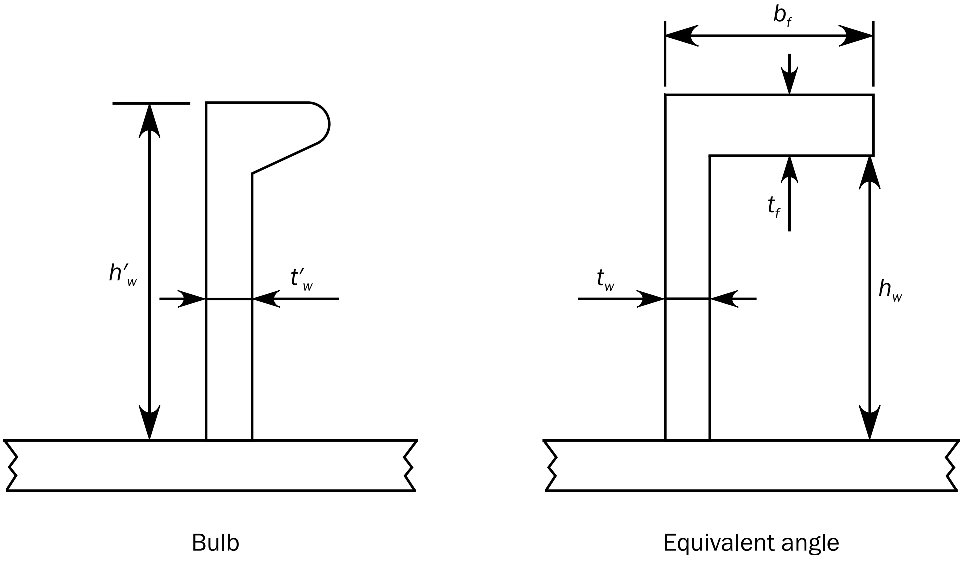
$h'_w$, $t'_w$ : Height and net thickness of the bulb section, in mm, as shown in Fig 1

$\alpha$ : Coefficient equal to:

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

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

**Figure 1 : Bulb section and its equivalent angle**




## 4.2 Span of ordinary stiffeners

### 4.2.1 General

The span $\ell$ of ordinary stiffeners is to be measured as shown in Fig 2 to Fig 5.

**Figure 2 : Ordinary stiffener without brackets**

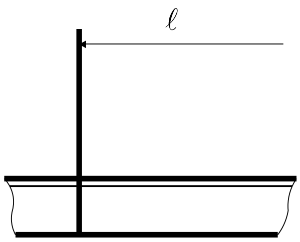



**Figure 3 : Ordinary stiffener with a stiffener at one end**

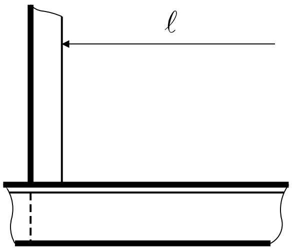



**Figure 4 : Ordinary stiffener with end bracket**

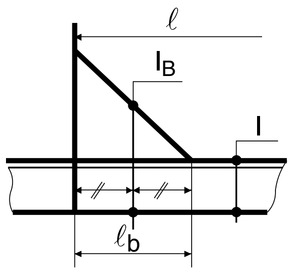
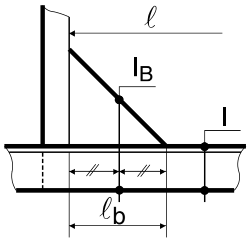


Figure 5 : Ordinary stiffener with a bracket and a stiffener at one end




## 4.3 Width of attached plating

### 4.3.1 Yielding check

The width of the attached plating to be considered for the yielding check of ordinary stiffeners is to be obtained, in m, from the following formulae:

- if the plating extends on both sides of the ordinary stiffener:

  $b_p = s$

- if the plating extends on one side of the ordinary stiffener (i.e. ordinary stiffeners bounding openings):

  $b_p = 0,5\ s$

### 4.3.2 Buckling check

The attached plating to be considered for the buckling check of ordinary stiffeners is defined in NR217, Pt B, Ch 2, Sec 7, [3].

## 4.4 Corrugations

**4.4.1** The net section modulus of a corrugation is to be obtained, in $cm^3$, from the following formula:

$$w = \frac{td}{6}(3b + c)10^{-3}$$

where:

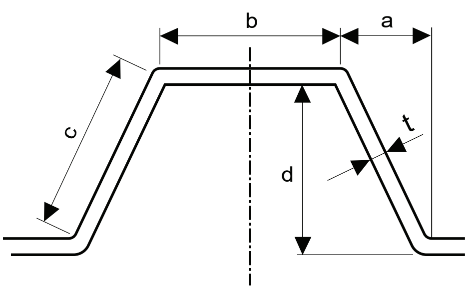
t : Net thickness of the plating of the corrugation, in mm

d, b, c : Dimensions of the corrugation, in mm, shown in Fig 6.

Where the web continuity is not ensured at ends of the bulkhead, the net section modulus of a corrugation is to be obtained, in $cm^3$, from the following formula:

$$w = 0,5\ b\ t\ d\ 10^{-3}$$

Figure 6 : Dimensions of a corrugation




## 4.5 End connections

### 4.5.1 Continuous ordinary stiffeners

Where ordinary stiffeners are continuous through primary supporting members, they are to be connected to the web plating so as to ensure proper transmission of loads, e.g. by means of one of the connection details shown in Fig 7 to Fig 10. In the case of high values for the design loads, additional stiffening is required.

Connection details other than those shown in Fig 7 to Fig 10 may be considered by the Society on a case-by-case basis.

In some cases, the Society may require the details to be supported by direct calculations submitted for review.

**Figure 7 : End connection of ordinary stiffener**
**Without collar plate**

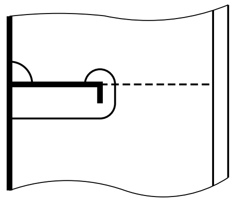


**Figure 8 : End connection of ordinary stiffener**
**Collar plate**

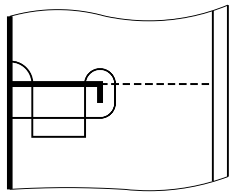


**Figure 9 : End connection of ordinary stiffener**
**One large collar plate**

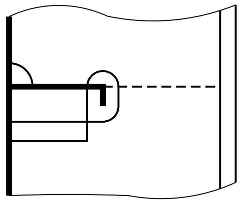
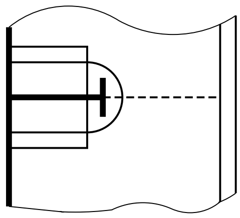


**Figure 10 : End connection of ordinary stiffener**
**Two large collar plates**



### 4.5.2 Intercostal ordinary stiffeners

Where ordinary stiffeners are cut at primary supporting members, brackets are to be fitted to ensure the structural continuity. Their section modulus and their sectional area are to be not less than those of the ordinary stiffeners.

All brackets for which:

$$\frac{\ell_{bf}}{t} > 60$$

with:

$\ell_{bf}$ : Length in mm, of the free edge of the bracket

t : Bracket net thickness, in mm,

are to be flanged or stiffened by a welded face plate.

The sectional area, in cm², of the flange or the face plate is to be not less than 0,01 $\ell_{bf}$.

The width of the face plate is to be not less than 10 t.

### 4.5.3 Sniped ends of stiffeners

Stiffeners may be sniped at the ends if the net thickness of the plating supported by the stiffener is not less than:

$$t = c\sqrt{\frac{ps(\ell - 0,5s)}{R_y}}$$

where:

p : Stiffener design load, in kN/m², defined in the relevant Chapter of Part D, for each harbour equipment type

c : Coefficient, defined as follows:
- c = 12,7 for watertight bulkheads
- c = 15,7 for all other components.

# 5 Primary supporting members

## 5.1 General

### 5.1.1 Primary supporting member not perpendicular to the attached plating

Where the primary supporting member is not perpendicular to the attached plating, the actual section modulus may be obtained, in accordance with [4.1.1].

## 5.2 Span of primary supporting members

**5.2.1** The span of primary members is to be determined in compliance with [4.2].

## 5.3 Width of attached plating

### 5.3.1 General

The width of the attached plating of primary supporting members is to be obtained according to [5.3.2] or [5.3.3], depending on the type of loading, where:

$S_0$ :
- $S_0 = S$ for plating extending on both sides of the primary supporting member
- $S_0 = 0,5\ S$ for plating extending on one side of the primary supporting member

$S_1$ :
- $S_1 = 0,2\ \ell$ for plating extending on one side of the primary supporting member
- $S_1 = 0,1\ \ell$ for plating extending on one side of the primary supporting member.

### 5.3.2 Loading type 1

Where the primary supporting members are subjected to uniformly distributed loads or else by not less than 6 equally spaced concentrated loads, the width $b_p$ of the attached plating is to be obtained, in m, from the following formulae:

- for $\ell / S_0 \le 4$:

$$b_p = 0,36 S_0 \left(\frac{\ell}{S_0}\right)^{0,67}$$

- for $\ell / S_0 > 4$:

$b_p = MIN\ (S_0\ ;\ S_1)$

### 5.3.3 Loading type 2

Where the primary supporting members are subjected to less than 6 concentrated loads, the width of the attached plating is to be obtained, in m, from the following formulae:

- for $\ell / S_0 < 8$:

$$b_p = 0,205 S_0 \left(\frac{\ell}{S_0}\right)^{0,72}$$

- for $\ell / S_0 \ge 8$:

$b_p = 0,9\ S_0$

### 5.3.4 Corrugated bulkheads

The width of attached plating of corrugated bulkhead primary supporting members is to be determined as follows:
- when primary supporting members are parallel to the corrugations and are welded to the corrugation flanges, the width of the attached plating is to be calculated in accordance with [5.3.2] or [5.3.3] and is to be taken not greater than the corrugation flange width
- when primary supporting members are perpendicular to the corrugations, the width of the attached plating is to be taken equal to the width of the primary supporting member face plate.

## 5.4 Bracketed end connections

**5.4.1** Arm lengths of end brackets are to be equal, as far as practicable (See Fig 11).

The height of end brackets is to be not less than that of the weakest primary supporting member.

**5.4.2** The scantlings of end brackets are generally to be such that the section modulus of the primary supporting member with end brackets is not less than that of the primary supporting member at mid-span.

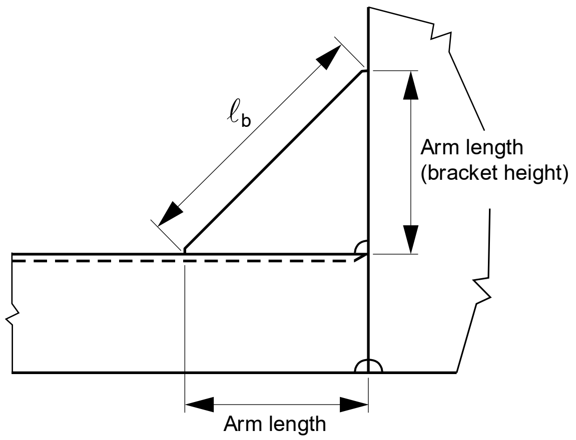
**5.4.3** The bracket web thickness is to be not less than that of the weakest primary supporting member.

**5.4.4** The face plate of end brackets is to have a width not less than the width of the primary supporting member face plates.

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

**5.4.5** In addition to the above requirements, the scantlings of end brackets are to comply with the applicable requirements of this Chapter.

**Figure 11 : Bracket dimensions**

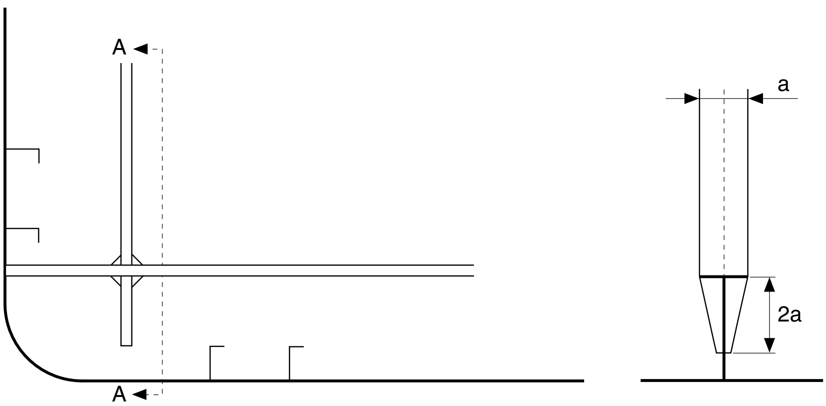



## 5.5 Bracketless end connections

**5.5.1** In the case of bracketless end connections between primary supporting members, the strength continuity is to be obtained as schematically shown in Fig 12 or by any other method which the Society may consider equivalent.

**5.5.2** In general, the continuity of the face plates is to be ensured.

**Figure 12 : Bracketless end connection of two primary supporting members**




## 5.6 Cut-outs and holes

**5.6.1** Cut-outs for the passage of ordinary stiffeners are to be as small as possible and well rounded with smooth edges.

In general, the height of cut-outs is to be not greater than 50% of the height of the primary supporting member. Other cases are to be covered by calculations submitted to the Society.

**5.6.2** Where openings such as lightening holes are cut in primary supporting members, they are to be equidistant from the face plate and corners of cut-outs and, in general, their height is to be not greater than 20% of the web height.

**5.6.3** Openings may not be fitted in way of toes of end brackets.

**5.6.4** Over half of the span of primary supporting members, the length of openings is to be not greater than the distance between adjacent openings.

At the ends of the span, the length of openings is to be not greater than 25% of the distance between adjacent openings.

**5.6.5** In the case of large openings as shown in Fig 13, the secondary stresses in primary supporting members are to be considered for the reinforcement of the openings.

The secondary stresses may be calculated in accordance with the following procedure.

Members (1) and (2) are subjected to the following forces, moments and stresses:

$$F = \frac{M_A + M_B}{2d}$$

$$m_1 = \left|\frac{M_A - M_B}{2}\right| K_1$$

$$m_2 = \left|\frac{M_A - M_B}{2}\right| K_2$$

$$\sigma_{F1} = 10\frac{F}{S_1}$$

$$\sigma_{F2} = 10\frac{F}{S_2}$$

$$\sigma_{m1} = \frac{m_1}{w_1}10^3$$

$$\sigma_{m2} = \frac{m_2}{w_2}10^3$$

$$\tau_1 = 10\frac{K_1 Q_T}{S_{w1}}$$

$$\tau_2 = 10\frac{K_2 Q_T}{S_{w2}}$$

where:

| | | |
|---|---|---|
| d | : | Distance, in m, between the neutral axes of (1) and (2) |
| $I_1$, $I_2$ | : | Net moments of inertia, in $cm^4$, of (1) and (2) with attached plating |
| $M_A$, $M_B$ | : | Bending moments, in kN.m, in sections A and B of the primary supporting member |
| $m_1$, $m_2$ | : | Bending moments, in kN.m, in (1) and (2) |
| $Q_T$ | : | Shear force, in kN, equal to $Q_A$ or $Q_B$, whichever is greater |
| $S_1$, $S_2$ | : | Net sectional areas, in $cm^2$, of (1) and (2) |
| $S_{w1}$, $S_{w2}$ | : | Net sectional areas, in $cm^2$, of webs in (1) and (2) |
| $\sigma_{F1}$, $\sigma_{F2}$ | : | Axial stresses, in $N/mm^2$, in (1) and (2) |
| $\sigma_{m1}$, $\sigma_{m2}$ | : | Bending stresses, in $N/mm^2$, in (1) and (2) |
| $\tau_1$, $\tau_2$ | : | Shear stresses, in $N/mm^2$, in (1) and (2) |
| $w_1$, $w_2$ | : | Net section moduli, in $cm^3$, of (1) and (2) |

$$K_1 = \frac{I_1}{I_1 + I_2}$$

$$K_2 = \frac{I_2}{I_1 + I_2}$$

The combined stress $\sigma_C$ calculated at the ends of members (1) and (2) is to be obtained from the following formula:

$$\sigma_c = \sqrt{(\sigma_F + \sigma_m)^2 + 3\tau^2}$$

The combined stress $\sigma_C$ is to comply with the checking criteria in NR217, Pt B, Ch 2, Sec 8, [2.3] or NR217, Pt B, Ch 2, Sec 8, [2.4], as applicable. Where these checking criteria are not complied with, the cut-out is to be reinforced according to one of the solutions shown in Fig 14 to Fig 16:

- continuous face plate (solution 1): see Fig 14
- straight face plate (solution 2): see Fig 15
- compensation of the opening (solution 3): see Fig 16
- combination of the above solutions.

Other arrangements may be accepted provided they are supported by direct calculations submitted to the Society for review.

Figure 13 : Large openings in primary supporting members - Secondary stresses

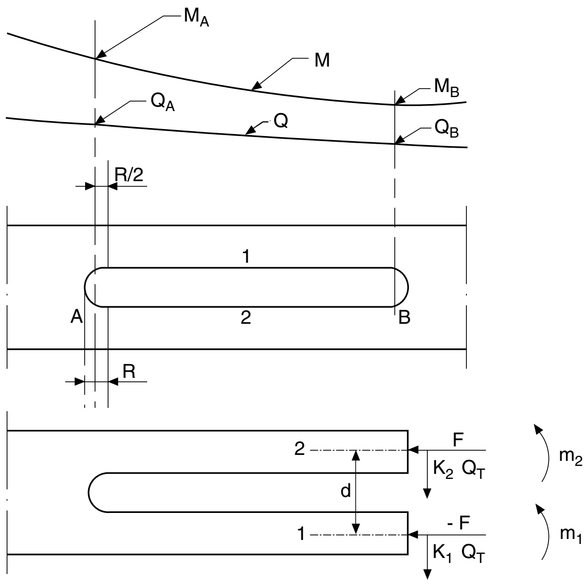



Figure 14 : Stiffening of large openings in primary supporting members - Solution 1

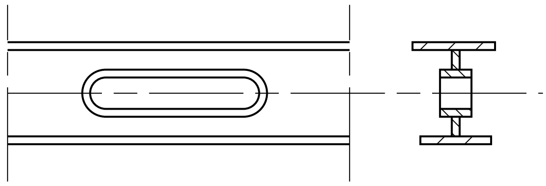


Figure 15 : Stiffening of large openings in primary supporting members - Solution 2

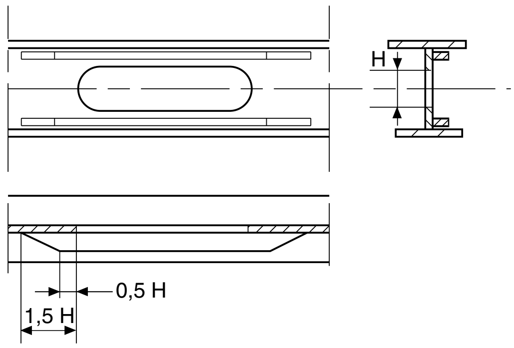
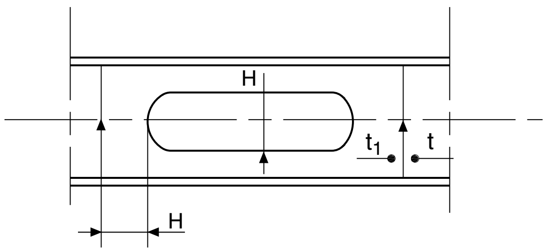



Figure 16 : Stiffening of large openings in primary supporting members - Solution 3

Inserted plate




## 5.7 Stiffening arrangement

**5.7.1** Webs of primary supporting members are generally to be stiffened where the height, in mm, is greater than 100 t, where t is the web net thickness, in mm, of the primary supporting member.

In general, the web stiffeners of primary supporting members are to be spaced not more than 110 t.

**5.7.2** Where primary supporting member web stiffeners are welded to ordinary stiffener face plates, their net sectional area at the web stiffener mid-height is to be not less than the value obtained, in $cm^2$, from the following formula:

$A = 0,1\ K_1\ k\ k_0 p\ s\ \ell$

where:

$K_1$ : Coefficient depending on the web connection with the ordinary stiffener, to be taken as:

- $K_1$ = 0,30 for connections without collar plate (see Fig 7)
- $K_1$ = 0,225 for connection with a collar plate (see Fig 8)
- $K_1$ = 0,20 for connections with one or two large collar plates (see Fig 9 and Fig 10)

p : Design pressure, in $KN/m^2$, acting on the ordinary stiffener, defined in the relevant Chapter of Part D, for each harbour equipment.

**5.7.3** The net moment of inertia, I, of the web stiffeners of primary supporting members is not to be less than the value obtained, in $cm^4$, from the following formula:

- for web stiffeners parallel to the flange of the primary supporting members (see Fig 17):

$$I = C\ell^2 A\frac{R_{eH}}{R}$$

- for web stiffeners normal to the flange of the primary supporting members (see Fig 18):

$$I = 11,4\ st_w(2,5\ \ell^2 - 2s^2)\frac{R_{eH}}{R}$$

where:

C : Slenderness coefficient to be taken as:

- C = 1,43 for longitudinal web stiffeners including sniped stiffeners
- C = 0,72 for other web stiffeners

$\ell$ : Length, in m, of the web stiffener

s : Spacing, in m, of web stiffeners

A : Net section area, in $cm^2$, of the web stiffener, including attached plate assuming effective breadth of 80% of stiffener spacings

R : Yield stress parameter to be taken equal to:

- R = 235 $N/mm^2$ for steel
- R = 100 $N/mm^2$ for aluminium alloys

**Figure 17 : Web stiffeners parallel to the flange**

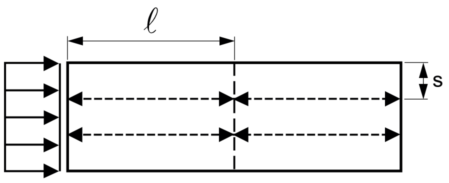
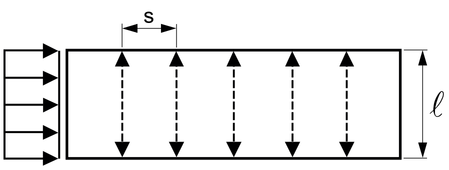



**Figure 18 : Web stiffeners normal to the flange**

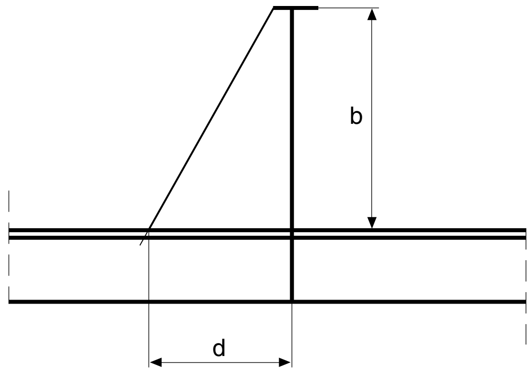



**5.7.4** Tripping brackets (see Fig 19) welded to the face plate are generally to be fitted:

- every fourth spacing of ordinary stiffeners, without exceeding 4 m
- in way of concentrated loads.

Where the width of the symmetrical face plate is greater than 400 mm, backing brackets are to be fitted in way of the tripping brackets.

**Figure 19 : Primary supporting member: web stiffener in way of ordinary stiffener**




**5.7.5** In general, the width of the primary supporting member face plate is to be not less than one tenth of the depth of the web, where tripping brackets are spaced as specified in [5.6.4].

**5.7.6** The arm length of tripping brackets, in m, is to be not less than:

$$d = MAX\left(0,38b\ ;\ 0,85b\sqrt{\frac{s_t}{t}}\right)$$

where:

b : Height, in m, of tripping brackets, shown in Fig 19

$s_t$ : Spacing, in m, of tripping brackets

t : Net thickness, in mm, of tripping brackets.

**5.7.7** Tripping brackets with a net thickness, in mm, less than 15 $L_b$ are to be flanged or stiffened by a welded face plate.

The net sectional area, in $cm^2$, of the flanged edge or the face plate is to be not less than 10 $L_b$ , where $L_b$ is the length, in m, of the free edge of the bracket.

# Section 4 Net Scantling Approach - Metallic Hulls

## 1 Application criteria

### 1.1 General

**1.1.1** The scantlings obtained by applying the criteria specified in these Rules are net scantlings, i.e. those which provide the strength characteristics required to sustain the loads, excluding any addition for corrosion. Exceptions are the scantlings of massive pieces made of steel forgings, steel castings or iron castings.

#### 1.1.2 Strength characteristics

The required strength characteristics are:

- thickness, for plating including that which constitutes primary supporting members
- section modulus, shear sectional area, moments of inertia and local thickness, for ordinary stiffeners and, as the case may be, primary supporting members
- section modulus, moments of inertia and single moment for the hull girder.

**1.1.3** The harbour equipment is to be built at least with the gross scantlings obtained by reversing the procedure described in [2.1.1].

## 2 Net strength characteristic calculation

### 2.1 Designer's proposals based on gross scantlings

**2.1.1** If the Designer provides the gross scantlings of each structural element, the structural checks are to be carried out on the basis of the net strength characteristics, derived as specified in [2.1.2] to [2.1.5].

#### 2.1.2 Plating

The net thickness is to be obtained by deducting the corrosion addition $t_C$ from the gross thickness.

#### 2.1.3 Ordinary stiffeners

The net transverse section is to be obtained by deducting the corrosion addition $t_C$ from the gross thickness of the elements which constitute the stiffener profile.

The net strength characteristics are to be calculated for the net transverse section. As an alternative, the net section modulus of bulb profiles may be obtained from the following formula:

$w = w_G (1 - \alpha t_C) - \beta t_C$

where:

$w_G$ : Stiffener gross section modulus, in $cm^3$

$\alpha, \beta$ : Coefficients defined in Tab 1.

**Table 1 : Coefficients $\alpha$ and $\beta$ for bulb profiles**

| Range of section modulus | $\alpha$ | $\beta$ |
|---|---|---|
| $w_G \leq 200$ cm$^3$ | 0,070 | 0,4 |
| $w_G > 200$ cm$^3$ | 0,035 | 7,4 |

#### 2.1.4 Primary supporting members

The net transverse section is to be obtained by deducting the corrosion addition $t_C$ from the gross thickness of the elements which constitute the primary supporting members.

The net strength characteristics are to be calculated for the net transverse section.

#### 2.1.5 Hull girder

For the hull girder, the net hull transverse sections are to be considered as being constituted by plating and stiffeners having net scantlings calculated on the basis of the corrosion additions $t_C$, according to [2.1.2] to [2.1.4].

## 2.2 Designer's proposals based on net scantlings

### 2.2.1 Net strength characteristics and corrosion additions

If the Designer provides the net scantlings of each structural element, the structural checks are to be carried out on the basis of the proposed net strength characteristics.

The Designer is also to provide the corrosion additions or the gross scantlings of each structural element. The proposed corrosion additions are to be not less than the values specified in [3.1.1].

### 2.2.2 Hull girder net strength characteristic calculation

For the hull girder, the net hull girder transverse sections are to be considered as being constituted by plating and stiffeners having the net scantlings proposed by the Designer.

# 3 Corrosion additions

## 3.1 Values of corrosion additions

### 3.1.1 General

The values of the corrosion additions specified in this Article are to be applied in relation to the relevant corrosion protection measures.

The Designer may define values of corrosion additions greater than those specified here below.

### 3.1.2 Corrosion additions for steels other than stainless steel

The corrosion addition for each of the two sides of a structural member, $t_{C1}$ or $t_{C2}$ , is specified in Tab 2.

- for plating with a gross thickness greater than 10 mm, the total corrosion addition $t_C$ , in mm, for both sides of the structural member is obtained by the following formula:

  $t_C = t_{C1} + t_{C2}$

- for plating with a gross thickness less than or equal to 10 mm, $t_C$ , in mm, for both sides of the structural member is the smallest of the following values:
  - 20% of the gross thickness of the plating
  - $t_C = t_{C1} + t_{C2}$

For an internal member within a given compartment, the total corrosion addition $t_C$ is to be determined as specified here below, where $t_{C1}$ is the value of the corrosion addition specified in Tab 2 for one side exposure to that compartment:

- for plating/stiffener plating with a gross thickness greater than 10 mm, $t_C$ , in mm, is twice the value of $t_{C1}$:

  $t_C = 2\ t_{C1}$

- for plating/stiffener plating with a gross thickness less than or equal to 10 mm, $t_C$ , in mm, is the smallest of the following values:
  - 20% of the gross thickness of the plating/stiffener plating
  - $t_C = 2\ t_{C1}$

### 3.1.3 Corrosion additions for stainless steel and aluminium

For structural members made of stainless steel or aluminium alloys, the corrosion addition is to be taken equal to 0,25 mm for one side exposure ($t_{C1} = t_{C2} = 0,25$ mm).

**Table 2 : Corrosion additions, in mm, for one side exposure ($t_{C1}$ or $t_{C2}$)**

| Compartment type | | Corrosion addition **(1)** |
|---|---|---|
| Ballast tank | | 1,00 |
| Fuel oil tank | Plating of horizontal surface | 0,75 |
| | Plating of non-horizontal surfaces | 0,50 |
| | Ordinary stiffeners and primary supporting members | 0,75 |
| Accommodation space | | 0,00 |
| Compartments and areas other than those mentioned above | | 0,50 |
| **(1)** Corrosion additions are applicable to all members of the considered item. | | |

# Section 5 Strength Criteria - Structural Items in Composite Material or Plywood

## Symbols

D : Depth, in m, defined in Ch 1, Sec 2, [3.4]

g : Gravitational acceleration:

$g = 9,81\ m/s^2$

$M_H$ : Design still water bending moment in hogging condition, in kN.m, defined in the relevant chapter of Part D, for each harbour equipment type

$M_S$ : Design still water vertical bending moment in sagging condition, in kN.m, defined in the relevant chapter of Part D, for each harbour equipment type

$M_{WV}$ : Vertical wave bending moment, in kN.m, defined in Ch 4, Sec 1, [4.2]

$p_B$ : Ballast design pressure, in kN/m², defined in the relevant chapter of Part D, for each harbour equipment type

$p_C$ : Cargo design pressure, in kN/m², defined in the relevant chapter of Part D, for each harbour equipment type

$p_D$ : External deck design pressure, in kN/m², defined in the relevant chapter of Part D, for each harbour equipment type

$p_E$ : External design pressure, in kN/m², defined in the relevant chapter of Part D, for each harbour equipment type

$p_{Em}$ : External counter pressure, in kN/m², in service conditions

$p_{ST}$ : Test pressure, in kN/m², defined in the relevant chapter of Part D, for each harbour equipment type

$p_{FL}$ : Flooding pressure, in kN/m²

$p_{FL} = \rho g\ d_F$

where:

$d_F$ : Distance, in m, from the calculation point to the deepest waterline to be provided by the Designer.

Where the location of the deepest waterline is not known, $d_F$ will be taken as:

$d_F = D - z$

$\rho$ : River/sea water density, in t/m³

z : Z co-ordinate, in m, of the calculation point of a structural element

## 1 General

### 1.1 Application

**1.1.1** The requirements of the present Section define the strength criteria to be considered for the strength check of structural items in composite material or plywood.

The hull strength check is to be carried out according to the applicable requirements of NR546 Composite Ships.

### 1.2 Ageing effect

**1.2.1** The scantlings obtained by applying the criteria specified in the present Rules for composite structures include a rule partial safety factor $C_V$ which takes into account the ageing effect on the laminate mechanical characteristics.

## 2 Local scantling analysis

### 2.1 Application

**2.1.1** The local scantling of panels, secondary and primary stiffeners is to be reviewed according to:

- local loads as defined in [2.3] and [2.4]
- rule analysis as defined in NR546, Sec 6 for panels and in NR546, Sec 7 for stiffeners
- minimum rule safety factors as defined in [4.3] for laminates and in [5.2] for plywood structure.

### 2.2 Local load calculation point

**2.2.1** Unless otherwise specified, the local loads are to be calculated:

- for plate panels:
  - at the lower edge of the plate panels for monolithic, and
  - at the middle of the plate panels for sandwich.
- for horizontal stiffeners: at mid-span of the stiffeners
- for vertical stiffeners: at the lower and upper vertical points of the stiffeners.

#### 2.2.2 Superstructures and deckhouses

For superstructures and deckhouses, the lateral pressures are to be calculated, for all type of materials:

- for plating: at mid-height of the bulkhead
- for horizontal and vertical stiffeners: at mid-span of the stiffeners.

### 2.3 Design lateral pressure

**2.3.1** The design lateral pressure, p, to be used for hull scantling is defined in Tab 1.

**Table 1 : Design lateral pressure, p, in kN/m²**

| | Structure | In service conditions | In testing conditions | In flooding conditions **(2)** |
|---|---|---|---|---|
| In general | Shell structure | $p_E$<br>$p_C - p_{Em}$<br>$p_B - p_{Em}$ | $p_{ST}$<br>$p_{ST} - p_{SE}$ **(1)** | – |
| | Deck structure | 4,9<br>$p_C$<br>$p_B$<br>$p_D$ | $p_{ST}$ | – |
| | Hatch coaming | 2,25 | – | – |
| | Internal structure | $p_C$<br>$p_B$ | $p_{ST}$ | $p_{FL}$ |
| Superstructures & deckhouses | Wall structure | 2,25 | – | – |
| | Deck structure | $p_D$ | – | – |

**(1)** Testing afloat
**(2)** On harbour equipment required to comply with damage stability
**Note 1:**
$p_{SE}$ : External still water counter pressure, in kN/m², to be determined by the Designer.

### 2.4 Other local loads

**2.4.1** Other local loads transmitted to the hull structure such as the forces induced by dry unit cargoes, wheeled cargoes, coupling and mooring systems, are to be determined according to the relevant chapter of Part D for each harbour equipment type.

## 3 Global strength scantling analysis

### 3.1 Application

#### 3.1.1 Global hull girder longitudinal strength

The global hull girder longitudinal strength will be examined on a case-by-case basis, where deemed appropriate by the Society.

#### 3.1.2 Global strength and local scantling analysis

When deemed necessary by the Society, the hull scantling may be checked taking into account a combination between the global hull girder and local stresses.

#### 3.1.3 Global transverse strength of catamaran

As a rule, the global transverse strength of catamaran is to be examined for all types of catamaran.

#### 3.1.4 Finite element calculation

The global strength analysis may also be examined with a Finite Element Analysis submitted by the Designer. In this case and where large openings are provided in side shell and/or in transverse cross bulkhead of catamaran, a special attention is to be paid to ensure a realistic modeling of the bending and shear strengths of the window jambs between windows.

### 3.2 Vertical overall longitudinal bending moment

**3.2.1** The vertical overall longitudinal bending moment $M_V$ to be considered for the scantling analysis is to be obtained from the following formulae:

- in sagging condition

  $M_V = M_S + M_{WV}$

- in hogging condition

  $M_V = M_H + M_{WV}$

## 4 Structural items in composite material

### 4.1 Application

**4.1.1** The requirements of the present Article define the permissible stresses considered for the strength check of composite structures.

### 4.2 General

#### 4.2.1 Principle of design review

The design review of composite structures is based on safety factors which are to be in compliance with the following criteria:

- minimum stress criteria in layers:

  $\frac{\sigma_{bri}}{\sigma_{iapp}} \geq SF$

- critical buckling stress criteria:

  $\frac{\sigma_c}{\sigma_A} \geq SF_B$

- combined stress criteria in layers:

  $SF_{CS} \geq SF_{CSiapp}$

where:

$\sigma_{bri}$ : In-plane theoretical individual layer breaking stresses defined in NR546 Composite Ships, Sec 5, [5]

$\sigma_C$ : Critical buckling stress of the composite element considered calculated as defined in NR546, Composite Ships, Sec 6, [4].

$\sigma_{iapp}$ : In-plane individual layer applied stresses

$\sigma_A$ : Compressive stress applied to the whole laminate considered

$SF$, $SF_B$ , $SF_{CS}$:Rule safety factors defined in [4.3.3]

$SF_{CSiapp}$ : Actual combined stress applied in layer as calculated in NR546 Composite ships, Sec 2, [1.3.3].

Note 1: The breaking stresses directly deduced from mechanical tests (as requested in NR546 Composite Ships) may be taken over from the theoretical breaking stresses if the mechanical test results are noticeably different from the expected values.

#### 4.2.2 Types of stress considered

The following different types of stress are considered, corresponding to the different loading modes of the fibres:

a) Principal stresses in the individual layers

- stress $\sigma_1$

  These stresses, parallel to the fibre (longitudinal direction), may be tensile or compressive stresses and are mostly located as follows:

  - in 0° direction of unidirectional tape or fabric reinforcement systems
  - in 0° and 90° directions of woven roving.

- stress $\sigma_2$

  These stresses, perpendicular to the fibre (transverse direction), may be tensile or compressive stresses and are mostly located as follows:

  - in 90° direction of unidirectional tape or combined fabrics when the fibres of the set are stitched together without criss-crossing.

- shear stress $\tau_{12}$ (in the laminate plane)

  These shear stresses, parallel to the fibre, may be found in all type of reinforcement systems

- shear stresses $\tau_{13}$ and $\tau_{23}$ (through the laminate thickness)

  These shear stresses, parallel or perpendicular to the fibre, are the same stresses than the interlaminar shear stresses $\tau_{IL2}$ and $\tau_{IL1}$
- combined stress (Hoffman criteria).

b) Stresses in the whole laminate
- compressive and shear stresses in the whole laminate inducing buckling.

#### 4.2.3 Theoretical breaking criteria

Three theoretical breaking criteria are used in the present Rules:

a) The maximum stress criteria leading to the breaking of the component resin/fibre of one elementary layer of the full lay-up laminate

b) The Hoffman combined stress criteria with the hypothesis of in-plane stresses in each layer

c) The critical buckling stress criteria applied to the laminate.

The theoretical breaking criteria defined in items a) and b) are to be checked for each individual layer.

The theoretical breaking criteria defined in item c) is to be checked for the global laminate.

#### 4.2.4 First ply failure

It is considered that the full lay-up laminate breaking strength is reached as soon as the lowest breaking strength of any elementary layer is reached. This is referred to as “first ply failure”.

### 4.3 Rule safety factors

#### 4.3.1 General

a) General consideration:

The rule safety factors to be considered for the composite structure check are defined in, [4.3.3] according to the partial safety factors defined in [4.3.2].

b) Additional considerations:

Rule safety factors other than those defined in [4.3.3] may be accepted for one elementary layer when the full lay-up laminate exhibits a sufficient safety margin between the theoretical breaking stress of this elementary layer and the theoretical breaking stress of the other elementary layers.

Finite Element Model analyses are examined on a case by case basis by the Society. As a rule, when the structure is checked with a Finite Element Model, the rule safety factors defined in [4.3.3] and [4.3.4] may be reduced by ten per cent.

#### 4.3.2 Partial safety factors

As a general rule, the minimum partial safety factors considered are to be as follows:

a) Ageing effect factor $C_V$

$C_V$ takes into account the ageing effect of the composites and is generally taken equal to:

$C_V$ = 1,2 for monolithic laminates (or for face-skins laminates of sandwich)

$C_V$ = 1,1 for sandwich core materials

b) Fabrication process factor $C_F$

$C_F$ takes into account the fabrication process and the reproducibility of the fabrication and is generally taken equal to:

$C_F$ = 1,10 in case of a prepreg process

$C_F$ = 1,15 in case of infusion and vacuum process

$C_F$ = 1,25 in case of a hand lay-up process

$C_F$ = 1,00 for the core materials of sandwich composite

c) Type of load factor $C_i$

$C_i$ takes into account the type of loads and is generally taken equal to:

$C_i$ = 1,0 for local external pressures and internal pressures or concentrated forces

$C_i$ = 0,8 for test pressures and flooding loads

d) Type of stress factor $C_R$

$C_R$ takes into account the type of stress in the fibres of the reinforcement fabrics and the cores and is generally taken equal to:

1) For fibres of the reinforcement fabrics
   - for tensile or compressive stress parallel to the continuous fibre of the reinforcement fabric:

     $C_R$ = 2,1 for unidirectional tape, bi-bias, three-unidirectional fabric

     $C_R$ = 2,4 for woven roving
   - for tensile or compressive stress perpendicular to the continuous fibre of the reinforcement fabric:

     $C_R$ = 1,25 for unidirectional tape, bi-bias, three-unidirectional fabric

- for shear stress parallel to the fibre in the elementary layer and for interlaminar shear stress in the laminate:
  $C_R$ = 1,6 for unidirectional tape, bi-bias, three-unidirectional fabric
  $C_R$ = 1,8 for woven roving
- for mat layer:
  $C_R$ = 2,0 for tensile or compressive stress in the layer
  $C_R$ = 2,2 for shear stress in the layer and for interlaminar shear stress

2) For core materials
   - for tensile or compressive stress for cores:
     - in the general case:
       $C_R$ = 2,1 for tensile or compressive stress
     - for balsa:
       $C_R$ = 2,1 for tensile or compressive stress parallel to the wood grain
       $C_R$ = 1,2 for tensile or compressive stress perpendicular to the wood grain
   - for shear stress, whatever the type of core material:
     $C_R$ = 2,5

3) For wood materials for strip planking
   $C_R$ = 2,4 for tensile or compressive stress parallel to the continuous fibre of the strip planking
   $C_R$ = 1,2 for tensile or compressive stress perpendicular to the continuous fibre of the strip planking
   $C_R$ = 2,2 for shear stress parallel to the fibre and for interlaminar shear stress in the strip planking.

#### 4.3.3 Rule safety factors

The rule safety factors SF, $SF_{CS}$ and $SF_B$ to be considered for the composite structure check are defined according to the type of hull structure calculation, as follows:

a) For structure checked under local loads:
   1) Minimum stress criterion in layers:
      $SF = C_V\ C_F\ C_R\ C_i$
      with:
      $C_V$, $C_F$, $C_R$, $C_i$: Partial safety factors defined in [4.3.2]
   2) Combined stress criterion in layers:
      $SF_{CS} = C_{CS}\ C_V\ C_F\ C_i$
      with:
      $C_{CS}$ : Partial safety factor, to be taken equal to:
      - $C_{CS}$ = 1,7 for unidirectional tape, bi-bias, three-unidirectional fabric
      - $C_{CS}$ = 2,1 for the other types of layer

      $C_V$, $C_F$, $C_i$: Partial safety factors defined in [4.3.2]

b) For structure element contributing to the global strength checked under global hull girder loads:
   The minimum stress criterion in layers and the combined stress criterion in layers are to be taken as defined in a) with a value of $C_i$ equal to 1,4.
   The critical buckling stress criterion is to be taken equal to:
   $SF_B = C_{buck}\ C_V,\ C_F,\ C_i$
   with:
   $C_{buck}$ : Partial safety factors to be taken equal to 1,45
   $C_V$, $C_F$ : Partial safety factors defined in [4.3.2]
   $C_i$ : Partial safety factors to be taken equal to 1,2

c) For structure element contributing to the global strength checked under global loads combined with local loads:
   The minimum stress criterion in layers and the combined stress criterion in layers are to be taken as defined in a) with a value of $C_i$ equal to 0,8.
   The critical buckling stress criterion is to be taken as defined in b) with a value of $C_i$ equal to 0,8.

#### 4.3.4 Rule safety factor for structural adhesive joints

The structural adhesive characteristics are to be as defined in NR546 Composite Ships.

As a general rule, the rule safety factor SF considered in the present Rules and applicable to the maximum shear stress in adhesive joints is to be calculated as follows:

$SF = 2{,}4\ C_F\ C_i$

where:

$C_F$ : Factor taking into account the gluing process and generally taken as follows:

- $C_F$ = 1,4 in case of a vacuum process with rising curing temperature
- $C_F$ = 1,5 in case of vacuum process
- $C_F$ = 1,7 in the other cases.

# 5 Structural items in plywood

## 5.1 General

### 5.1.1 Principle of design review

As a rule, plywood structures are checked according to an homogeneous material approach, or by a “ply by ply” approach as defined in NR546 Composite Ships.

## 5.2 Rule safety factors

### 5.2.1 Homogeneous material approach

As a general rule, the rule safety factor SF to be taken into account in the global formula used to determine the plating thickness or the permissible stress in stiffeners is to be equal to, or greater than, 4,0.

### 5.2.2 Ply by ply approach

As a general rule, the rule safety factor SF applicable to the maximum stress in each layer of the plywood is to be calculated as follows:

a) Minimum stress criterion in layers

$SF = C_R\ C_i\ C_V$

with:

$C_R$ : Factor taking into account the type of stress in the grain of the plywood layer. Generally:

- $C_R$ = 3,7

  for a tensile or compressive stress parallel to the grain of the ply considered
- $C_R$ = 2,4

  for tensile or compressive stress perpendicular to the grain of the ply considered
- $C_R$ = 2,9

  for a shear stress parallel to the grain of the ply considered

$C_i$ : Factor taking into account the type of loads. Generally:

- $C_i$ = 1,0

  for local external pressures and internal pressures or concentrated forces
- $C_i$ = 0,8

  for test pressures and flooding loads

$C_V$ : Factor taking into account the ageing effect of the plywood, to be taken at least equal to 1,2

b) Critical buckling stress criterion

As a general rule, the rule safety factor $SF_B$ applicable to the critical buckling stress criterion is to be calculated as follows:

$SF_B = C_{buck}\ C_V\ C_i$

with:

$C_{buck}$, $C_V$ : Partial safety factors, to be taken equal to:

- $C_{buck}$ =1,45 and $C_V$ = 1,2

  for the check of the structure under local loads
- $C_{buck}$ = 1,35 and $C_V$ = 1,0

  for the check of the global hull girder structure, if required.

$C_i$ : Partial safety factor defined in [4.3.2].

# Section 6 Bottom Structure

## 1 General

### 1.1 Application

**1.1.1** The requirements of this Section apply to longitudinally or transversely framed single and double bottom structures of hulls built in metallic materials.

Equivalent arrangement for hulls built in composite materials and/or plywood is defined in NR546 Composite Ships.

### 1.2 Scantlings

**1.2.1** The scantlings of bottom and double bottom structural members are to comply with Part B, Chapter 4.

### 1.3 General arrangement

**1.3.1** The bottom structure is to be checked by the Designer to make sure that it withstands the loads resulting from the dry-docking of the harbour equipment.

**1.3.2** The bottom is to be locally stiffened where concentrated loads are envisaged.

**1.3.3** Girders or floors are to be fitted under each line of pillars, when deemed necessary by the Society on the basis of the loads carried by the pillars.

**1.3.4** Adequate tapering is to be provided between double bottom and adjacent single bottom structures. Similarly, adequate continuity is to be provided in the case of height variation in the double bottom. Where such a height variation occurs within 0,6 L amidships, the inner bottom is generally to be maintained continuous by means of inclined plating.

**1.3.5** Provision is to be made for the free passage of water from all parts of the bottom to the suctions, taking into account the pumping rate required.

### 1.4 Drainage and openings for air passage

**1.4.1** Holes are to be cut into floors and girders to ensure the free passage of air and liquids from all parts of the double bottom.

## 2 Transversely framed single bottom

### 2.1 Floors

**2.1.1** Floors are to be fitted at every frame.

In the case of harbour equipment with rise of floor, the floor height may be required to be increased so as to assure a sa-tisfactory connection to the side frames.

### 2.2 Center girder

**2.2.1** All single bottom harbour equipment are to have a center girder. The Society may waive this rule for harbour equipment with $B_F$ less than 6 m, when the floor is a rolled section or when the floor stability is covered otherwise, where $B_F$ is the breadth of the harbour equipment, in m, measured on the top of floor.

The web depth of the centre girder is to extend to the floor plate upper edge. The web thickness is not to be less than that of the floor plates.

Center girder is to be fitted with a face plate or a flange, the net sectional area of which, in cm$^2$, is not to be less than:

$A_f = 0,6\ k_0 k L + 2,7$

where

k : Material factor defined in:
- Ch 2, Sec 2, [2.3] for steel
- Ch 2, Sec 2, [3.5] for aluminium alloys.

$k_0$ : Coefficient to be taken equal to:
- $k_0$= 1 for steel
- $k_0$= 2,35 for aluminium alloys.

### 2.3 Side girders

**2.3.1** Depending on the breadth $B_F$ defined in [2.1.1], side girders are to be fitted in compliance with the following:

- $B_F \leq 6$ m: no side girder
- 6 m < $B_F \leq 9$ m: one side girder at each side
- $B_F > 9$ m: two side girders at each side.

Side girders are to be fitted with a face plate or a flange, the net sectional area of which is not to be less than that of the floor plate.

Centre and side girders are to be extended as far aft and forward as practicable.

Intercostal web plates of centre and side girders are to be aligned and welded to floors.

Where two girders are slightly offset, they are to be shifted over a length at least equal to two frame spacings.

Towards the ends, the thickness of the web plate as well as the sectional area of the top plate may be reduced by 10%. Lightening holes are to be avoided.

Where side girders are fitted in lieu of the centre girder, the scarfing is to be adequately extended and additional stiffening of the centre bottom may be required.

## 3 Longitudinally framed single bottom

### 3.1 Bottom longitudinals

**3.1.1** Longitudinal ordinary stiffeners are generally to be continuous when crossing primary supporting members.

The section modulus of longitudinals located in way of the web frames of transverse bulkheads is to be increased by 10%.

The Society may call for strengthening of the longitudinal located in the centreline of the harbour equipment.

### 3.2 Bottom transverses

**3.2.1** In general, the transverse spacing is to be not greater than 8 frame spacing, not than 4m, which is the lesser.

Where the ratio of the bottom transverse web height to its net thickness exceeds 100, the bottom transverse web is to be provided with stiffeners in way of longitudinals in compliance with Ch 2, Sec 3, [5.7.1], Ch 2, Sec 3, [5.7.2] and Ch 2, Sec 3, [5.7.3], as applicable. The stiffeners are to extend between the longitudinals and the upper faceplate of the transverse, without any connection with that faceplate.

In the case of harbour equipment with rise of floor, the bottom transverse height may be required to be increased so as to assure a satisfactory connection to the side transverses.

### 3.3 Bottom girders

**3.3.1** The requirement in [2.2] and [2.3] apply also to longitudinally framed single bottoms, with transverses instead of floors.

## 4 Transversely framed double bottom

### 4.1 Double bottom arrangement

**4.1.1** Where the height of the double bottom varies in the longitudinal direction, the variation is to be made gradually over an adequate length.

The knuckles of inner bottom plating are to be located in way of plate floors. Where this is impossible, suitable longitudinal structures such as partial girders, longitudinal brackets etc., fitted across the knuckle are to be arranged.

For harbour equipment without a flat bottom, the height of double bottom may be required to be adequately increased such as to ensure sufficient access to the areas towards the sides.

Adequate strength continuity of floors is to be ensured in way of the side tank by means of brackets.

### 4.2 Floors

**4.2.1** Floors are to be fitted at every frame.

Watertight floors are to be fitted in way of:

- transverse watertight bulkheads
- double bottom steps.

In general, floors are to be continuous.

Where the double bottom height does not enable to connect the floors and girders to the inner bottom by fillet welding, slot welding may be used. In that case, the floors and girders are to be fitted with a face plate or a flange.

### 4.3 Bilge wells

**4.3.1** Bilge wells arranged in the double bottom are to be limited in depth and formed by steel plates having a thickness not less than the greater of the required for watertight floors and that required for the inner bottom.

In harbour equipment subject to damage stability requirements, such bilge wells are to be fitted so that the distance of their bottom from the shell plating is not less than 400 mm.

### 4.4 Girders

**4.4.1** A center girder is to be fitted on all harbour equipment exceeding 6 m in breadth.

This centre girder is to be formed by a vertical intercostal plate connected to the bottom plating and to double bottom top.

The intercostal centre girder is to extend over the full length of the harbour equipment or over the greatest length consistent with the lines. It is to have the same thickness as the floors. No manholes are to be provided into the centre girder.

harbour equipment built in the transverse system without web frames are to be fitted with partial intercostal girders in way of the transverse bulkheads of the side tanks, in extension of the inner sides. These girders are to be extended at each end by brackets having a length equal to one frame spacing. They are to have a net thickness equal to that of the inner sides.

## 5 Longitudinally framed double bottom

### 5.1 General

**5.1.1** The requirements in [4.1], [4.3] and [4.4] are applicable to longitudinally framed double bottoms.

### 5.2 Transverses

**5.2.1** The spacing of transverses, in m, is generally to be not greater than 8 frame spacings nor 4 m, whichever is the lesser.

Additional transverses are to be fitted in way of transverse watertight bulkheads.

Where the ratio of the bottom transverse web height to its net thickness exceeds 100, the bottom transverse web is to be provided with stiffeners in way of longitudinals in compliance with Ch 2, Sec 3, [5.7.1], Ch 2, Sec 3, [5.7.2] and Ch 2, Sec 3, [5.7.3], as applicable. The stiffeners are to extend between the longitudinals and the upper faceplate of the transverse, without any connection with that faceplate.

### 5.3 Bottom and inner bottom longitudinal ordinary stiffeners

**5.3.1** Bottom and inner bottom longitudinal ordinary stiffeners are generally to be continuous through the transverses.

In the case the longitudinals are interrupted in way of a transverse, brackets on both sides of the transverse are to be fitted in perfect alignment.

### 5.4 Brackets to centreline girder

**5.4.1** In general, intermediate brackets are to be fitted connecting the centre girder to the nearest bottom and inner bottom ordinary stiffeners.

Such brackets are to be stiffened at the edge with a flange having a width not less than 1/10 of the local double bottom height.

If necessary, the Society may require a welded flat bar to be arranged in lieu of the flange.

# Section 7 Side Structure

## 1 General

### 1.1 Application

**1.1.1** The requirements of this Section apply to longitudinally or transversely framed single and double side structures of harbour equipment of hulls built in metallic materials.

Equivalent arrangement for hulls built in composite materials and/or plywood is defined in NR546 Composite Ships.

### 1.2 Scantling

**1.2.1** The scantlings of side and inner side structural members are to comply with Part B, Chapter 4.

A thicker sheerstrake may be waived if an efficient fender is fitted in way of the main deck.

### 1.3 General arrangement

**1.3.1** The transversely framed side structures are built with transverse frames possibly supported by struts, side stringers and web frames.

**1.3.2** The longitudinally framed side structures are built with longitudinal ordinary stiffeners supported by side vertical primary supporting members.

## 2 Transversely framed single side

### 2.1 Side frames

**2.1.1** Transverse frames are to be fitted at every frame.

#### 2.1.2 Continuity

Frames are generally to be continuous when crossing primary supporting members.

Otherwise, the detail of the connection is to be examined by the Society on a case by case basis.

The frames are to be connected to the floors in accordance with Fig 1 or in an equivalent way.

For overlapping connection as to Fig 1, sketches b and c, a fillet weld run all around has to be provided.

At the upper end of frames, connecting brackets are to be provided in compliance with Article [6].

In the case of longitudinally framed deck, connecting brackets are to extend up to the deck longitudinal most at side.

When a side stringer is fitted at about mid-span of the frame, the required section modulus of the frame may be reduced by 20%.

In the case of a longitudinally framed single bottom, the side frames are to be connected to the bottom longitudinal most at side, either directly or by means of a bracket, in accordance with Fig 2.

### 2.2 Side stringers

**2.2.1** Side stringers, if fitted, are to be flanged or stiffened by a welded face plate.

The side stringers are to be connected to the frames by welds, either directly or by means of collar plates.

### 2.3 Web frames

**2.3.1** Web frames are to be fitted with a spacing, in m, not greater than 5 m.

For a construction on the combination system, side web frames are to be provided in way of bottom transverses.

Where the web frames are connected to the floors or the strong beams, web frame strength continuity is to be ensured according to Ch 2, Sec 3, [5.5].

**Figure 1 : Connection with floors**

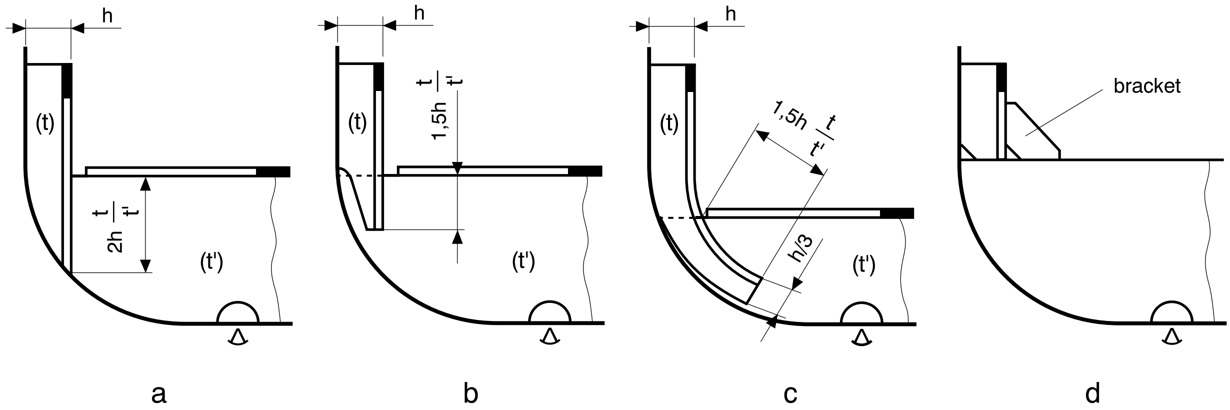
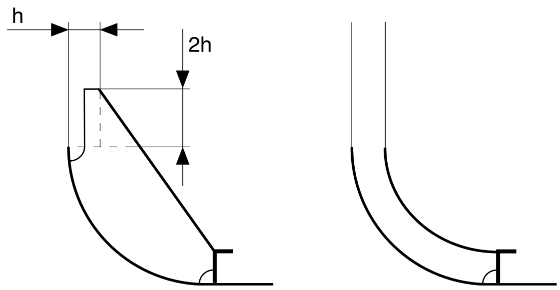



**Figure 2 : Connection of frames to bottom longitudinals**




# 3 Longitudinally framed single side

## 3.1 Side transverses

**3.1.1** Side transverses are to be fitted:

- in general, with a spacing not greater than 8 frame spacing, nor than 4 m
- in way of hatch and beams.

The side transverses are generally directly welded to the shell plating.

In the case of a double bottom, the side transverses are to be bracketed to the bottom transverses.

## 3.2 Side longitudinals

**3.2.1** Longitudinal ordinary stiffeners are generally to be continuous when crossing primary supporting members.

In the case the longitudinals are interrupted by a primary supporting member, brackets on both sides of the primary supporting member are to be fitted in perfect alignment.

The section modulus of side longitudinals located in way of the stringers of transverse bulkheads is to be increased by 20%.

# 4 Transversely framed double side

## 4.1 General

**4.1.1** Adequate continuity of strength is to be ensured in way of breaks or changes in width of the double side.

In particular, scarfing of the inner side is to be ensured beyond the centre part.

## 4.2 Side and inner side frames

**4.2.1** Side frames may be connected to the inner side frames by means of struts having a sectional area not less than those of the connected frames.

Struts are generally to be connected to side and inner side frames by means of vertical brackets or by appropriate weld sections.

Where struts are fitted between side and inner side frames at mid-span, the section modulus of side frames and inner side frames may be reduced by 30%.

### 4.3 Side and inner side web frames

**4.3.1** It is recommended to provide web frames, fitted every 3 m and in general not more than 6 frame spacings apart.

In any case, web frames are to be fitted in way of strong deck beams.

At their upper end, side and inner side web frames are to be connected by means of a bracket. This bracket can be a section or a flanged plate with a section modulus at least equal to that of the web frames.

At mid-span, the web frames are to be connected by means of struts, the cross sectional area of which is not to be less than those of the connected web frames.

At their lower end, the web frames are to be adequately connected to the floors.

## 5 Longitudinally framed double side

### 5.1 General

**5.1.1** The requirements in [4.1.1] also to apply to longitudinally framed double side.

### 5.2 Side and inner side longitudinals

**5.2.1** Side longitudinals may be connected to the inner side longitudinals by means of struts having a sectional area not less than those of the connected longitudinals.

Struts are generally to be connected to side and inner side longitudinals by means of brackets or by appropriate weld sections.

Where struts are fitted between side and inner side longitudinals at mid-span, the section modulus of side longitudinals and inner side longitudinals may be reduced by 30%.

### 5.3 Side transverses

**5.3.1** The requirements in [4.3.1] also apply to longitudinally framed double side, with side transverses instead of side web frames.

## 6 Frame connection

### 6.1 General

#### 6.1.1 End connections

At their lower end, frames are to be connected to floors, by means of lap weld or by means of brackets.

At the upper end of frames, connecting brackets are to be provided, in compliance with [6.2].

Brackets are normally connected to frames by lap welds. The length of overlap is to be not less than the depth of frames.

#### 6.1.2 Brackets

The same minimum value d is required for both arm lengths of straight brackets. Straight brackets may therefore have equal sides.

A curved bracket is to be considered as the largest equal-sided bracket contained in the curved bracket.

### 6.2 Upper and lower brackets of frames

**6.2.1** The arm length of upper brackets, connecting frames to deck beams, and the lower brackets, connecting frames to the inner bottom or to the face plate of floors is to be not less than the value obtained, in mm, from the following formula:

$$d = \varphi\sqrt{\frac{w+30}{t}}$$

where:

$\varphi$ : Coefficient defined as follows:

- for unflanged brackets:

  $\varphi = 50$

- for flanged brackets:

  $\varphi = 45$

w : Required net section modulus of the stiffener, in $cm^3$, given in [6.2.2] and depending on the type of connection

t : Bracket net thickness, in mm, to be taken not less than the stiffener thickness.

#### 6.2.2 Section modulus of connections

For connections of perpendicular stiffeners located in the same plane (see Fig 3) or connections of stiffeners located in perpendicular planes (see Fig 4), the required section modulus is to be taken equal to:

$w = w_2$ if $w_2 \le w_1$

$w = w_1$ if $w_2 > w_1$

where $w_1$ and $w_2$ are the required net section moduli of stiffeners, as shown in Fig 3 and Fig 4.

**6.2.3** All brackets for which:

$$\frac{\ell_b}{t} > 60$$

where:

$l_b$ : Length, in mm, of the free edge of the bracket

t : Bracket net thickness, in mm,

are to be flanged or stiffened by a welded face plate.

The sectional area, in cm², of the flange or the face plate is to be not less than $0{,}01\ l_b$ .

The width of the faceplate, in mm, is to be not less than 10 t.

**Figure 3 : Connections of perpendicular stiffeners in the same plane**

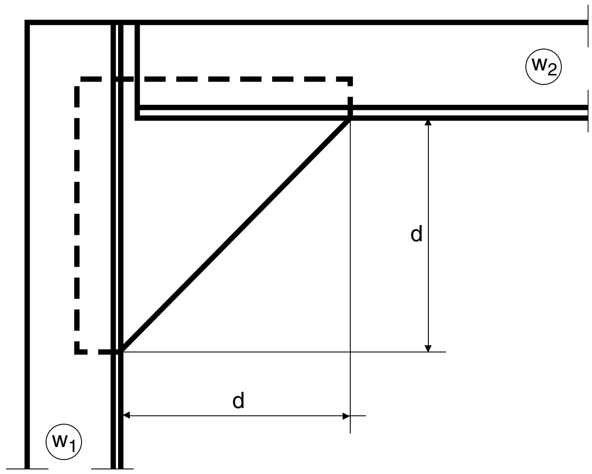
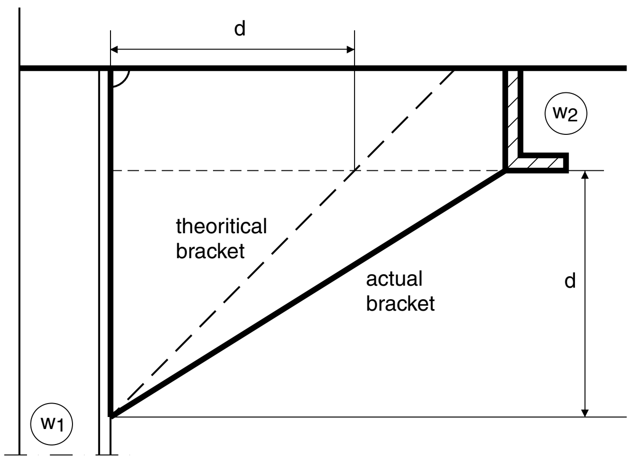



**Figure 4 : Connection of stiffeners located in perpendicular planes**



# Section 8 Deck Structure

## 1 General

### 1.1 Application

**1.1.1** The requirements of this Section apply to longitudinally or transversely framed deck structures of hulls built in metallic materials.

Equivalent arrangement for hulls built in composite materials and/or plywood is defined in NR546 Composite Ships.

### 1.2 Scantlings

**1.2.1** The scantling of deck structural members are to comply with Part B, Chapter 4.

### 1.3 General arrangement

**1.3.1** The deck supporting structure consists of ordinary stiffeners (beams or longitudinals), longitudinally or transversely arranged, supported by primary supporting members which may be sustained by pillars.

**1.3.2** Where beams are fitted in a hatched deck, these are to be effectively supported by at least two longitudinal girders located in way of hatch side girders to which they are to be connected by brackets and/or clips.

**1.3.3** Adequate continuity of strength is to be ensured in way of:

- stepped strength decks
- changes in the framing system.

Details of structural arrangements are to be submitted for review to the Society.

**1.3.4** Where applicable, deck transverses of reinforced scantlings are to be aligned with floors.

**1.3.5** Inside the line of openings, a transverse structure is generally to be adopted for cross-deck structures, beams are to be adequately supported by girders and, in units greater than 120 m in length, extend up to the second longitudinal from the hatch side girders toward the bulwark.

Where this is impracticable, intercostal stiffeners are to be fitted between the hatch side girder and the second longitudinal.

Other structural arrangements may be accepted, subject to their strength verification. In particular, their buckling strength against the transverse compression loads is to be checked. Where needed, deck transverses may be required to be fitted.

**1.3.6** Deck supporting structures under deck machinery, cranes and king posts are to be adequately stiffened.

**1.3.7** Pillars or other supporting structures are generally to be fitted under heavy concentrated loads.

**1.3.8** Special arrangements, such as girders supported by cantilevers, are considered by the Society on a case-by-case basis.

**1.3.9** Stiffeners are also to be fitted in way of the ends and corners of deck houses and partial superstructures.

#### 1.3.10 Manholes and flush deck plugs

Manholes and flush deck plugs exposed to the weather are to be fitted with steel covers of efficient construction capable of ensuring tightness.

These covers are to be fitted with permanent securing device, unless they are secured with closed spaced bolts.

#### 1.3.11 Scuppers

Scuppers on the weather deck and terminating outside the hull are to be made of pipes the gross thickness of which, as a rule, is not to be less than that of the side plating under the sheerstrake but, however needs not exceed 8 mm.

#### 1.3.12 Stringer plate openings

The openings made in the stringer plate other than scupper openings are to be wholly compensated to the satisfaction of the Society.

### 1.4 Coaming of separate hatchways

#### 1.4.1 Height

The coaming upper edge is not to be less than 300 mm above the deck.

Furthermore, the height of the hatch coaming, $h_c$, above the deck is to comply with the following:

$z_c \geq T + 0,45$

#### 1.4.2 Net thickness

The net thickness of the coaming boundaries is not to be less than:

$t = 0{,}25\ a + 3(k_0 k)^{0{,}5} \leq 5 k_0^{0{,}5} mm,$

where:

a : The greater dimension of the hatchway, in m

k : Material factor defined in:
- Ch 2, Sec 2, [2.3] for steel
- Ch 2, Sec 2, [3.5] for aluminium alloys

$k_0$ : Coefficient to be taken equal to:
- $k_0$= 1 for steel
- $k_0$= 2,35 for aluminium alloys

#### 1.4.3 Stiffening

The coaming boundaries are to be stiffened with an horizontal stiffening member close to the coaming upper edge. In the case the coaming is higher than 750 mm, a second stiffener is to be fitted at about 0,75 times the hatch coaming height.

The coaming boundaries are to be stiffened with stays, the ends of which are to be connected to the deck and to the upper horizontal stiffeners.

Where necessary, stiffeners are to be provided under deck in way of the stays.

#### 1.4.4 Strength continuity

Arrangements are to be made to ensure strength continuity of the top structure, at the end of large-size hatchways, mainly by extending the deck girders along the hatchway, beyond the hatchways, up to the end bulkhead or over two frame spacings, whichever is greater.

## 2 Transversely framed deck

### 2.1 Deck beams

**2.1.1** In general, deck beams or deck half-beams are to be fitted at each frame.

### 2.2 Deck girders

**2.2.1** Deck girders subjected to concentrated loads are to be adequately strengthened.

Deck girders are to be fitted with tripping stiffeners or brackets:
- spaced not more than 20 times the girder faceplate width
- in way of concentrated loads and pillars.

Where a deck girder comprises several spans and its scantlings vary from one span to another, the connection of two different parts is to be effected gradually by strengthening the weaker part over a length which, as a rule, is to be equal to 25% of its length.

The connection of girders to the supports is to ensure correct stress transmission. In particular, connection to the bulkheads is to be obtained by means of flanged brackets having a depth equal to twice that of the deck girder and the thickness of the girder, or by any equivalent method.

## 3 Longitudinally framed deck

### 3.1 Deck longitudinals

**3.1.1** Deck longitudinals are to be continuous, as far as practicable, in way of deck transverses and transverse bulkheads.

Other arrangements may be considered, provided adequate continuity of longitudinal strength is ensured.

The section modulus of deck longitudinals located in way of the web frames of transverse bulkheads is to be increased by 20%.

Frame brackets, in harbour equipment units with transversely framed sides, are generally to have their horizontal arm extended to the adjacent longitudinal ordinary stiffener.

### 3.2 Deck transverses

**3.2.1** In general, the spacing of deck transverses is not to exceed 8-frame spacings or 4 m, whichever is the lesser.

Where applicable, deck transverses of reinforced scantlings are to be aligned with bottom transverses.

The section modulus of transverse parts in way of the stringer plate is not to be less than the rule value obtained by determining them as deck transverses or as side shell transverses, whichever is greater.

# 4 Pillars

## 4.1 General

**4.1.1** Pillars are to be fitted, as far as practicable, in the same vertical line.

**4.1.2** In general, pillars are to be fitted below winches, cranes, in the engine room and at the corners of deckhouses.

**4.1.3** In tanks, solid or open section pillars are generally to be fitted. Pillars located in spaces intended for products which may produce explosive gases are to be of open section type.

**4.1.4** Tight or non-tight bulkheads may be considered as pillars, provided that their arrangement complies with Article [5].

## 4.2 Connections

**4.2.1** Heads and heels of pillars are to be attached to the surrounding structure by means of brackets or insert plates so that the loads are well distributed.

Insert plates may be replaced by doubling plates, except in the case of pillars which may also work under tension such as those in tanks.

In general, the net thickness of doubling plates is to be not less than 1,5 times the net thickness of the pillar.

**4.2.2** Pillars are to be attached at their heads and heels by continuous welding.

**4.2.3** Pillars are to be connected to the inner bottom at the intersection of girders and floors.

**4.2.4** Where pillars connected to the inner bottom are not located in way of intersections of floors and girders, partial floors or girders or equivalent structures suitable to support the pillars are to be arranged.

**4.2.5** Manholes may not be cut in the girders and floors below the heels of pillars.

**4.2.6** Where pillars are fitted in tanks, head and heel brackets may be required if tensile stresses are expected.

**4.2.7** Where side pillars are not fitted in way of hatch ends, vertical stiffeners of bulkheads supporting hatch side girders or hatch end beams are to be bracketed at their ends.

# 5 Bulkheads acting as pillars

## 5.1 General

**5.1.1** Partial or complete bulkheads may be substituted to pillars. In this case, the scantlings and arrangement of the vertical stiffeners of the bulkheads are to comply with applicable requirements of Ch 2, Sec 9, [4.1.3].

# Section 9 Bulkhead Structure

## 1 General

### 1.1 Application

**1.1.1** The requirements of this Section apply to longitudinal or transverse bulkhead structures of hulls built in metallic materials. Equivalent arrangement for hulls built in composite materials and/or plywood is defined in NR546 Composite Ships.

**1.1.2** Bulkheads may be plane or corrugated, horizontally or vertically stiffened.

Horizontally framed bulkheads consist of horizontal ordinary stiffeners supported by vertical primary supporting members.

Vertically framed bulkheads consist of vertical ordinary stiffeners which may be supported by horizontal girders.

### 1.2 Scantling

**1.2.1** The scantlings of bulkhead structural members are to comply with Part B, Chapter 4.

### 1.3 General arrangement

**1.3.1** The number and location of watertight bulkheads are to be in accordance with the relevant requirements given in Ch 2, Sec 1, [1].

**1.3.2** Where an inner bottom terminates on a bulkhead, the lowest strake of the bulkhead forming the watertight floor of the double bottom is to extend at least 300 mm above the inner bottom.

**1.3.3** Longitudinal bulkheads are to terminate at transverse bulkheads and are to be effectively tapered to the adjoining structure at the ends and adequately extended in the machinery space, where applicable.

**1.3.4** The structural continuity of the bulkhead vertical and horizontal primary supporting members with the surrounding supporting structures is to be carefully ensured.

**1.3.5** The height of vertical primary supporting members of longitudinal bulkheads may be gradually tapered from bottom to deck.

## 2 Plane bulkheads

### 2.1 General

**2.1.1** Where a bulkhead does not extend up to the upper most continuous deck, such as the after peak bulkhead, suitable strengthening is to be provided in the extension of the bulkhead.

**2.1.2** Bulkheads are to be stiffened in way of deck girders.

**2.1.3** The stiffener webs of side tank watertight bulkheads are generally to be aligned with the webs of inner hull longitudinal stiffeners.

**2.1.4** Floors are to be fitted in the double bottom in way of plane transverse bulkheads.

**2.1.5** Instead of the thickness increase required here before, a doubling plate of the same thickness as the bulkhead plating may be fitted.

### 2.2 Bulkhead stiffeners

**2.2.1** As a rule, stiffeners are to be fitted in way of structural components likely to exert concentrated loads, such as deck girders and pillars, and for engine room end bulkheads, at the ends of the engine seatings.

On vertically framed watertight bulkheads, where stiffeners are interrupted in way of the watertight doors, stanchions are to be fitted on either side of the door, carlings are to be fitted to support the interrupted stiffeners.

### 2.3 End connections of ordinary stiffeners

**2.3.1** In general, end connections of ordinary stiffeners are to be welded directly to the plating or bracketed. However, stiffeners may be sniped, provided the scantlings of such stiffeners are modified accordingly.

**2.3.2** Sniped ends may be accepted where the hull lines make it mandatory in the following cases:

- liquid compartment boundaries
- end bulkheads.

**2.3.3** Where sniped ordinary stiffeners are fitted, the snipe angle is to be not greater than 30° and their ends are to be extended, as far as practicable, to the boundary of the bulkhead.

Moreover, the thickness of the bulkhead plating supported by the stiffener is to be in compliance with Ch 2, Sec 3, [4.5.3].

## 2.4 Bracketed ordinary stiffeners

**2.4.1** Where bracketed ordinary stiffeners are fitted, the arm lengths of end brackets of ordinary stiffeners, as shown in Fig 1 and Fig 2 are to be not less than the following values, in mm:

- for arm length a:
  - brackets of horizontal stiffeners and bottom bracket of vertical stiffeners:

    $a = 100\, l$
  - upper bracket of vertical stiffeners:

    $a = 80\, l$
- for arm length b, the greater of:

$$b = 80\sqrt{\frac{w+20}{t}}$$

$$b = \alpha\frac{ps\ell}{t}$$

where:

l : Span, in m, of the stiffener measured between supports

w : Net section modulus, in cm$^3$, of the stiffener

t : Net thickness, in mm, of the bracket

p : Design pressure, in kN/m$^2$, calculated at mid span

α : Coefficient defined as follows:

$\alpha = 4{,}9$ for tank bulkheads

$\alpha = 3{,}6$ for watertight bulkheads.

**Figure 1 : Bracket at upper end of ordinary stiffener on plane bulkhead**

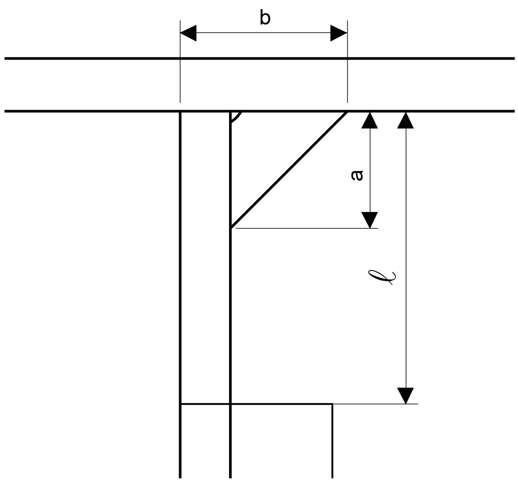
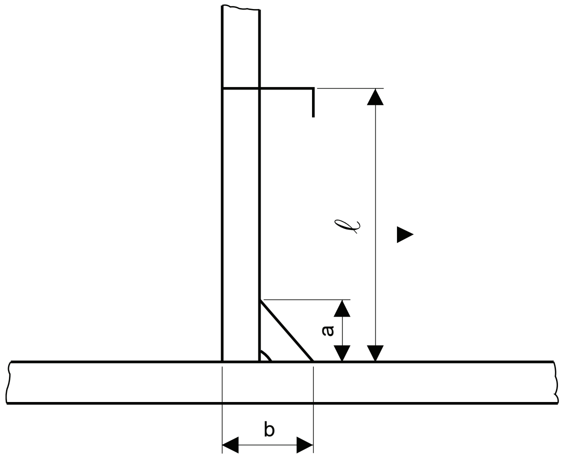


**Figure 2 : Bracket at lower end of ordinary stiffener on plane bulkhead**




**2.4.2** The connection between the stiffener and the bracket is to be such that the section modulus of the connection is not less than that of the stiffener.

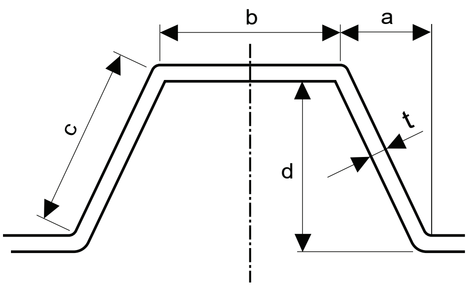
The brackets are to extend up to the next stiffener where the framing is transverse, or connect the stiffener to a longitudinal stiffener where the framing is longitudinal.

# 3 Corrugated bulkheads

## 3.1 General

**3.1.1** The main dimensions a, b, c and d of corrugated bulkheads are defined in Fig 3.

**Figure 3 : Corrugated bulkheads**




**3.1.2** Unless otherwise specified, the following requirement is to be complied with:

$a \leq b$

Moreover, in some cases, the Society may prescribe an upper limit for the ratio b / t.

**3.1.3** In general, the bending internal radius $R_i$ is to be not less than the following values, in mm:

- for normal strength steel:

  $R_i = 2,5\ t$

- for high tensile steel:

  $R_i = 3,0\ t$

where t is the thickness, in mm, of the corrugated plate.

**3.1.4** When butt welds in a direction parallel to the bend axis are provided in the zone of the bend, the welding procedures are to be submitted to the Society for approval, as a function of the importance of the structural element.

**3.1.5** Transverse corrugated bulkheads having horizontal corrugations are to be fitted with vertical primary supporting members of number and size sufficient to ensure the required vertical stiffness of the bulkhead.

**3.1.6** In general, where girders or vertical primary supporting members are fitted on corrugated bulkheads, they are to be arranged symmetrically.

## 3.2 Bulkhead scantlings

### 3.2.1 Bulkhead plating

The bulkhead plating net thickness is to be determined as specifies in Ch 4, Sec 2 substituting the stiffener spacing by the greater of the two values b and c, in m, as per [3.1.1].

### 3.2.2 Corrugations

The section modulus of a corrugation is to be not less than that of the equivalent stiffener having the same span as the corrugation and an attached plating width equal to (b + a).

The actual section modulus of a corrugation having the width (b + a) is to be obtained, in cm³, from following formula:

$$w = \frac{td}{6}(3b + c) \cdot 10^{-3}$$

where:

t : Net thickness of the plating of the corrugation, in mm

d, b, c : Dimensions of the corrugation, in mm, shown in Fig 3.

Moreover, where the ratio b / t ≥ 46, the net section modulus required for a bulkhead is to be in accordance with the following formula:

$$w = 206 c_k \frac{(b+a)}{E} p \left(\frac{\ell b}{80t}\right)^2$$

where:

$c_k$ : Coefficient defined in Tab 1

p : Bulkhead design pressure, in kN/m², calculated at mid-span.

E : Young's modulus, in N/mm²:

- $E = 2,06 \cdot 10^5$ for steel, in general
- $E = 1,95 \cdot 10^5$ for stainless steel
- $E = 7,00 \cdot 10^4$ for aluminium alloys

**Table 1 : Values of coefficient $c_k$**

| Boundary conditions | End bulkheads | Watertight bulkhead | Cargo hold bulkhead |
|---|---|---|---|
| simply supported | 1,73 | 1,38 | 1,04 |
| simply supported (at one end) | 1,53 | 1,20 | 0,92 |
| clamped | 1,15 | 0,92 | 0,69 |

### 3.2.3 Stringer and web frames

It is recommended to fit stringers or web frames symmetrically with respect to the bulkhead. In all cases, their section modulus is to be determined in the same way as for a plane bulkhead stringer or web frame.

## 3.3 Structural arrangement

**3.3.1** The strength continuity of corrugated bulkheads is to be ensured at ends of corrugations.

**3.3.2** where stools are fitted at the lower part of transverse bulkheads, the thickness of adjacent plate floors is to be not less than that of the stool plating.

**3.3.3** In general, where vertically corrugated longitudinal bulkheads are welded on the inner bottom, girders are to be fitted in double bottom in way of the flanges of corrugations.

However, other arrangements ensuring adequate structural continuity may be accepted by the Society.

**3.3.4** In general, the upper and lower parts of horizontally corrugated bulkheads are to be flat over a depth equal to 0,1 D.

## 3.4 Bulkhead stool

**3.4.1** In general, plate diaphragms or web frames are to be fitted in bottom stools in way of the double bottom longitudinal girders or plate floors, as the case may be.

**3.4.2** Brackets or deep webs are to be fitted to connect the upper stool to the deck transverses or hatch end beams, as the case may be.

**3.4.3** The continuity of the corrugated bulkhead with the stool plating is to be adequately ensured. In particular, the upper strake of the lower stool is to be of the same thickness and yield stress as those of the lower strake of the bulkhead.

# 4 Non-watertight bulkheads

## 4.1 Non-watertight bulkheads

### 4.1.1 Definition

A bulkhead is considered to be acting as a pillar when besides the lateral loads, axial loads are added.

### 4.1.2 Non-watertight bulkheads not acting as pillars

Non-tight bulkheads not acting as pillars are to be provided with vertical stiffeners with a maximum spacing equal to:

- 0,9 m, for transverse bulkheads
- two frame spacings with a maximum of 1,5 m, for longitudinal bulkheads.

### 4.1.3 Non-watertight bulkheads acting as pillars

Non-tight bulkheads acting as pillars are to be provided with vertical stiffeners with a maximum spacing equal to:

- two frame spacings, when the frame spacing does not exceed 0,75 m
- one frame spacing, when the frame spacing is greater than 0,75 m.

Each vertical stiffener, in association with a width of plating equal to 35 times the plating thickness, is to comply with the applicable requirements for pillars in Ch 4, Sec 4, [3.2].

In the case of non-tight bulkheads supporting longitudinally framed decks, web frames are to be provided in way of deck transverses.

Part B
Hull Design and Construction

# CHAPTER 3
# GLOBAL STRENGTH ANALYSIS - METALLIC HULLS

# Section 1 Longitudinal Hull Girder Strength Analysis

## Symbols

L : Rule length, in m, defined in Ch 1, Sec 2, [3.1]

D : Depth, in m, defined in Ch 1, Sec 2, [3.4]

k : Material factor defined in:

- Ch 2, Sec 2, [2.3] for steel
- Ch 2, Sec 2, [3.5] for aluminium alloys

$M_H$ : Design still water bending moment in hogging condition, in kN.m, defined in the relevant chapter of Part D

$M_S$ : Design still water vertical bending moment in sagging condition, in kN.m, defined in the relevant chapter of Part D

$M_{WV}$ : Vertical wave bending moment, in kN.m, defined in Ch 4, Sec 1, [4.2] for operation in smooth water stretches or Pt D, Ch 8, Sec 4, [2.4.1] for harbour equipment assigned notation $\mathbf{H_S \le x}$

Z : Hull girder section modulus, in $cm^3$.

## 1 General

### 1.1 Application

**1.1.1** This Section specifies:

- the criteria for calculating the hull girder strength characteristics to be used for the checks, in association with the hull girder loads
- the yielding strength check criteria.

### 1.2 Length-to-depth ratio - Steel hulls

**1.2.1** In principle, the length-to-depth ratio is not to be greater than L/D = 35.

Harbour equipment having a length-to-depth ratio greater than L/D = 35 will be considered by the Society on a case- by-case basis.

### 1.3 Length-to-depth ratio - Aluminium alloy hulls

**1.3.1** For harbour equipment with a rule length L equal to or greater than 40 m, the length-to-depth ratio will be specially considered by the Society.

## 2 Characteristics of the hull girder transverse sections

### 2.1 Hull girder transverse sections

#### 2.1.1 General

The hull girder transverse sections are to be considered as being constituted by the members contributing to the hull girder longitudinal strength, i.e. all continuous longitudinal members below the strength deck defined in [2.2], taking into account the requirements of [2.1.2] to [2.1.8].

#### 2.1.2 Continuous trunks and continuous longitudinal hatch coamings

Continuous trunks and continuous longitudinal hatch commons may be included in the hull girder transverse sections, provided they are effectively supported by longitudinal bulkheads or primary supporting members.

#### 2.1.3 Longitudinal ordinary stiffeners or girders welded above the decks

Longitudinal ordinary stiffeners or girders welded above the decks (including the deck of any trunk fitted as specified in [2.1.2]) may be included in the hull girder transverse sections.

#### 2.1.4 Longitudinal bulkheads with vertical corrugations

Longitudinal bulkheads with vertical corrugations may not be included in the hull girder transverse sections.

#### 2.1.5 Members in materials other than steel

In steel hulls, where a member contributing to the longitudinal strength is made in material other than steel with a Young's modulus E equal to 2,06 $10^5$ N/mm², the steel equivalent sectional area that may be included in the hull girder transverse sections is obtained, in m², from the following formula:

$$A_{SE} = \frac{E}{2{,}06{,}10^5} A_M$$

where:

$A_M$ : Sectional area, in m², of the member under consideration.

#### 2.1.6 Large openings and scallops

Large openings are:

- in the side shell plating: openings having a diameter greater than or equal to 300 mm
- in the strength deck: openings having a diameter greater than or equal to 350 mm.

Large openings and scallops, where scallop welding is applied, are always to be deducted from the sectional areas included in the hull girder transverse sections.

#### 2.1.7 Small openings

Individual small openings which do not comply with the arrangement requirements given in Ch 5, Sec 4, [2] and Ch 5, Sec 4, [3], are to be deducted from the sectional areas included in the hull girder transverse sections.

#### 2.1.8 Lightening holes, draining holes and single scallops

Lightening holes, draining holes and single scallops in longitudinals or girders need not be deducted if their height is less than 0,25 $h_W$, without being greater than 75 mm, where $h_W$ is the web height, in mm.

Otherwise, the excess is to be deducted from the sectional area or compensated.

### 2.2 Strength deck

**2.2.1** The strength deck is, in general, the uppermost continuous deck.

In the case of a superstructure or deckhouses contributing to the longitudinal strength, the strength deck is the deck of the superstructure or the deck of the uppermost deckhouse.

Superstructures and deckhouses are deck erections defined in Ch 1, Sec 2, [3.8] and Ch 1, Sec 2, [3.9].

**2.2.2** A superstructure extending at least 0,15 L within 0,4 L amidships may generally be considered as contributing to the longitudinal strength. For other superstructures and for deckhouses, their contribution to the longitudinal strength is to be assessed on a case by case basis, through a finite element analysis of the whole harbour equipment, which takes into account the general arrangement of the longitudinal elements (side, decks, bulkheads).

The presence of openings in the side shell and longitudinal bulkheads is to be taken into account in the analysis. This may be done in two ways:

- by including these openings in the finite element model
- by assigning to the plate panel between the side frames beside each opening an equivalent thickness, in mm, obtained from the following formula:

$$t_{EQ} = 10^3 \left[ \ell_P \left( \frac{Gh^2}{12 E I_J} + \frac{1}{A_J} \right) \right]^{-1}$$

where (see Fig 1):

$\ell_P$ : Longitudinal distance, in m, between the frames beside the opening

h : Height, in m, of openings

$I_J$ : Moment of inertia, in m⁴, of the opening jamb about the transverse axis y-y (jamb stiffeners included)

$A_J$ : Shear area, in m², of the opening jamb in the direction of the longitudinal axis x-x (jamb stiffeners not included)

G : Coulomb's modulus, in N/mm², of the material used for the opening jamb, to be taken equal to:

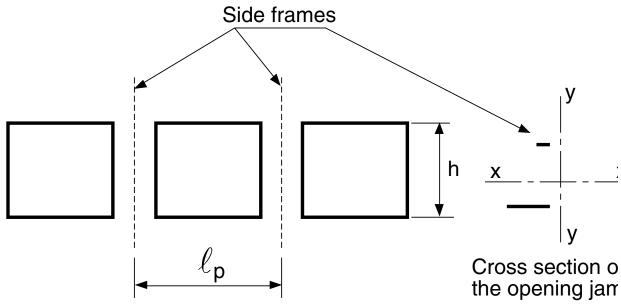
- for steels:

  $G = 8{,}0.10^4$ N/mm²

- for aluminium alloys:

  $G = 2{,}7.10^4$ N/mm².

Figure 1 : Side openings




### 2.3 Hull girder section modulus

**2.3.1** The section modulus at any point of a hull transverse section is obtained, in $cm^3$, from the following formula:

$$Z = \frac{I_Y}{100|z-N|}$$

where:

$I_Y$ : Moment of inertia, in $cm^4$, of the hull girder transverse section defined in [2.1], about its horizontal neutral axis

N : Z co-ordinate, in m, of the centre of gravity of the hull transverse section

z : Z co-ordinate, in m, of the calculation point of a structural element.

**2.3.2** The section moduli at bottom and at deck are obtained, in $m^3$, from the following formulae:

- at bottom:

$$Z = \frac{I_Y}{N}$$

- at deck:

$$Z = \frac{I_Y}{V_D}$$

where:

$I_Y$, N : Defined in [2.3.1]

$V_D$ : Vertical distance, in m:

- in general:
  $V_D = z_D - N$
- if continuous trunks or hatch coamings are taken into account in the calculation of $I_Y$:

$$V_D = (z_T - N)\left(0{,}9 + 0{,}2\frac{y_T}{B}\right) \geq z_D - N$$

- if longitudinal ordinary stiffeners or girders welded above the strength deck are taken into account in the calculation of $I_Y$, $V_D$ is to be obtained from the formula given above for continuous trunks and hatch coamings. In this case, $y_T$ and $z_T$ are the Y and Z co-ordinates, in m, of the top of the longitudinal stiffeners or girders with respect to the reference co-ordinate system defined in Ch 1, Sec 2, [4].

$z_D$ : Z co-ordinate, in m, of strength deck with respect to the reference co-ordinate system defined in Ch 1, Sec 2, [4]

$y_T$, $z_T$ : Y and Z co-ordinates, in m, of the top of continuous trunk or hatch coaming with respect to the reference co-ordinate system defined in Ch 1, Sec 2, [4]; $y_T$ and $z_T$ are to be measured for the point which maximises the value of $V_D$

## 3 Characteristics of the hull girder transverse sections for multihulls

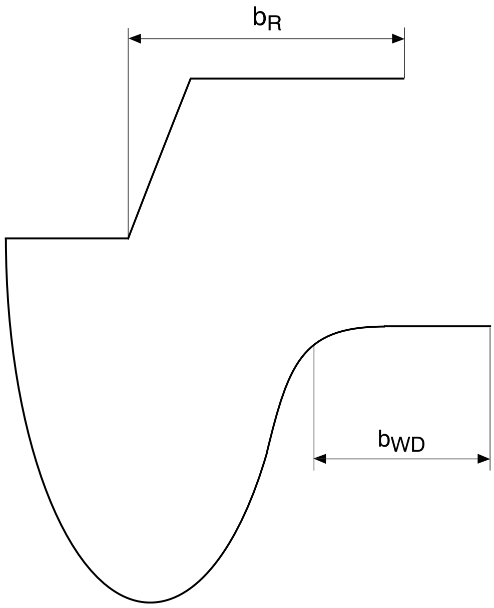
### 3.1 General

**3.1.1** The longitudinal hull girder strength of a multihull having more than two floats will be considered on a case-by-case basis.

**3.1.2** The characteristics of the hull girder transverse sections are to be determined as specified in Article [2].

The moment of inertia $I_Y$ is to be calculated for only one float. A platform extending in length over at least 0,4 $L_{WL}$ is to be considered for the calculation of the inertia of the float with breadths $b_R$ and $b_{WD}$ as defined in Fig 2, limited to 10% of the platform longitudinal length.

**Figure 2 : Hull girder strength areas to be taken into account for continuous structural members**




# 4 Yielding strength check

## 4.1 Stress calculation

**4.1.1** The hull girder normal stresses $\sigma_1$ induced by vertical bending moments are obtained, in N/mm², from the following formulae:

- in sagging conditions

$$\sigma_1 = \frac{M_S + M_{WV}}{Z} 10^3$$

- in hogging conditions

$$\sigma_1 = \frac{M_H + M_{WV}}{Z} 10^3$$

## 4.2 Checking criterion

**4.2.1** It is to be checked that the hull girder normal stresses, in N/mm², at any point of the net hull girder transverse section, calculated according to Article [2] are in compliance with the following condition:

$\sigma_1 \leq \sigma_{1,All}$

where

$\sigma_{1,All}$ : Allowable hull girder normal stress, in N/mm²

- $\sigma_{1,All}$ = 190/k, for steel hulls
- $\sigma_{1,All}$ =80/k, for aluminium alloy hulls.

# Section 2 Transverse Strength Analysis

## Symbols

L : Rule length, in m, defined in Ch 1, Sec 2, [3.1]

k : Material factor defined in:

- Ch 2, Sec 2, [2.3] for steel
- Ch 2, Sec 2, [3.5] for aluminium alloys

## 1 Transverse strength analysis for monohulls

### 1.1 General

**1.1.1** Transverse strength analysis may be required, if deemed necessary by the Society, depending on the harbour equipment geometry and structural configuration.

## 2 Transverse strength analysis for catamarans

### 2.1 General

**2.1.1** The transverse strength of catamarans is to be examined according to:

- the present sub-article for catamarans built in steel material
- the present sub-article and NR561 Hull in Aluminium Alloys for catamarans built in aluminium alloys
- the present sub-article and NR546 Hull in Composite Materials for catamarans built in composite materials.

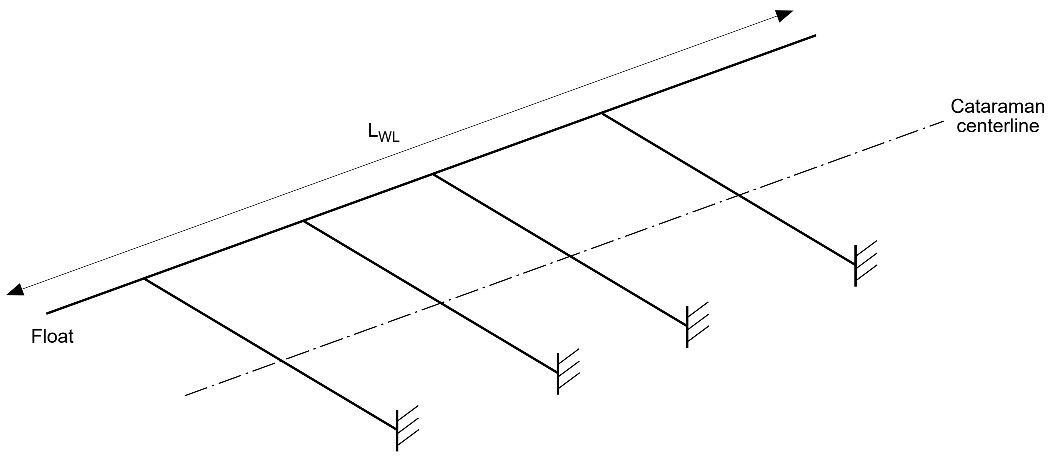
The global strength analysis may be carried out by a beam model as shown in Fig 1, taking into account the bending and shear stiffness of the primary transverse cross structure of the platform and of one float.

The transverse cross beams are fixed in the model in way of the inner side shell of the other float.

Any other justified global analysis submitted by the Designer may be considered.

The global strength of a multihull having more than two floats is to be examined on a case-by-case basis.

**Figure 1 : Model principle**




### 2.2 Additional wave hull girder loads

**2.2.1** The bending moments and the shear forces in hogging and sagging conditions along the floats as well as those in the primary transverse cross structure of the platform are to be determined by a beam model as defined in [2.3].

The beam model is to be loaded by forces F, in kN, as shown on Fig 2, where F is successively equal to:

$F = \gamma M_{WVQ} / L$

$F = - \gamma M_{WVQ} / L$

where:

$M_{WVQ}$ : Additional wave bending moment, in kN·m, as defined in Ch 4, Sec 1, [4.2] for operation in smooth water stretches or Pt D, Ch 8, Sec 4, [2.4.1] for harbour equipment assigned notation $\mathbf{H_S \le x}$.

$\gamma$ : Factor taken equal to

- 1 for operation in smooth stretches of water
- 0,625 or harbour equipment assigned notation $\mathbf{H_S \le x}$.

#### 2.2.2 Strength assessment approach

The global strength of catamarans is to be examined for additional wave hull girder loads by combining the stress analysis carried out according to Ch 3, Sec 1, [4.1], considering only the bending moment in still water conditions, and the stress induced by additional wave hull girder loads according to [2.3.3].

### 2.3 Global strength analysis

#### 2.3.1 Primary transverse cross structure model

Each primary transverse cross structure in the platform is considered as a beam in the global model, taking into account:

- its bending inertia about an horizontal axis (depending mainly on the web height of the transverse cross beam or bulkhead, and the thickness of the bottom and deck platform
- its vertical shear inertia (depending on the web height of the transverse cross beams or bulkheads and their thickness)
- its span between inner side shell of floats.

#### 2.3.2 Float model

The float is modelled as a beam having, as far as practicable:

- vertical and horizontal bending inertia, and
- a shear inertia, and
- a torsional inertia about longitudinal float axis

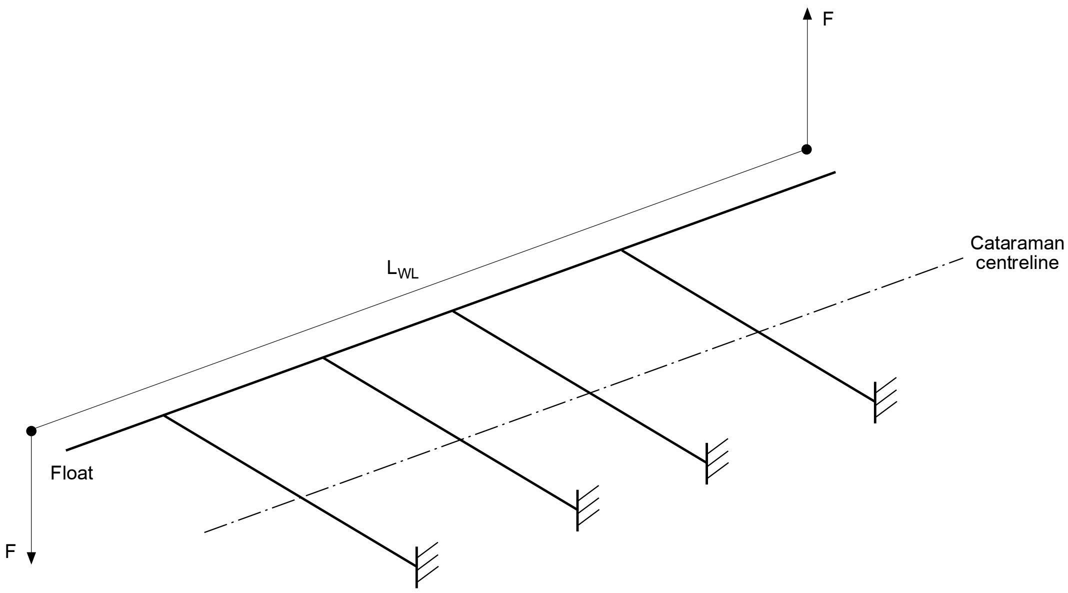
close to the actual float values.

#### 2.3.3 Loading of the model

The loads shown on Fig 2, where the torsional moment exerted on the platform and induced by the additional wave hull girder loads is represented by two vertical forces F defined in [2.2.1], are to be considered.

Note 1: As a general rule, two successive loading cases are to be taken into account: the case as shown in Fig 2 and the same case with forces in opposite direction.

**Figure 2 : Primary transverse cross structure of catamaran - Loading**




#### 2.3.4 Main structure check

The global bending moments and shear forces distribution in the float are as shown in Fig 3, and in the primary transverse cross structure as shown in Fig 4.

The bending stresses $\sigma_A$ and the shear stresses $\tau_A$ in the float and in the platform of the catamaran are to be directly deduced from the beam model calculation and are to be in compliance with the criteria defined in [2.4].

For the primary transverse cross structure, the bending stresses and shear stresses are to be calculated in way of the modeled float.

Particular attention is to be paid to:

- shear buckling check of cross bulkheads
- compression/bending buckling check of platform bottom and platform deck platings in areas where the bending moment is maximum.

**Figure 3 : Longitudinal distribution of the bending moment and shear force along the float**

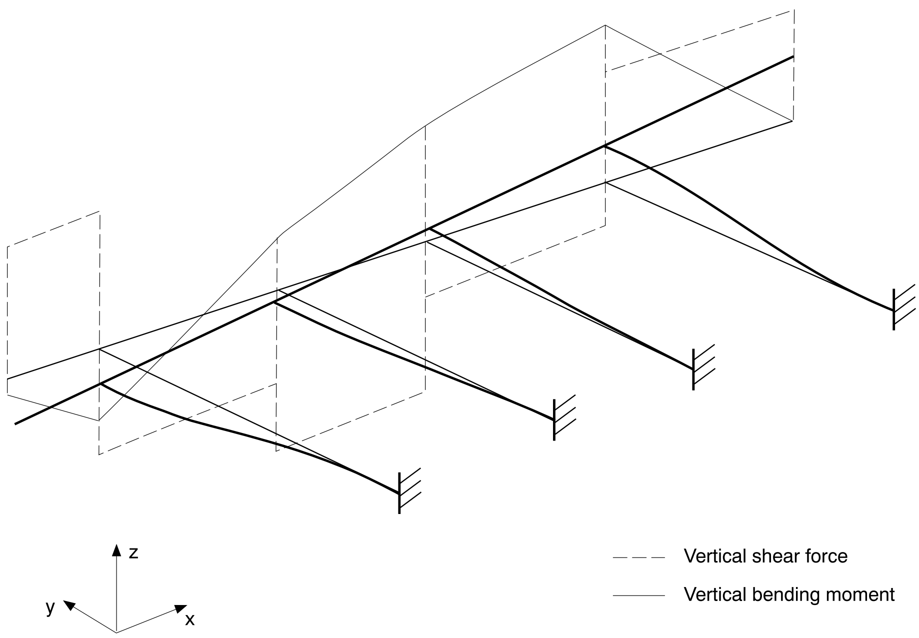
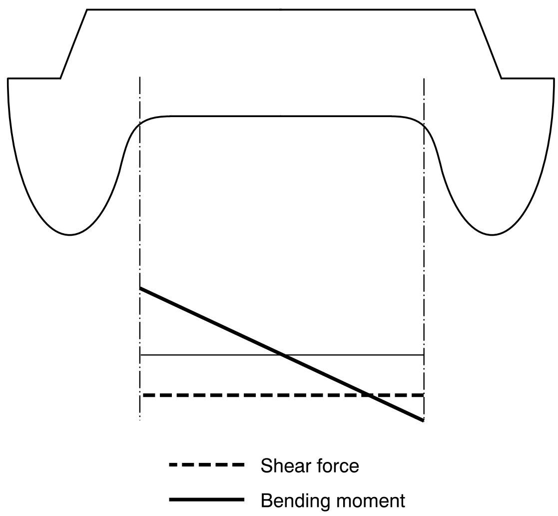



**Figure 4 : Transverse distribution of bending moments and shear forces**




## 2.4 Checking criteria

**2.4.1** It is to be checked that the actual normal stresses $\sigma_A$, in N/mm², and the actual shear stresses $\tau_A$, in N/mm², calculated according to [2.3] are in compliance with the following criteria:

$\sigma_A \leq \sigma_{All}$

$\tau_A \leq \tau_{All}$

where:

$\sigma_{All}$ : Allowable global bending stress, in N/mm²

- $\sigma_{All}$ = 140/k, for steel hulls
- $\sigma_{All}$ = 60/k, for aluminium alloy hulls

$\tau_{All}$ : Allowable global shear stress, in N/mm²

- $\tau_{All}$ = 95/k, for steel hulls
- $\tau_{All}$ = 40/k, for aluminium alloy hulls

Part B
Hull Design and Construction

# CHAPTER 4
# HULL SCANTLINGS

# Section 1 General

## Symbols

L : Rule length, in m, defined in Ch 1, Sec 2, [3.1]

B : Breadth, in m, defined in Ch 1, Sec 2, [3.3]

D : Depth, in m, defined in Ch 1, Sec 2, [3.4]

$C_B$ : Block coefficient, defined in Ch 1, Sec 2, [1.1.1]

$I_Y$ : Moment of inertia, in $cm^4$, of the hull girder transverse section about its horizontal neutral axis, defined in Ch 3, Sec 1

$M_H$ : Design still water bending moment in hogging condition, in kN.m, defined in the relevant chapter of Part D, for each harbour equipment type

$M_S$ : Design still water vertical bending moment in sagging condition, in kN.m, defined in the relevant chapter of Part D, for each harbour equipment type

N : Z co-ordinate, in m, of the centre of gravity of the hull transverse section

$p_B$ : Ballast design pressure, in $kN/m^2$, defined in the relevant chapter of Part D, for each harbour equipment type

$p_C$ : Cargo or supply design pressure, in $kN/m^2$, defined in the relevant chapter of Part D, for each harbour equipment type

$p_D$ : Deck design pressure, in $kN/m^2$, defined in the relevant chapter of Part D, for each harbour equipment type

$p_E$ : External design pressure, in $kN/m^2$, defined in the relevant chapter of Part D, for each harbour equipment type

$p_{Em}$ : External counter pressure, in $kN/m^2$, in service conditions

$p_{ST}$ : Test pressure, in $kN/m^2$, defined in the relevant chapter of Part D, for each harbour equipment type

$p_{FL}$ : Flooding pressure, in $kN/m^2$

$p_{FL} = \rho g\ d_F$

where:

$d_F$ : Distance, in m, from the calculation point to the deepest waterline to be provided by the Designer. Where the location of the deepest waterline is not known, $d_F$ will be taken as:

$d_F = D - z$

z : Z co-ordinate, in m, of the calculation point of a structural element.

## 1 General

### 1.1 Application

**1.1.1** This Chapter contains the requirements for the arrangement and the determination of the hull scantling of all harbour equipment made of metallic material complying with Ch 1, Sec 1, [1.1.1].

## 2 Net scantling

### 2.1 General

**2.1.1** All scantlings referred to in this Chapter are net, i.e. they do not include any margin for corrosion.

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

## 3 Partial safety factors

### 3.1 General

**3.1.1** The values of partial safety factors covering uncertainties on resistance ($\gamma_R$) and material ($\gamma_m$) to be considered for checking structures are specified in Tab 1 to Tab 5.

**Table 1 : Partial safety factors $\gamma_R$ and $\gamma_m$ - Plating**

| Limit state | Condition | $\gamma_R$ | $\gamma_m$ |
|---|---|---|---|
| Strength check of plating subjected to lateral pressure | General | 1,20 | 1,02 |
| | Testing | 1,05 | 1,02 |
| Buckling check | | 1,10 | 1,02 |

**Table 2 : Partial safety factors $\gamma_R$ and $\gamma_m$**
**Ordinary stiffeners**

| Limit state | Condition | $\gamma_R$ | $\gamma_m$ |
|---|---|---|---|
| Yielding check | General | 1,02 | 1,02 |
| | Testing | 1,02 | 1,02 |
| Buckling check | | 1,10 | 1,02 |

**Table 3 : Partial safety factors $\gamma_R$ and $\gamma_m$**
**Primary supporting members analysed through isolated beam models**

| Limit state | Condition | $\gamma_R$ | $\gamma_m$ |
|---|---|---|---|
| Yielding check | General | 1,02 | 1,02 |
| | Bottom and side girders | 1,15 | 1,02 |
| | Testing | 1,02 | 1,02 |
| Buckling check | Plate panels | 1,10 | 1,02 |
| | Pillars column buckling | 1,15 | 1,02 |
| | Pillars local buckling | 1,05 | 1,02 |

**Table 4 : Partial safety factors $\gamma_R$ and $\gamma_m$**
**Primary supporting members analysed through three-dimensional models**

| Limit state | Condition | $\gamma_R$ | $\gamma_m$ |
|---|---|---|---|
| Yielding check | General | See Tab 5 | 1,02 |
| | Testing | 1,02 | 1,02 |
| Buckling check | Plane pate panels | 1,02 | 1,02 |
| | Corrugated plate panels | 1,10 | 1,02 |
| | Pillars: column buckling | 1,15 | 1,02 |
| | Pillars: local buckling | 1,05 | 1,02 |

**Table 5 : Resistance partial safety factor $\gamma_R$**
**Primary supporting members analysed through three-dimensional model**

| Condition | Calculation model | $\gamma_R$ |
|---|---|---|
| Yielding check, General | Beam model | 1,20 |
| | Coarse mesh finite element model | 1,20 |
| | Fine mesh finite element model | 1,05 |

# 4 Hull girder loads

## 4.1 Still water hull girder loads

**4.1.1** The still water hull girder loads in hogging and sagging conditions are to be determined according to the relevant Chapter of Part D, for each harbour equipment type.

## 4.2 Vertical wave hull girder loads

**4.2.1** For harbour equipment operated in smooth stretches of water as defined in Pt A, Ch 1, Sec 1, [1.2.11], the absolute values of the vertical wave hull girder loads in hogging and sagging conditions are to be determined according to Tab 6.

As an alternative, the Society may accept the values of wave induced loads derived from direct calculations, when justified on the basis of the harbour equipment characteristics and intended service. The calculations are to be submitted to the Society.

**Table 6 : Vertical wave hull girder loads**

| Vertical wave hull girder loads | | Monohull unit | Multihull unit |
|---|---|---|---|
| In general | Bending moment, in kN.m | $M_{WV} = 0,045 F_{MT} L^2 B C_B$ | $M_{WV} = 0,05 F_{MT} L^2 B C_B$ |
| | Shear force, in kN | $Q_{WV} = 0,14 F_Q L B C_B$ | $Q_{WV} = 0,15 F_Q L B C_B$ |
| Additional wave hull girder loads **(1)** | Bending moment, in kN.m | NA | $M_{WVQ} = 0,05 C_{WQ} L^2 B C_B$ |
| | Shear force, in kN | NA | $Q_{WVQ} = 0,08 C_{WQ} L B C_B$ |

**(1)** To be considered only for transverse strength analysis. See Ch 3, Sec 2

**Note 1:** NA = Not applicable.

$F_{MT}$ : Distribution factor defined in Tab 7 and Fig 1

$F_Q$ : Distribution factor defined in Tab 8 and Fig 2

$L_{WQ}$ : Parameter, in m, defined as follows:

$$L_{WQ} = \frac{2 L B_E}{\sqrt{L^2 + B_E^2}}$$

where:

$B_E$ : Distance, in m, between the float axes

$C_{WQ}$ : Parameter, in m, taken equal to:

$C_{WQ} = (118 - 0,36\, L_{WQ})\, L_{WQ} \cdot 10^{-3}$

**Figure 1 : Distribution factor $F_{MT}$**

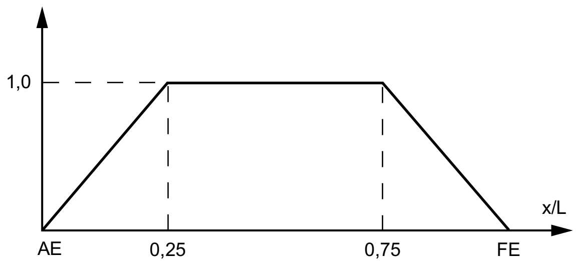



**Table 7 : Distribution factor $F_{MT}$**

| Hull transverse section location | Distribution factor $F_{MT}$ |
|---|---|
| $0 \le x < 0,25\,L$ | $4\frac{x}{L}$ |
| $0,25\,L \le x \le 0,75\,L$ | 1 |
| $0,75\,L < x \le L$ | $4\left(1 - \frac{x}{L}\right)$ |

**Figure 2 : Distribution factor $F_Q$**

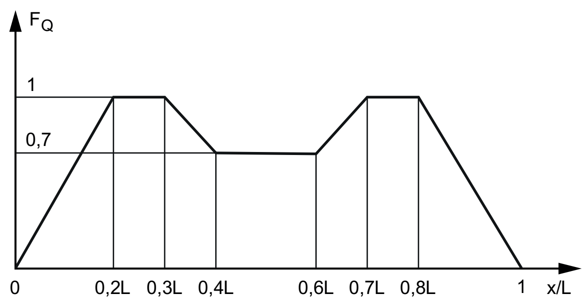


**Table 8 : Distribution factor $F_Q$**

| Transverse section location | Distribution factor $F_Q$ |
|---|---|
| $0 \le x < 0,2\ L$ | $5\frac{x}{L}$ |
| $0,2\ L \le x \le 0,3\ L$ | 1 |
| $0,3\ L < x < 0,4\ L$ | $3\left(0,4 - \frac{x}{L}\right) + 0,7$ |
| $0,4\ L \le x \le 0,6\ L$ | 0,7 |
| $0,6\ L < x < 0,7\ L$ | $3\left(\frac{x}{L} - 0,6\right) + 0,7$ |
| $0,7\ L \le x \le 0,8\ L$ | 1 |
| $0,8\ L < x \le L$ | $5\left(1 - \frac{x}{L}\right)$ |

# 5 Load model

## 5.1 Design lateral pressure

**5.1.1** The design lateral pressure, p, to be used for hull scantling is defined in Tab 9.

## 5.2 Other local loads

**5.2.1** Other local loads transmitted to the hull structure such as the forces induced by dry unit cargoes, wheeled cargoes, coupling and mooring systems, are to be determined according to the relevant Chapter of Part D for each harbour equipment type.

**Table 9 : Design lateral pressure, p, in kN/m²**

| | Structure | In service conditions | In testing conditions | In flooding conditions **(2)** |
|---|---|---|---|---|
| In general | Shell structure | $p_E$<br>$p_C - p_{Em}$<br>$p_B - p_{Em}$ | $p_{ST}$<br>$p_{ST} - p_{SE}$ **(1)** | – |
| | Deck structure | $p_E$ **(3)**<br>4,9<br>$p_C$<br>$p_B$<br>$p_D$ | $p_{ST}$ | – |
| | Hatch coaming | 2,25 | – | – |
| | Internal structure | $p_C$<br>$p_B$ | $p_{ST}$ | $p_{FL}$ |
| Superstructures and deckhouses | Wall structure | 2,25 | – | – |
| | Deck structure | $p_D$ | – | – |

**(1)** Testing afloat
**(2)** On harbour equipment required to comply with damage stability
**(3)** On pontoon deck of floating dock
**Note 1:**
$p_{SE}$ : External still water counter pressure to be determined by the Designer

## 5.3 Hull girder normal stresses

**5.3.1** The hull girder normal stresses to be considered for the strength check of plating, ordinary stiffeners and primary supporting members are obtained, in N/mm², from the following formulae:

- in general $\sigma_{X1} = \sigma_{S1} + \sigma_{WV1}$
- for structural members not contributing to the hull girder longitudinal strength: $\sigma_{X1} = 0$

where:

$\sigma_{S1}$, $\sigma_{WV1}$: Hull girder normal stresses, in N/mm², defined in:

- Tab 10, for plating subjected to lateral loads
- Tab 11, for ordinary stiffeners and primary supporting members subjected to wheeled loads
- Tab 12, for ordinary stiffeners and primary supporting members subjected to lateral pressure.

## 6 Buckling strength check

### 6.1 General

**6.1.1** The buckling strength check of structural members is to be carried out according to NR217, Pt B, Ch 2, Sec 7, using the application guidelines in [5.2] and [5.3].

**Table 10 : In-plane hull girder normal stresses - Plating subjected to lateral loads**

| Condition | $\sigma_{S1}$, in N/mm² **(1)** | $\sigma_{WV1}$, in N/mm² |
|---|---|---|
| $\frac{M_S + M_{WV}}{M_H + M_{WV}} \geq 1$ | $\left\lvert\frac{M_S}{I_Y}(z-N)\right\rvert 10^{-3}$ | $\left\lvert\frac{M_{WV}}{I_Y}(z-N)\right\rvert 10^{-3}$ |
| $\frac{M_S + M_{WV}}{M_H + M_{WV}} < 1$ | $\left\lvert\frac{M_H}{I_Y}(z-N)\right\rvert 10^{-3}$ | $\left\lvert\frac{M_{WV}}{I_Y}(z-N)\right\rvert 10^{-3}$ |
| **(1)** When the harbour equipment in still water is always in hogging condition, $M_S$ is to be taken equal to 0. | | |

**Table 11 : Hull girder normal stresses**
**Ordinary stiffeners and primary supporting members subjected to wheeled loads**

| Condition | $\sigma_{S1}$, in N/mm² **(1)** | $\sigma_{WV1}$, in N/mm² |
|---|---|---|
| Hogging | $\left\lvert\frac{M_H}{I_Y}(z-N)\right\rvert 10^{-3}$ | $\left\lvert\frac{M_{WV}}{I_Y}(z-N)\right\rvert 10^{-3}$ |
| Sagging **(1)** | $\left\lvert\frac{M_S}{I_Y}(z-N)\right\rvert 10^{-3}$ | $\left\lvert\frac{M_{WV}}{I_Y}(z-N)\right\rvert 10^{-3}$ |
| **(1)** When the harbour equipment in still water is always in hogging condition, $M_S$ is to be taken equal to 0. | | |

**Table 12 : Hull girder normal stresses**
**Ordinary stiffeners and primary supporting members subjected to lateral pressure**

| Condition | $\sigma_{S1}$, in N/mm² **(1)** | $\sigma_{WV1}$, in N/mm² |
|---|---|---|
| Lateral pressure applied on the side opposite to the ordinary stiffener, with respect to the plating: | | |
| • $z \geq N$ in general ;<br>$z < N$ for stiffeners simply supported at both ends | $\left\lvert\frac{M_S}{I_Y}(z-N)\right\rvert 10^{-3}$ | $\left\lvert\frac{M_{WV}}{I_Y}(z-N)\right\rvert 10^{-3}$ |
| • $z < N$ in general ;<br>$z \geq N$ for stiffeners simply supported at both ends | $\left\lvert\frac{M_H}{I_Y}(z-N)\right\rvert 10^{-3}$ | $\left\lvert\frac{M_{WV}}{I_Y}(z-N)\right\rvert 10^{-3}$ |
| Lateral pressure applied on the same side as the ordinary stiffener: | | |
| • $z \geq N$ in general ;<br>$z < N$ for stiffeners simply supported at both ends | $\left\lvert\frac{M_H}{I_Y}(z-N)\right\rvert 10^{-3}$ | $\left\lvert\frac{M_{WV}}{I_Y}(z-N)\right\rvert 10^{-3}$ |
| • $z < N$ in general ;<br>$z \geq N$ for stiffeners simply supported at both ends | $\left\lvert\frac{M_S}{I_Y}(z-N)\right\rvert 10^{-3}$ | $\left\lvert\frac{M_{WV}}{I_Y}(z-N)\right\rvert 10^{-3}$ |
| **(1)** When the harbour equipment in still water is always in hogging condition, $M_S$ is to be taken equal to 0. | | |

### 6.2 Change of thickness within an elementary plate panel

**6.2.1** If the plate thickness of an elementary plate panel varies over the width b, the buckling check may be performed for an equivalent elementary plate panel $a \times b_{eq}$ having a thickness equal to the smaller plate thickness $t_1$. The width of this equivalent elementary plate panel is defined by the following formula:

$$b_{eq} = \ell_1 + \ell_2 \left(\frac{t_1}{t_2}\right)^{1,5}$$

where:

$\ell_1$ : Width of the part of the plate panel with the smaller net plate thickness $t_1$, in mm, as defined in Fig 3

$\ell_2$ : Width of the part of the plate panel with the greater net plate thickness $t_2$, in mm, as defined in Fig 3.

#### 6.2.2 Assessment of floors, transverses or other high girders with holes

The following procedure may be used to assess high girders with holes:

a) Divide the plate field in sub-elementary plate panels according to Fig 4

b) Assess the elementary plate panel and all sub-elementary plate panels separately with the following boundary conditions:

- for sub-panels 1 to 4: all edges are simply supported (load cases 1 and 2)
- for sub-panels 5 to 6: simply supported, one side free (load case 3).

**Figure 3 : Plate thickness change over the width b**

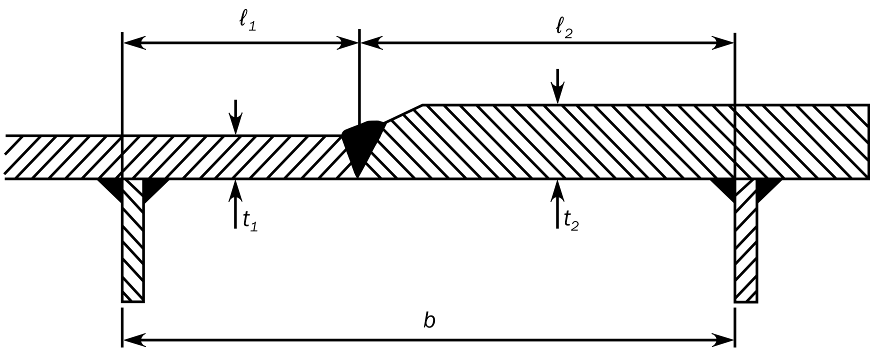
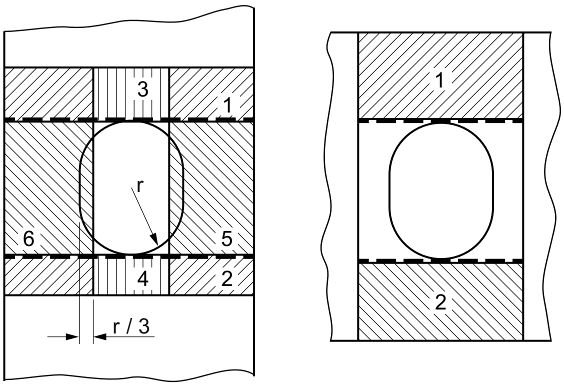



**Figure 4 : Elementary plate panels of high girder with hole**




### 6.3 Application to hull transverse section analysis

#### 6.3.1 Membrane stresses

The membrane stresses to be considered for the buckling strength check of plating and ordinary stiffeners are obtained, in N/mm², from the following formula:

$$\sigma_{X1} = \sigma_{S1} + \sigma_{WV1}$$

where:

$\sigma_{S1}$ : Still water hull girder normal stresses, in N/mm², defined in Tab 13

$\sigma_{WV1}$ : Wave hull girder normal stresses, in N/mm², defined in Tab 13

#### 6.3.2 Design lateral pressure

The design lateral pressure, p, to be used for buckling check is defined in [5.1].

#### 6.3.3 Idealisation of elementary plate panel

The structural members at a considered hull transverse section are to be checked for buckling criteria under the stresses defined in [5.3.1].

The determination of the buckling and reduction factors is made according to relevant table for the plane plate panel and the curved plate panel.

For the determination of the buckling and reduction factors for plane plate panels, the following cases are to be used according to the framing system:

- buckling load case 1 for longitudinally framed plating, the membrane stress in x-direction $\sigma_x$ being the hull girder normal stress $\sigma_{x1}$ defined in [5.3.1]
- buckling load case 2 for transversely framed plating, the membrane stress in y-direction $\sigma_y$ being the hull girder normal stress $\sigma_{x1}$ defined in [5.3.1], and the values of a and b exchanged to obtain $\alpha$ value greater than 1 as it is considered in load case 2.

#### 6.3.4 Ordinary stiffeners

The buckling check of the longitudinal and transverse ordinary stiffeners of partial or total plate panels is to be performed under the loads in defined in [5.3.1]with:

- $\sigma_x = \sigma_{x1}$
- $\sigma_y = 0$

The effective width of the attached plating of the stiffeners is to be determined in accordance with NR 217, Pt B, Ch 2, [3]. A constant stress is to be assumed corresponding to the greater of the following values:

- stress at half length of the stiffener
- 0,5 of the maximum compressive stress of the adjacent elementary plate panels.

## 7 Direct calculation

### 7.1 General

**7.1.1** Direct calculation may be adopted instead of the Rule scantling requirements in the following cases:

- as an alternative to the Rule scantling formulae
- for the analysis of structural members not covered by the Rules
- for the analysis of structural members with configurations not covered by the Rules.

**7.1.2** The direct calculation guidance for the yielding and buckling strength checks of structural members is given in NR 217, Ch 2, Sec 8, [2].

**7.1.3** The loads are to be calculated for the most severe loading conditions, with a view to maximising the stresses in the primary supporting members.

### 7.2 Structure checks

**7.2.1** As a rule, the following checks are to be carried out:

- level of normal stresses and shear stresses, in particular in way of holes and passage of longitudinals
- buckling strength of unstiffened webs
- for double hull units, continuity of double bottom in the side tanks.

#### 7.2.2 Corrugated bulkheads

Where corrugated bulkheads are fitted, the following checks are to be carried out:

- section modulus of beam
- section modulus of welds
- buckling of face plate
- section modulus of welds when there is no continuity of web in double bottom.

**Table 13 : In-plane hull girder normal stresses**

| | Condition | $\sigma_{S1}$, in N/mm² | $\sigma_{WV1}$, in N/mm² |
|---|---|---|---|
| Compressive stresses | $z \geq N$ | $\left\lvert \frac{M_S}{I_Y}(z-N) \right\rvert 10^{-3}$ | $\left\lvert \frac{M_{WV}}{I_Y}(z-N) \right\rvert 10^{-3}$ |
| | $z < N$ | $\left\lvert \frac{M_H}{I_Y}(z-N) \right\rvert 10^{-3}$ | $\left\lvert \frac{M_{WV}}{I_Y}(z-N) \right\rvert 10^{-3}$ |
| Tensile stresses | $z \geq N$ | $\left\lvert \frac{M_H}{I_Y}(z-N) \right\rvert 10^{-3}$ | $\left\lvert \frac{M_{WV}}{I_Y}(z-N) \right\rvert 10^{-3}$ |
| | $z < N$ | $\left\lvert \frac{M_S}{I_Y}(z-N) \right\rvert 10^{-3}$ | $\left\lvert \frac{M_{WV}}{I_Y}(z-N) \right\rvert 10^{-3}$ |

# Section 2 Plating

## Symbols

L : Rule length, in m, defined in Ch 1, Sec 2, [3.1]

D : Depth, in m, defined in Ch 1, Sec 2, [3.4]

$C_a$ : Aspect ratio, equal to:

$$c_a = 1,21\sqrt{1 + 0,33\left(\frac{s}{\ell}\right)^2} - 0,69\frac{s}{\ell} \le 1$$

$C_r$ : Coefficient of curvature:

$$c_r = 1 - 0,5\frac{s}{r} \ge 0,5$$

where:

r : Radius of curvature, in m

$\gamma_R$ : Partial safety factor covering uncertainties regarding resistance, defined in Ch 4, Sec 1, [3]

$\gamma_m$ : Partial safety factor covering uncertainties regarding material, defined in Ch 4, Sec 1, [3]

k : Material factor defined in:

- Ch 2, Sec 2, [2.3] for steel
- Ch 2, Sec 2, [3.5] for aluminium alloys

$k_0$ : Coefficient to be taken equal to:

- $k_0$= 1 for steel
- $k_0$= 2,35 for aluminium alloys

$\ell$ : Span, in m, of ordinary stiffeners or primary supporting members defined in Ch 2, Sec 3, [4.2] or Ch 2, Sec 3, [5.2]

p : Design lateral pressure, in kN/m$^2$, to be determined according to Ch 4, Sec 1, [5.1]

$R_y$ : Minimum yield stress, in N/mm$^2$, of the material to be taken equal to:

- $R_y$= 235/k N/mm$^2$ for steel
- $R_y$= 100/k N/mm$^2$ for aluminium alloys

unless otherwise specified

s : Spacing, in m, of ordinary stiffeners

$\sigma_{X1}$ : Hull girder normal stress, in N/mm$^2$, to be determined according to Ch 4, Sec 1, [5.3]

t : Net thickness, in mm, of plating

## 1 General

### 1.1 Elementary plate panel

**1.1.1** The elementary plate is the smallest unstiffened part of plating.

### 1.2 Load point

**1.2.1** Unless otherwise specified, lateral pressure and hull girder stresses are to be calculated:

- for longitudinal framing, at the lower edge of the elementary plate panel or, in the case of horizontal plating, at the point of minimum y-value among those of the elementary plate panel considered
- for transverse framing, at the lower edge of the strake.

## 2 General requirements

### 2.1 Minimum net thickness

**2.1.1** The net thickness of plating is to be not less than the values given in Tab 1.

**Table 1 : Minimum net thickness of plating**

| Plating | t, in mm |
|---|---|
| Decks, sides, bottom, bulkheads, web of primary supporting members, web of ordinary stiffeners and other structures | • for $L \le 40$ m: $t = 3{,}3 + 0{,}048\ L\ (k_0 k)^{0{,}5}$<br>• for $L > 40$ m: $t = 4{,}8 + 0{,}019\ L\ (k_0 k)^{0{,}5}$ |
| Keel plate | t = thickness of adjacent bottom plating |

## 2.2 Keel

**2.2.1** Harbour equipment having a rise of floor are to be fitted with a keel plate of about 0,1 B in width, with a thickness equal to 1,15 times the bottom plating thickness.

In the case there is no rise of floor, the keel plate thickness is to be not less than the bottom plating thickness.

## 2.3 Bilge scantling

### 2.3.1 Radius

Where the bilge plating is rounded, the radius of curvature is not to be less than 20 times the thickness of the plating.

### 2.3.2 Extension of rounded bilge

The bilge is to extend at least 100 mm on either side of the rounded part.

### 2.3.3 Scantling of rounded bilge

The bilge plating net thickness, in mm, is to be not less than the following values:

- in the case of a bilge radius of curvature practically equal to the floor depth or bottom transverse depth:
  $t = 1{,}15\ t_0$
- in the case of a bilge radius of curvature less than the floor depth or bottom transverse depth but greater than 20 times the bottom plating thickness:
  $t = 1{,}15\ t_0 + 1$

where:

$t_0$ : Adjacent bottom plating rule thickness.

### 2.3.4 Scantling of square bilge

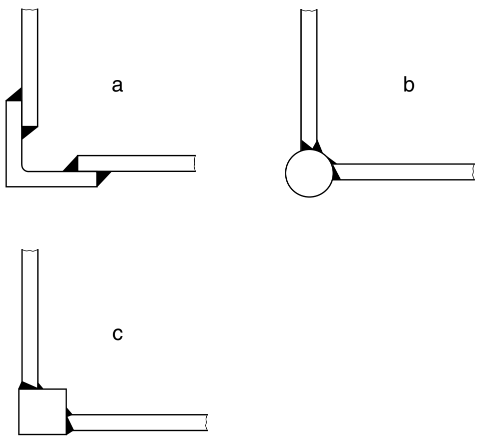
In the case of a square bilge with chine bars (sketches a, b, and c of Fig 1), the net scantling of the chine bar is to be determined as follows:

- angle bars:
  The net thickness of the bars plating, in mm, is to be not less than the following formulas, where $t_0$ is the rule bottom plating net thickness:
  - angle bars inside the hull: $t = t_0 + 2$
  - other cases: $t = t_0 + 3$
- round bars and square bars:
  The diameter of the round bars or the side of the square bars is to be not less than 30 mm,

where:

$t_0$ : Adjacent bottom plating thickness.

**Figure 1 : Square bilge**



### 2.4 Sheerstrake

#### 2.4.1 General

The sheerstrake may be either an inserted side strake welded to the stringer plate or a doubling plate.

**2.4.2** The sheerstrake net thickness is not to be less than that of the stringer plate nor than that of the side shell plating.

#### 2.4.3 Rounded sheerstrake

In the case of a rounded sheerstrake connecting the side shell to the deck, the radius of curvature of the strake, in mm, is not to be less than 5 times its thickness.

#### 2.4.4 Width

Where the sheerstrake thickness is greater than that of the adjacent side shell plating, the sheerstrake is to extend over a height b, measured from the deckline, in compliance with the following relation:

$0,08\ D \le b \le 0,15\ D$

Where a sheerstrake does not rise above deck, a footguard angle or flat is to be fitted at about 100 mm from the side shell.

The height of the sheerstrake/footguard above the deck is to be at least 50 mm.

### 2.5 Stringer plate

#### 2.5.1 Width

Where the stringer plate has a thickness greater than that the deck plating, its width is to be not less than 50 times its thickness.

#### 2.5.2 Stringer angle

Where a stringer angle is fitted, its thickness is not to be less than that of the side shell plating increased by 1 mm nor, as a rule, when the harbour equipment is built on the transverse system, than that of the stringer plate.

**2.5.3** If the stringer plate is rounded at side, it is to extend in the side shell plating over a length at least equal to 25 times its thickness, for harbour equipment units built on the transverse system.

## 3 Strength check of plating subjected to lateral pressure

### 3.1 Net thickness of plating subjected to lateral pressure

**3.1.1** The net thickness of plating subjected to lateral pressure is to be not less than the values obtained, in mm, from the formulae given in Tab 2.

**Table 2 : Plating subjected to lateral pressure**

| Conditions | Net thickness t, in mm | |
|---|---|---|
| | Transverse framing | Longitudinal framing |
| Service | $17,2 C_a C_r s \sqrt{\frac{\gamma_R \gamma_m p}{\lambda_T R_y}}$ | $14,9 C_a C_r s \sqrt{\frac{\gamma_R \gamma_m p}{\lambda_L R_y}}$ |
| Flooding **(2)** | $14,9 C_a C_r s \sqrt{\frac{\gamma_R \gamma_m p}{\lambda_L R_y}}$ | |
| Testing | $14,9 C_a C_r s \sqrt{\frac{\gamma_R \gamma_m p}{R_y}}$ | |

**Note 1:**

- For plating contributing to hull girder strength:

$$\lambda_T = 1 - 0,89 \gamma_m \frac{\sigma_{x1}}{R_y}$$

$$\lambda_L = \sqrt{1 - 0,95\left(\gamma_m \frac{\sigma_{x1}}{R_y}\right)^2} - 0,225 \gamma_m \frac{\sigma_{x1}}{R_y}$$

- For plating not contributing to hull girder strength:

**(1)** $\lambda_T = \lambda_L = 1$

**(2)** On harbour equipment required to comply with damage stability, shell plating excluded

# Section 3 Ordinary Stiffeners

## Symbols

L : Rule length, in m, defined in Ch 1, Sec 2, [3.1]

$\gamma_R$ : Partial safety factor covering uncertainties regarding resistance, defined in Ch 4, Sec 1, [3]

$\gamma_m$ : Partial safety factor covering uncertainties regarding material, defined in Ch 4, Sec 1, [3]

k : Material factor defined in:

- Ch 2, Sec 2, [2.3] for steel
- Ch 2, Sec 2, [3.5] for aluminium alloys

$k_0$ : Coefficient to be taken equal to:

- $k_0$= 1 for steel
- $k_0$= 2,35 for aluminium alloys

$\ell$ : Span, in m, of ordinary stiffeners or primary supporting members defined in Ch 2, Sec 3, [4.2] or Ch 2, Sec 3, [5.2]

p : Lateral design pressure, in kN/m², to be determined according to Ch 4, Sec 1, [5.1]

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

- $R_y$= 235/k N/mm² for steel
- $R_y$= 100/k N/mm² for aluminium alloys

unless otherwise specified

$\sigma_{X1}$ : Hull girder normal stress, in N/mm², to be determined according to Ch 4, Sec 1, [5.3]

s : Spacing, in m, of ordinary stiffeners

t : Net thickness, in mm, of plating

## 1 General

### 1.1 Load point for lateral pressure

**1.1.1** Unless otherwise specified, lateral pressure is to be calculated at mid-span of the ordinary stiffener considered.

### 1.2 Load point for hull girder stresses

**1.2.1** For longitudinal ordinary stiffeners contributing to the hull girder longitudinal strength, the hull girder normal stresses are to be calculated in way of the attached plating of the stiffener considered.

### 1.3 Span correction coefficients

**1.3.1** These Rules apply to ordinary stiffeners without end brackets, with a bracket at one end or with two equal end brackets.

The span correction coefficients $\beta_b$ and $\beta_s$ of ordinary stiffeners are to be determined using the following formulae:

$$\beta_b = \left(1 - \sum_{i=1}^{n} \frac{\ell_{bi}}{\ell}\right)^2$$

$$\beta_s = \left(1 - \sum_{i=1}^{n} \frac{\ell_{bi}}{\ell}\right)$$

where:

l : Span, in m, of ordinary stiffener, defined in Ch 2, Sec 3, [4.2]

$\ell_{bi} = 0,5\ \ell_b$

$l_b$ = MIN (d ; b)

d, b : Lengths, in m, of bracket arms

n : Number of end brackets.

### 1.4 Coefficients for pressure distribution correction

**1.4.1** The scantling of non-horizontal structural members are to be determined using the coefficients for pressure distribution correction $\lambda_b$ and $\lambda_s$ defined as follows:

$\lambda_s = 2\,\lambda_b - 1$

$$\lambda_b = 1 + 0,2\left|\frac{p_d - p_u}{p_d + p_u}\right|$$

where:

$p_u$ : Pressure, in kN/m², at the upper end of the structural member considered:

$p_u = p_{su} + p_{wu}$

$p_{su}$ , $p_{wu}$ : River water pressure and wave pressure respectively, in kN/m², at the upper end of the structural member considered

$p_d$ : Pressure, in kN/m², at the lower end of the structural member considered:

$p_d = p_{sd} + p_{wd}$

$p_{sd}$ , $p_{wd}$ : River water pressure and wave pressure respectively, in kN/m², at the lower end of the structural member considered.

## 2 General requirements

### 2.1 Web minimum net thicknesses

**2.1.1** The net thickness, in mm, of the web of ordinary stiffeners is to be not less than:

- for $L \leq 40$ m: $t = 3,3 + 0,048\,L\,(k_0 k)^{0,5}$
- for $L > 40$ m: $t = 4,8 + 0,019\,L\,(k_0 k)^{0,5}$

## 3 Strength check of ordinary stiffeners subjected to lateral pressure

### 3.1 Application

**3.1.1** The requirements of this Article apply for the yielding check of ordinary stiffeners subjected to lateral pressure and, for ordinary stiffeners contributing to the hull girder longitudinal strength, to hull girder normal stresses.

The yielding check is also to be carried out for ordinary stiffeners subjected to specific loads, such as concentrated loads.

### 3.2 Net section modulus and net shear sectional area of ordinary stiffeners

**3.2.1** The net section modulus w, in cm³,and the net shear sectional area $A_{Sh}$ , in cm², of ordinary stiffeners subjected to lateral pressure are to be not less than the values obtained from Tab 1.

**Table 1 : Net scantling of ordinary stiffeners**

| Conditions | Structural item | | w, in cm³ | $A_{Sh}$, in cm² |
|---|---|---|---|---|
| Service Flooding **(1)** | Longitudinal stiffeners | | $w = \frac{\gamma_R\gamma_m\beta_b p}{m(R_y - \gamma_R\gamma_m\sigma_{X1})} s\ell^2 10^3$ | $A_{sh} = 10\gamma_R\gamma_m\beta_s\frac{p}{R_y}\eta s\ell$ |
| | Transverse stiffeners | | $w = \frac{\gamma_R\gamma_m\beta_b p}{mR_y} s\ell^2 10^3$ | |
| | Vertical stiffeners (other than side frames of single hull) | | $w = \gamma_R\gamma_m\lambda_b\beta_b\frac{p}{mR_y} s\ell^2 10^3$ | $A_{Sh} = 10\gamma_R\gamma_m\lambda_S\beta_s\frac{p}{R_y}\eta s\ell$ |
| | Side frames | if $\ell_0 > \ell$: | $w = \frac{\gamma_R\gamma_m\beta_b s}{mR_y}(\lambda_b p\ell^2 + 1,45\lambda_W p_F\ell_F^2)10^3$ | $A_{sh} = 10\gamma_R\gamma_m\lambda_S\beta_s\frac{p}{R_y}\eta s\ell$ |
| | | if $\ell_0 \le \ell$: | $w = \frac{\gamma_R\gamma_m\beta_b s}{mR_y}(6\ell\ell_0^2 + 1,45\lambda_W p_F\ell_F^2)10^3$ | $A_{sh} = 68\gamma_R\gamma_m\beta_s\frac{\ell}{R_y}\eta s\ell_0$ |
| Testing | Longitudinal and transverse stiffeners | | $w = \gamma_R\gamma_m\beta_b\frac{p_T}{mR_y} s\ell^2 10^3$ | $A_{Sh} = 10\gamma_R\gamma_m\beta_s\frac{p_T}{R_y}\eta s\ell$ |
| | Vertical stiffeners (other than side frames of single hull) | | $w = \gamma_R\gamma_m\lambda_b\beta_b\frac{p_T}{mR_y} s\ell^2 10^3$ | $A_{Sh} = 10\gamma_R\gamma_m\lambda_S\beta_s\frac{p_T}{R_y}\eta s\ell$ |
| | Side frames | | $w = \frac{\gamma_R\gamma_m\beta_b s}{mR_y}(\lambda_b p_T\ell^2 + 1,45\lambda_W p_{FT}\ell_F^2)10^3$ | $A_{Sh} = 10\gamma_R\gamma_m\beta_s\frac{p_T}{R_y}\eta s\ell$ |

**Note 1:**

m : Boundary coefficient, to be taken, in general, equal to:
m = 12

$\ell_F$ : Floor span, in m

$\ell_0$ : Span parameter, in m, equal to:
$\ell_0 = p_d / 9,81$

$p_d$ : Total pressure, in kN/m², at the lower end of the stiffener

$p_F$ : Floor design lateral pressure, in kN/m²

$\lambda_W$ : Coefficient to be taken equal to:

- single side: $\lambda_W = 0,08$
- double side: $\lambda_W = 0$

$p_{FT}$ : Floor lateral pressure in testing conditions, in kN/m²

**Note 2:** The value of $\sigma_{X1}$ is to be taken in relation with the pressure p considered.

**(1)** On harbour equipment required to comply with damage stability, shell structural items excluded.

# Section 4 Primary Supporting Members

## Symbols

L : Rule length, in m, defined in Ch 1, Sec 2, [3.1]

$\gamma_R$ : Partial safety factor covering uncertainties regarding resistance, defined in Ch 4, Sec 1, [3]

$\gamma_m$ : Partial safety factor covering uncertainties regarding material, defined in Ch 4, Sec 1, [3]

k : Material factor defined in:

- Ch 2, Sec 2, [2.3] for steel
- Ch 2, Sec 2, [3.5] for aluminium alloys

$k_0$ : Coefficient to be taken equal to:

- $k_0$= 1 for steel
- $k_0$= 2,35 for aluminium alloys

$\ell$ : Span, in m, of ordinary stiffeners or primary supporting members defined in Ch 2, Sec 3, [4.2] or Ch 2, Sec 3, [5.2]

p : Lateral design pressure, in kN/m$^2$, to be determined according to Ch 4, Sec 1, [5.1]

$R_y$ : Minimum yield stress, in N/mm$^2$, of the material to be taken equal to:

- $R_y$= 235/k N/mm$^2$ for steel
- $R_y$= 100/k N/mm$^2$ for aluminium alloys

unless otherwise specified

$\sigma_{X1}$ : Hull girder normal stress, in N/mm$^2$, to be determined according to Ch 4, Sec 1, [5.3]

S : Spacing, in m, of primary supporting members

t : Net thickness, in mm, of plating

## 1 General

### 1.1 Application

**1.1.1** The requirements of this Section apply to the yielding and column buckling checks of primary supporting members.

### 1.2 Minimum net thicknesses

**1.2.1** The net thickness, in mm, of the web of primary supporting members is to be not less than:

- for L ≤ 40 m:

  $t = 3,3 + 0,048\,L\,(k_0 k)^{0,5}$

- for L > 40 m:

  $t = 4,8 + 0,019\,L\,(k_0 k)^{0,5}$

## 2 Yielding check of primary supporting members analysed through an isolated beam structural model subjected to lateral pressure

### 2.1 General requirements

#### 2.1.1 Load point for lateral pressure

Unless otherwise specified, lateral pressure is to be calculated at mid-span of the primary supporting member considered.

#### 2.1.2 Load point for hull girder normal stresses

For longitudinal primary supporting members contributing to the hull girder longitudinal strength, the hull girder normal stresses are to be calculated in way of the neutral axis of the primary supporting member with attached plating.

#### 2.1.3 Span correction coefficients

Conventional parameters of end brackets are given in Fig 1.

Special consideration is to be given to conditions different from those shown.

The span correction coefficients, $\beta_b$ and $\beta_s$, of primary supporting members are to be determined using the following formulae:

$$\beta_b = \left(1 - \sum_{i=1}^{n} \frac{\ell_{bi}}{\ell}\right)^2$$

$$\beta_s = \left(1 - \sum_{i=1}^{n} \frac{\ell_{bi}}{\ell}\right)$$

where:

l : Span, in m, of primary supporting member, defined in Ch 2, Sec 3, [5.2]

$l_{bi} = l_b - 0,25\ h_W$

$l_b$ = MIN (d ; b)

d, b : Length, in m, of bracket arms, defined in Fig 1

$h_W$ : Height, in m, of the primary supporting members (see Fig 1)

n : Number of end brackets.

#### 2.1.4 Coefficients for pressure distribution correction

The scantling of non-horizontal structural members are to be determined using the coefficients for pressure distribution correction $\lambda_b$ and $\lambda_S$ defined in Ch 4, Sec 3, [1.4.1].

### 2.2 Net section modulus and net shear sectional area of primary supporting members

**2.2.1** The net section modulus w, in $cm^3$, and the net shear sectional area $A_{Sh}$, in $cm^2$, of primary supporting members subjected to lateral pressure are to be not less than the values obtained from Tab 1.

## 3 Pillars subjected to compression axial load

### 3.1 General

**3.1.1** Pillars or other supporting structures are generally to be fitted under heavy concentrated loads.

Structural members at head and heels of pillars as well as substructures are to be constructed according to the forces they are subjected to. The connection is to be so dimensioned that at least 1 $cm^2$ cross-sectional area is available for 10 kN of load.

Where pillars are affected by tension loads doubling are not permitted.

Pillars in tanks are to be checked for tension.

Tubular pillars are not permitted in tanks for flammable liquids.

Pillars are to be fitted, as far as practicable, in the same vertical line.

#### 3.1.2 Connections

Pillars are to be attached at their heads and heels by continuous welding.

Pillars working under pressure may be fitted by welds only, in the case the thickness of the attached plating is at least equal to the thickness of the pillar.

Where the thickness of the attached plating is smaller than the thickness of the pillars, a doubling plate is to be fitted.

Heads and heels of pillars which may also work under tension (such as those in tanks) are to be attached to the surrounding structure by means of brackets or insert plates so that the loads are well distributed.

Pillars are to be connected to the inner bottom, where fitted, at the intersection of girders and floors.

Where pillars connected to the inner bottom are not located in way of intersections of floors and girders, partial floors or girders or equivalent structures suitable to support the pillars are to be arranged.

Manholes and lightening holes may not be cut in the girders and floors below the heels of pillars.

### 3.2 Buckling strength check

**3.2.1** The buckling strength check of pillars is to be carried out according to NR 217, Pt B, Ch 2, Sec 7, [6].

### Table 1 : Net scantling of primary supporting members

| Conditions | Structural item | | w, in cm³ | $A_{sh}$, in cm² |
|---|---|---|---|---|
| Service Flooding **(1)** | Longitudinal members | | $w = \frac{\gamma_R \gamma_m \beta_b p}{m(R_y - \gamma_R \gamma_m \sigma_{X1})} S \ell^2 10^3$ | $A_{sh} = 10 \gamma_R \gamma_m \beta_s \frac{p}{R_y} S \ell$ |
| | Transverse members | | $w = \frac{\gamma_R \gamma_m \beta_b p}{m R_y} S \ell^2 10^3$ | |
| | Vertical members | | $w = \frac{\gamma_R \gamma_m \lambda_b \beta_b p}{m R_y} S \ell^2 10^3$ | $A_{sh} = 10 \gamma_R \gamma_m \lambda_s \beta_s \frac{p}{R_y} S \ell$ |
| | Side web frames and Side transverses | $\ell_0 \le \ell$ | $w = 6 \frac{\gamma_R \gamma_m \beta_b \ell}{m R_y} S \ell_0^2 10^3$ | $A_{sh} = 68 \gamma_R \gamma_m \beta_s \frac{\ell}{R_y} S \ell_0$ |
| | | $\ell_0 > \ell$ | $w = \frac{\gamma_R \gamma_m \lambda_b \beta_b p}{m R_y} S \ell^2 10^3$ | $A_{sh} = 10 \gamma_R \gamma_m \lambda_s \beta_s \frac{p}{R_y} S \ell$ |
| Testing | Longitudinal and transverse members | | $w = \frac{\gamma_R \gamma_m \beta_b p_T}{m R_y} S \ell^2 10^3$ | $A_{sh} = 10 \gamma_R \gamma_m \beta_s \frac{p_T}{R_y} S \ell$ |
| | Vertical members | | $w = \frac{\gamma_R \gamma_m \lambda_b \beta_b p_T}{m R_y} S \ell^2 10^3$ | $A_{sh} = 10 \gamma_R \gamma_m \lambda_s \beta_s \frac{p_T}{R_y} S \ell$ |

**Note 1:**

m : Boundary coefficient, to be taken, in general, equal to:
m = 8

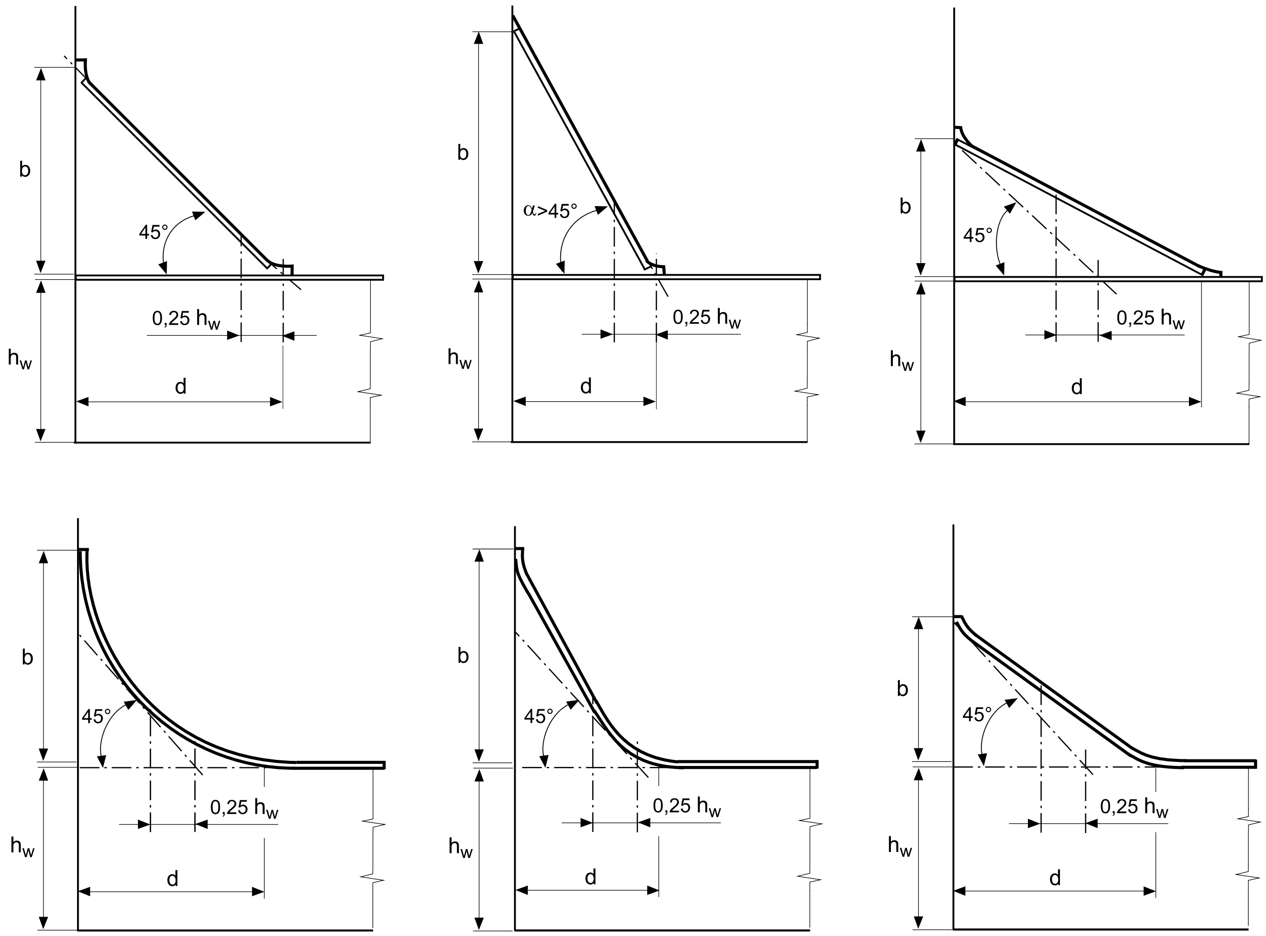
$\ell_0$ : Span parameter, in m
$\ell_0 = p_d / 9,81$

$p_d$ : Total pressure, in kN/m², at the lower end of the stiffener.

**Note 2:** The value of $\sigma_{X1}$ is to be taken in relation with the pressure p considered.

**(1)** On harbour equipment required to comply with damage stability, shell structural items excluded.

### Figure 1 : Characteristics of primary supporting member brackets



Part B
Hull Design and Construction

# CHAPTER 5
# OTHER STRUCTURES AND FITTINGS

# Section 1 End Parts

## 1 General

### 1.1 General

#### 1.1.1 Application

The requirements of this Section apply to all harbour equipment types made of steel or aluminium alloys, for the arrangement of the end part structures as defined in Ch 1, Sec 1, [2.1.3].

As to the requirements which are not explicitly dealt with in the present Section, refer to the previous Sections.

#### 1.1.2 Tapering

Adequate tapering is to be ensured between the scantlings of the end part structures and those of the central part. The tapering is to be such that the scantling requirements for both areas are fulfilled.

### 1.2 Scantlings

**1.2.1** The scantlings of end part structural members are to comply with Part B, Chapter 4, taking $\sigma_{X1} = 0$.

### 1.3 Bottom structural arrangement

#### 1.3.1 Longitudinally framed bottom

Bottom transverses are to be fitted at every 8 frame spacings and generally spaced no more than 4 m apart.

The arrangements of bottom transverses are to be as required in the midship region.

Where no centreline bulkhead is fitted, a centre bottom girder having the same dimensions and scantlings as required for bottom transverses is to be provided.

The centre bottom girder is to be connected to the end bulkhead by means of a large end bracket.

Side girders, having the same dimensions and scantlings as required for bottom transverses, are generally to be fitted every two longitudinals, in line with bottom longitudinals located beyond the end bulkhead. Their extension is to be compatible in each case with the shape of the bottom.

#### 1.3.2 Transversely framed bottom

Floors are to be fitted at every frame spacing.

A relaxation from the Rules of dimensions and scantlings may be granted by the Society for very low draught units.

Where no centreline bulkhead is fitted, a centre bottom girder is to be provided according to [1.3.1].

### 1.4 Side structural arrangement

#### 1.4.1 Arrangement

In way of the anchors, if fitted, the side plating thickness is to be increased by 50%, or a doubling plate is to be provided.

Where a break is located in the end part deck, the thickness of the sheerstrake is to be increased by 40% in the region of the break.

#### 1.4.2 Longitudinally framed side

Side transverses are to be located in way of bottom transverses and are to extend to the upper deck. Their ends are to be amply faired in way of bottom and deck transverses.

#### 1.4.3 Transversely framed side

Side frames fitted at every frame space are to have the same vertical extension as the end bulkhead.

Where, due to the hull design, the distance between transverse stiffeners, measured on the plating, is quite greater than the frame spacing, this latter should be reduced, or intermediate frames with adequate scantlings, are to be provided.

It is recommended to provide a side stringer where intermediate frames are fitted over a distance equal to the breadth B of the unit.

The value of the side frame section modulus is generally to be maintained for the full extension of the side frame.

The web frames in a transverse framing system are to be spaced not more than 4 m apart.

The web frame section modulus is to be equal to the section modulus of the floor connected to it.

Depending on the hull body shape and structure beyond the end bulkhead, one or more adequately spaced side stringers per side are to be fitted.

Manholes may be cut in the structural members to provide convenient access to all parts of the peaks.

These manholes are to be cut smooth along a well rounded design and are not to be greater than that strictly necessary to provide the man access. Where manholes of greater sizes are needed, edge reinforcement by means of flat bar rings or other suitable stiffeners may be required.

### 1.5 Deck structural arrangement

**1.5.1** Where a break is located in the end part deck, the thickness of the sheerstrake is to be increased by 40% in the region of the break.

The deck plating is to be reinforced in way of the deck machinery, bollards, cranes, masts and derrick posts.

# Section 2 Superstructures and Deckhouses

## 1 General

### 1.1 Application

**1.1.1** The requirements of this Section apply to the scantling and arrangement of superstructures and deckhouses, which may or may not contribute to the longitudinal strength, on harbour equipment made of steel or aluminium alloys.

As to the requirements which are not explicitly dealt with in the present Section, refer to the previous Chapters.

### 1.2 Definitions

#### 1.2.1 Superstructures

Superstructures are defined in Ch 1, Sec 2, [3.8].

Superstructures may be:

- closed, where they are enclosed by front, side and aft bulkheads complying with the requirements of this Section, the openings of which are fitted with weathertight means of closing
- open, where they are not enclosed.

#### 1.2.2 Superstructures contributing to the longitudinal strength

A superstructure may be considered as contributing to the longitudinal strength if its deck satisfies the basic criteria given in Ch 3, Sec 1, [2.2].

#### 1.2.3 Tiers of superstructures

The lowest tier is normally that which is directly situated above the strength deck defined in Ch 1, Sec 2, [3.10] and Ch 3, Sec 1, [2.2.1].

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

## 2 Arrangements

### 2.1 Connections of superstructures and deckhouses with the hull structure

**2.1.1** 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.

**2.1.2** 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.

**2.1.3** 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.

**2.1.4** 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 a 3-frame spacing.

### 2.2 Structural arrangement of superstructures and deckhouses

#### 2.2.1 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 0,5 B in breadth extending more than 0,15 L in length within 0,4 L amidships. These transverse strengthening reinforcements 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.

#### 2.2.2 Strengthening of the raised quarter deck stringer plate

When a superstructure is located above a raised quarter deck, the thickness of the raised quarter deck stringer plate is to be increased by 30% and is to be extended within the superstructure.

The increase above may be reduced when the raised quarter deck terminates outside 0,5 L amidships.

#### 2.2.3 Openings

Openings are to be in accordance with Ch 3, Sec 1, [2.1].

Continuous coamings are to be fitted above and below doors or similar openings.

#### 2.2.4 Constructional details

Lower tier stiffeners are to be welded to the decks at their ends.

Brackets are to be fitted at the upper and preferably also the lower ends of vertical stiffeners of exposed front bulkheads of engine casings and superstructures or deckhouses protecting pump room openings.

#### 2.2.5 Gastight bulkheads

The accommodation shall be separated from engine rooms, boiler rooms and holds by gastight bulkheads.

#### 2.2.6 Local reinforcements

Local reinforcements are to be foreseen in way of areas supporting cars or ladders.

## 3 Design loads

### 3.1 Sides and bulkheads

**3.1.1** The lateral pressure to be used for the determination of scantlings of structure of sides and bulkheads of superstructures is $p = 2,25$ kN/m$^2$.

### 3.2 Pressure on decks

#### 3.2.1 Pressure due to load carried on deck

The lateral pressure, p, in kN/m$^2$, transmitted to the deck structure, is to be defined by the Designer. In general, p is not be taken less than the values given in Tab 1.

**Table 1 : Pressure on exposed decks**

| Exposed deck location | $p_S$, in kN/m$^2$ |
|---|---|
| • First tier (non public) | 2,0 |
| • Upper tiers (non public) | 1,5 |
| • Public | 4,0 |

## 4 Scantlings

### 4.1 General

**4.1.1** The Society may ask additional arrangements deemed necessary in order to keep, in acceptable limits, the level of stresses liable to occur in the superstructure structural members.

**4.1.2** The hull girder section modulus to be used for the scantling of hull and contributing superstructures, is to be determined in compliance with Ch 3, Sec 1, taking into account the strength deck or the contributing deck up to which extends the considered superstructure.

**4.1.3** The scantlings of the structural members of superstructures are to comply with Part B, Chapter 4, using the design loads defined in Article [3] and taking into account the additional requirements of [4.1.4] and [4.1.5].

#### 4.1.4 Minimum net thickness of plating of superstructures not contributing to the longitudinal strength

The minimum net thickness of plating, in mm, of not contributing superstructures is to be derived from the following formulae:

a) $t = 3,5 + 0,01L(k_0k)^{0,5}$

for:

- sides
- end bulkheads
- not exposed deck

b) $t = 4,0 + 0,01L(k_0k)^{0,5}$

for exposed decks

where:

L : Rule length, in m, defined in Ch 1, Sec 2, [3.1]

k : Material factor defined in:
- Ch 2, Sec 2, [2.3] for steel
- Ch 2, Sec 2, [3.5] for aluminium alloys

$k_0$ : Coefficient to be taken equal to:
- $k_0$= 1 for steel
- $k_0$= 2,35 for aluminium alloys

#### 4.1.5 Scantling of vertical stiffeners

The net scantlings of vertical stiffeners derived from Part B, Chapter 4 are to be multiplied by the coefficient $k_1$ defined as:

$k_1 = 1 + 0,1\ n_t$

where:

$n_t$ : Number of tiers above the tier considered.

# Section 3 Hull Outfittings

## 1 Guard rails

### 1.1 General

**1.1.1** The requirements of this Article apply to the arrangement and scantling of guard rails provided at the boundaries of decks and work stations.

**1.1.2** Requirements other than those set out in this Article may be called for by national or international authorities, in order to allow the persons to move about under adequate safety conditions.

### 1.2 Arrangement

**1.2.1** Guard rails are to be at least 0,9 m high and are to comprise a hand rail, intermediate rails and a foot-guard.

**1.2.2** The spacing between railing stanchions is not to be greater than 2 m.

**1.2.3** The foot-guard is to rise at least 50 mm above the weather deck.

### 1.3 Scantlings

**1.3.1** Guard rails are to maintain loads in such a way that deflection without permanent deformation is not to exceed 50 mm in the centre between two stanchions when a load of 500 N/m is acting on the railing.

**1.3.2** Hand rails are to be of circular section 40 to 50 mm in diameter.

**1.3.3** Adequate strength of guard rails is to be proved by means of a direct calculation submitted to the Society for review, or the design is to be in compliance with an appropriate design standard recognised by the Society.

## 2 Ramps

### 2.1 General

#### 2.1.1 Materials

The ramps are to be made of steel or aluminium alloys complying with the requirements of Ch 2, Sec 2. Other materials of equivalent strength may be used, subject to a case by case examination by the Society.

#### 2.1.2 Net scantlings

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

The gross scantlings are to be obtained as specified in Ch 2, Sec 4, [2].

**2.1.3** The ramps are to be able to operate with a heel angle of 5° and a trim of 2°.

**2.1.4** The ramps are to be examined for their watertightness, if applicable.

#### 2.1.5 Minimum net thickness

The minimum net thickness of the ramp structural members is to be in compliance with the requirements of the relevant Sections of Part B, Chapter 4.

**2.1.6** The net scantlings of the ramp structural elements are to comply with [2.2] and/or [2.3], as applicable.

**2.1.7** The harbour equipment’s structure under the reactions due to the ramp will be examined by the Society on a case by case basis.

#### 2.1.8 Allowable deflection

The scantlings of main stiffeners and the distribution of supports are to be such that the deflection of the ramp does not exceed 5 mm/m.

### 2.2 Ramps subjected to lateral pressure

#### 2.2.1 Scantling

The net thickness of ramp plating, ordinary stiffeners and primary supporting members subjected to lateral pressure in service condition is to be determined according to Part B, Chapter 4, where the design pressure is to be defined by the designer.

### 2.3 Ramps subjected to wheeled loads

#### 2.3.1 Plating

The net thickness of plate panels subjected to wheeled loads is not to be less than the value obtained from Pt D, Ch 8, Sec 2, [3], where:

($n_p$ F) is not to be taken less than 50 kN,

with:

$n_p$ : Number of wheels on the plate panel, taken equal to:

- 1 in the case of a single wheel
- the number of wheels in the case of double or triple wheels

F : Wheeled force, in kN.

#### 2.3.2 Ordinary stiffeners

The net section modulus and the net shear sectional area of ordinary stiffeners subjected to wheeled loads are not to be less than the value obtained from Pt D, Ch 8, Sec 2, [3].

#### 2.3.3 Primary supporting members

a) General

The supporting structure of ramps is to be verified through direct calculation, considering the ramp loaded in sloped position, supported by hinges at one end and by a deck at the other, with possible intermediate supports.

b) Loading cases

The scantlings of the structure are to be verified for both following cases:

- loaded ramp under loads according to the load distribution indicated by the designer
- loaded ramp under uniformly distributed loads corresponding to a pressure, in kN/m², taken equal to:

$$p_1 = \frac{n_V p_V + p_P}{A_p}$$

where:

$n_V$ : Maximum number of vehicles loaded on the ramp

$p_V$ : Weight of a vehicle, in kN

$p_P$ : Weight of the ramp, in kN

$A_p$ : Effective area of the ramp, in m².

c) Lateral pressure

The lateral pressure is constituted by still water pressure determined, taking [2.1.3] into account.

d) Checking criteria

It is to be checked that the combined stress $\sigma_{VM}$, in N/mm², is in compliance with the criteria defined in Ch 4, Sec 1, [6].

## 3 Mooring and towing equipment

### 3.1 General

**3.1.1** Harbour equipment is to be fitted with suitable arrangements for mooring and towing.

**3.1.2** Harbour equipment is to be equipped with one bollard each on the fore and aft body on port side and starboard side. In between, depending on the harbour equipment length, one bollard has to be arranged on either side.

**3.1.3** The bollards are to be led through the deck and below be attached to a horizontal plate spaced at least one bollard diameter from the deck. Said plate being of the same thickness as the bollard wall is to be connected to the side wall and adjacent beam knees. Should this be impossible, the bollards are to be constrained in a bollard seat on deck.

## 4 Footbridges

### 4.1 Society involvement

**4.1.1** The examination of the design, construction and installation of the footbridges, as well as the inspections to be carried out by the Surveyors, do not fall within the scope of the classification.

### 4.2 Design

**4.2.1** The footbridges are to be designed in compliance with applicable recognised standards, taking into account the following:

- minimum design vertical load: 3,5 kN/$m^2$
- minimum design lateral load: 1,5 kN/$m^2$
- maximum slope:
  - 20% in general
  - 10% for passenger access footbridge.

### 4.3 Arrangement

**4.3.1** Footbridges are to be anti-slip and fitted with guard rails complying with [1].

**4.3.2** The width of access footbridges is to be not less than 0,90 m.

## 5 Supporting hull structures associated with coupling and mooring

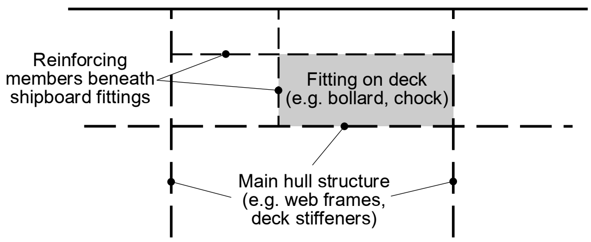
### 5.1 General

**5.1.1** The strength and arrangement of supporting hull structures associated with towing and mooring are to comply with the present Article.

On board fittings, winches and capstans 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 and mooring loads.

The reinforced members beneath on board fittings are to be effectively arranged for any variation of direction (horizontally and vertically) of the mooring and towing forces acting upon the on board fittings, see Fig 1 for a sample arrangement. Proper alignment of fitting and supporting hull structure is to be ensured.

**Figure 1 : Reinforced members beneath onboard fittings**




### 5.2 Information to be submitted

**5.2.1** A plan showing the towing and mooring arrangement is to be submitted to the Society for information. This plan is to define the method of using the towing and mooring lines and is to include the following information for each on board fitting:

a) Location on the harbour equipment

b) Fitting type

c) Safe working load

d) Purpose (mooring, towing)

e) Manner of applying towing and mooring lines (including line load, line angles, etc.).

### 5.3 Hull structure reinforcement

**5.3.1** As a general rule, hull structure reinforcements in way of mooring and towing equipment are to be examined by direct calculation, taking into account a tension in the mooring or towing line equal to the safe working load of the equipment and considering the following allowable stresses:

a) For strength assessment with beam theory or grillage analysis:
   - normal stress: $\sigma \le R_y$
   - shear stress: $\tau \le 0{,}6R_y$

b) For strength assessment with finite element analysis:
   - $\sqrt{\sigma^2 + 3\tau^2} \le R_Y$

where:

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

- $R_y$= 235/k N/mm² for steel
- $R_y$= 100/k N/mm² for aluminium alloys

unless otherwise specified

with:

k : Material factor defined in:

- Ch 2, Sec 2, [2.3] for steel
- Ch 2, Sec 2, [3.5] for aluminium alloys

Note 1: Normal stress is to be considered as 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.

Note 2: When the mooring plan is not available, the equipment such as bitts and bollards (when the line may come and go from the same direction) are to be loaded up to twice their safe working loads.

### 5.4 Corrosion additions

**5.4.1** The scantlings obtained by applying the allowable stresses as specified in [5.3.1] are net scantlings excluding any addition for corrosion.

The total corrosion addition $t_c$ is not to be less than the following values:

- for the supporting hull structure, according to Ch 2, Sec 4, [3], 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 a recognised standard, 2.0 mm.
- for onboard fittings not selected from a recognised standard, 2.0 mm.

Note 1: In addition to the corrosion addition $t_c$ given above, a wear down allowance $t_w$ not less than 1.0 mm is to be included for on board fittings not selected from an recognised standard. This wear allowance is to be added to surfaces which are intended to regularly contact the line.

## 6 Lifting appliances - Hull connections

### 6.1 Application

**6.1.1** The present Article applies to the structural arrangement and strength of the hull in way of the connections with the lifting appliances (cranes, derrick, bunker masts).

**6.1.2** The fixed parts of lifting appliances and their connections to the hull structure are within the harbour equipment classification scope, even when the certification of lifting appliances is not required.

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

### 6.2 Structural arrangement

**6.2.1** The hull structure is to be suitably reinforced in the area of lifting appliance attachments in order to avoid excessive local stresses or possible buckling of the deck plating.

**6.2.2** When inserted plates are provided in deck, side shell or bulkheads in way of crane foundation, these inserts are to have well radiused corners and are to be edge-prepared prior to welding.

### 6.3 Load transmitted by the lifting appliances

**6.3.1** The forces and moments transmitted by the lifting appliances to the hull structures are to be submitted to the Society.

**6.3.2** For a lifting appliance having a safe working load F less than 50 kN, and when its deadweights are unknown, the bending moment M, in kNm, induced by the pedestal to the hull is not to be taken less than:

$M = 2{,}2 F x_0$

where:

$x_0$ : Maximum jib radius of the crane, in m.

**6.3.3** For cranes having a safe working load greater than 50 kN, the bending moment and forces induced by the crane pedestal to the hull are to be as defined in NR526 Rules for the Certification of Lifting Appliances on board Ships and Offshore Units.

## 6.4 Strength criteria for steel and aluminium structures

**6.4.1** Local reinforcements and hull structure surrounding the lifting appliance pedestal are to be checked by direct calculation according to the following:

$$\sqrt{\sigma^2 + 3\tau^2} \leq 0,63 R_Y$$

where:

$\sigma$ : Normal stress, in N/mm², calculated considering the bending moments and the tensile and compressive forces

$\tau$ : Shear stress, in N/mm², calculated considering the torsional moment and the shear forces

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

- $R_y$= 235/k N/mm² for steel
- $R_y$= 100/k N/mm² for aluminium alloys

unless otherwise specified

with:

k : Material factor defined in:

- Ch 2, Sec 3, [2.3] for steel
- Ch 2, Sec 3, [2.4] for aluminium alloys

#### 6.4.2 Corrosion additions

The scantlings obtained by applying the allowable stresses as specified in [6.4.1] are gross scantlings including corrosion additions.

The net scantlings for the surrounding hull structure is to be obtained according to the process defined in Ch 2, Sec 4, [3].

## 6.5 Strength criteria for structures in composite materials

**6.5.1** Local reinforcements and hull structure surrounding the crane pedestal are to be checked by direct calculations, taking into account the following permissible stresses:

$SF_{CRANE}$ = 1,7 SF

$SF_{CSCRANE}$ = 1,7 $SF_{CS}$

where:

SF : Rules safety factor applicable to maximum stress defined in Ch 2, Sec 5, [4.3.3]

$SF_{CS}$ : Rules safety factor applicable to combined stress defined in Ch 2, Sec 5, [4.3.3].

# Section 4 Hull Integrity

## Symbols

L : Rule length, in m, defined in Ch 1, Sec 2, [3.1]

D : Depth, in m, defined in Ch 1, Sec 2, [3.4]

T : Draught, in m, defined in Ch 1, Sec 2, [3.5]

$\gamma_R$ : Partial safety factor covering uncertainties regarding resistance

- $\gamma_R$ =1,20, for plating
- $\gamma_R$ =1,02, for ordinary stiffeners and primary supporting members

$\gamma_m$ : Partial safety factor covering uncertainties regarding material: $\gamma_m$ =1,02

k : Material factor defined in:

- Ch 2, Sec 2, [2.3] for steel
- Ch 2, Sec 2, [3.5] for aluminium alloys

$\ell$ : Span, in m, of stiffeners, defined in Ch 2, Sec 3, [4.2].

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

- $R_y$= 235/k N/mm² for steel
- $R_y$= 100/k N/mm² for aluminium alloys

unless otherwise specified

s : Spacing, in m, of ordinary stiffeners

$z_{hc}$ : Z co-ordinate, in m, of the top of sill or hatch coaming

$z_{LE}$ : Z co-ordinate, in m, of the lower edge of opening

## 1 River chests

### 1.1 Shell plating

**1.1.1** The shell plate gross thickness t, in mm, in way of river chests as well as the gross thickness of all boundary walls of the river chests are not to be less than:

$$t = 17,2s\sqrt{\frac{\gamma_R\gamma_m p}{R_y}} + t_C$$

where:

p : Pressure at the safety relief valve, in kN/m²:

- in general:

  $p \geq 200$ kN/m²

- for river chests without any compressed air connection and which are accessible at any time:

  $p \geq 100$ kN/m².

$t_C$ : Corrosion margin to be taken as

- $t_C$ = 1,5 mm for steel
- $t_C$ = 1 mm for aluminium alloys

### 1.2 Stiffeners

**1.2.1** The net section modulus, in cm³, of river chest stiffeners is not to be less than:

$$w = \frac{\gamma_R\gamma_m p}{8R_y}s\ell^2 10^3$$

where:

p : Design pressure, in kN/m², defined in [1.1.1].

## 2 Side shell openings

### 2.1 General

**2.1.1** Openings in the harbour equipment's sides are to be well rounded at the corners and located well clear of superstructure ends or any openings in the deck areas at sides of hatchways.

### 2.2 Arrangement

#### 2.2.1 Shell plating openings

Openings are to be compensated if their edge is less than 0,2 D from the bottom or from the deck and if all these openings are located over 0,25 L from either end perpendicular.

Compensation is not required for circular openings having a diameter at most equal to 300 mm.

#### 2.2.2 Openings for water intakes

Openings for water intakes are to be well rounded at the corners and, within 0,6 L amidships, located outside the bilge strakes. Where arrangements are such that water intakes are unavoidably located in the curved zone of the bilge strakes, such openings are to be elliptical with the major axis in the longitudinal direction.

#### 2.2.3 Other openings

Other opening are considered by the Society on a case by case basis.

#### 2.2.4 Sheerstrake openings

Circular opening on the sheerstrake need not be compensated where their diameter does not exceed 20% of the sheerstrake minimum width, and where they are located away from openings on deck at the side of hatchways or superstructure ends.

### 2.3 Strengthening

**2.3.1** Openings in [2.2] and, when deemed necessary by the Society, other openings of considerable size, are to be compensated by means of insert plates or doublers sufficiently extended in length. Such compensation is to be partial or total depending on the stresses occurring in the area of the openings.

## 3 Deck openings

### 3.1 Openings in the strength deck

**3.1.1** Openings in the strength deck are to be kept to a minimum and spaced as far apart from one another and from breaks of effective superstructures as practicable. Openings are to be cut as far as practicable from hatchway corners.

**3.1.2** No compensation is required where the openings are:

- circular of less than 350 mm in diameter and at a distance sufficiently far from any other opening
- elliptical with the major axis in the longitudinal direction and the ratio of the major to minor axes not less than 2.

### 3.2 Corners of hatchways

#### 3.2.1 General

Hatchways are to be rounded at their corners. The radius of circular corners is to be not less than:

## 4 Scuppers and discharges

### 4.1 Material

**4.1.1** The scuppers and discharge pipes are to be constructed of steel. Other equivalent materials are considered by the Society on a case by case basis.

### 4.2 Pipe connections at the shell plating

**4.2.1** Scupper pipes and valves are to be connected to the shell by weld flanges. Instead of weld flanges short-flanged sockets with an adequate thickness may be used if they are welded to the shell in an appropriate manner.

### 4.3 Wall thickness

**4.3.1** The wall gross thickness of scuppers and discharge pipes is to be not less than the shell plating thickness in way of the scuppers, respectively discharge pipes, but need not exceed 8 mm.

# 5 Machinery space openings

## 5.1 Skylight hatches

**5.1.1** Engine room skylights are to be fitted with weathertight hatches made of steel or any other equivalent material. The hatches are to be permanently secured to the sides where the lower edge of the opening is at a height above the load waterline of less than 0,5 m.

## 5.2 Closing devices

**5.2.1** Openings in machinery space casings are to be surrounded by a steel casing of efficient construction. The openings of the casings exposed to the weather are to be fitted with strong and weathertight doors.

## 5.3 Position of openings

**5.3.1** In any case, the distance, in m, of the lower edge of an opening to the load waterline is to be such that:

$$z_{LE} \geq T + 0{,}3$$

## 5.4 Entrances

**5.4.1** The height, in m, of entrances to machinery space, $h_C$, above the deck is not to be less than 0,3 m.

Furthermore, this height $h_C$, above the deck, is to be such that:

$$z_{hc} \geq T + 0{,}45$$

# 6 Companionway

## 6.1 General

**6.1.1** Companions leading under the bulkhead deck are to be protected by a superstructure or closed deckhouse, or by a companionway having equivalent strength and tightness.

### 6.1.2 Companion sill height

The sill height above the deck is not to be less than 0,15 m.

Furthermore, this height $h_c$, above the deck, is to be such that:

$$z_{hc} \geq T + 0{,}45$$

# 7 Ventilators

## 7.1 General

**7.1.1** Ventilator openings below main deck are to have coamings of steel or other equivalent material, substantially constructed and efficiently connected to the deck.

### 7.1.2 Coamings

The coaming height above the deck is not to be less than 0,30 m and this height is to be such that:

$$z_{hc} \geq T + 0{,}45$$

Part B
Hull Design and Construction

# CHAPTER 6
# CONSTRUCTION AND TESTING

# Section 1 Construction and Fabrication

## 1 General

### 1.1 Application

**1.1.1** The requirements of this Section apply to the construction and fabrication of welded steel hulls.

The construction and fabrication of welded aluminium alloy hulls are defined in NR561 Hull in Aluminium Alloys.

### 1.2 Workmanship

**1.2.1** All workmanship is to be of standard marine quality and acceptable to the Surveyor. Welding is to be in accordance with the requirements of Ch 6, Sec 2. Any defect is to be rectified to the satisfaction of the Surveyor before the material is covered with paint, cement or any other component.

### 1.3 Fabrication standard

**1.3.1** Structural fabrication is to be carried out in accordance with a recognised fabrication standard which has been accepted by the Society prior to the commencement of fabrication/construction.

**1.3.2** The fabrication standard to be used during fabrication/construction is to be made available to the attending representative of the Society prior to the commencement of the fabrication/construction.

**1.3.3** The fabrication standard is to include information, to establish the range and the tolerance limits, for the items specified as follows:

a) Cut edges

   The slope of the cut edge and the roughness of the cut edges.

b) Flanged stiffeners and brackets and built-up sections

   The breadth of flange and depth of web, angle between flange and web, and straightness in plane of flange or at the top of face plate

c) Pillars

   The straightness between decks and cylindrical structure diameter

d) Brackets and flat bar stiffeners

   The distortion at the free edge line of tripping brackets and flat bar stiffeners

e) Sub-assembly stiffeners

   Details of sniped end of face plates and webs

f) Plate assembly

   For flat and curved blocks, the dimensions (length and breadth), distortion and squareness, and the deviation of interior members from the plate

g) Cubic assembly

   In addition to the criteria for plate assembly, twisting deviation between upper and lower plates, for flat and curved cubic blocks

h) Special assembly

i) Butt joints in plating

   Alignment of butt joint in plating

j) Cruciform joints

   Alignment measured on the median line and measured on the heel line of cruciform joints

k) Alignment of interior members

   Alignments of flange of T profiles, alignment of panel stiffeners, gaps in T joints and lap joints, and distance between scallop and cut-outs for continuous stiffeners in assembly and in erection joints

l) Keel and bottom sighting

   Deflections for whole length of the floating establishment, and for the distance between two adjacent bulkheads, cocking-up of fore body and of aft body, and rise of floor amidships

m) Dimensions

   Length between perpendiculars, moulded breadth and depth at midship

n) Fairness of plating between frames
Deflections between frames of shell, tank top, bulkhead, upper deck, superstructure deck, deckhouse deck and wall plating

o) Fairness of plating in way of frames
Deflections of shell, tank top, bulkhead, strength deck plating and other structures measured in way of frames.

# 2 Cut-outs, plate edges

## 2.1 General

**2.1.1** The free edges (cut surfaces) of cut-outs, hatch corners, etc are to be properly prepared and are to be free from notches. As a general rule, cutting draglines, etc are to be smoothly ground. All edges are to be broken or in cases of highly stressed parts, be rounded off.

Free edges on flame or machine cut plates or flanges are not to be sharp cornered and are to be finished off as specified above. This also applies to cutting drag lines, etc, in particular to the upper edge of sheer strake and analogously to weld joints, changes in sectional areas or similar discontinuities.

**2.1.2** Corners in hatch opening are to be machine cut.

# 3 Cold forming

## 3.1 Special structural members

**3.1.1** For highly stressed components of the hull girder where notch toughness is of particular concern (e.g. items such as radius gunwales (bent sheer plates) and bilge strakes), the inside bending radius, in cold formed plating, is not to be less than 10 times the as-built plate thickness for carbon-manganese steels. The allowable inside bending radius may be reduced provided the requirements stated in [3.3] are complied with.

## 3.2 Corrugated bulkheads and hopper knuckles

**3.2.1** For corrugated bulkheads and hopper knuckles, the inside bending radius R in cold formed plating, is not to be less than 4.5 times the as-built plate thickness for carbon-manganese steels. The allowable inside bending radius may be reduced provided the requirements stated in [3.3] are complied with.

## 3.3 Low bending radius

**3.3.1** When the inside bending radius is reduced below the limits defined in [3.1], supporting data is to be provided. The bending radius is in no case to be less than 2 times the as-built plate thickness. As a minimum, the following additional requirements are to be complied with:

a) For all bent plates:
   - 100% visual inspection of the bent area is to be carried out
   - random checks by magnetic particle testing are to be carried out

b) In addition to item a), for bent plates at boundaries to tanks or ballast holds:
   - the steel is to be of grade D/DH or higher
   - the material is impact tested in the strain-aged condition and satisfies the requirements stated herein. The deformation is to be equal to the maximum deformation to be applied during production, calculated by the formula $t_{as\text{-}built}/(2R+t_{as\text{-}built})$, where $t_{as\text{-}built}$ is the as-built thickness of the plate material and R is the bending radius. One sample is to be plastically strained at the calculated deformation or 5%, whichever is greater and then artificially aged at 250°C for one hour then subject to Charpy V-notch testing. The average impact energy after strain ageing is to meet the impact requirements specified for the grade of steel used.

# 4 Hot forming

## 4.1 Temperature requirements

**4.1.1** Steel is not to be formed between the upper and lower critical temperatures. If the forming temperature exceeds 650°C for as-rolled, controlled rolled, thermo-mechanical controlled rolled or normalised steels, or is not at least 30°C lower than the tempering temperature for quenched and tempered steels, mechanical tests are to be made to assure that these temperatures have not adversely affected both the tensile and impact properties of the steel. Where curve forming or fairing, by line or spot heating, is carried out in accordance with [4.2.1], these mechanical tests are not required.

**4.1.2** After further heating, other than specified in [4.1.1], of thermo-mechanically controlled steels (TMCP plates) for forming and stress relieving, it is to be demonstrated that the mechanical properties meet the requirements specified by a procedure test using representative material.

### 4.2 Line or spot heating

**4.2.1** Curve forming or fairing, by linear or spot heating, is to be carried out using approved procedures in order to ensure that the properties of the material are not adversely affected. Heating temperature on the surface is to be controlled so as not to exceed the maximum allowable limit applicable to the plate grade.

## 5 Modifications and repairs during construction

### 5.1 General

**5.1.1** Deviations in the joint preparation and other specified requirements, in excess of the permitted tolerances and found during construction, are to be repaired as agreed with the Society on a case by case basis.

### 5.2 Gap and weld deformations

**5.2.1** Welding by building up of gaps exceeding the required values and repairs of weld deformations may be accepted by the Society upon special examination.

### 5.3 Defects

**5.3.1** Defects and imperfections on the materials and welded connections found during construction are to be evaluated for possible acceptance on the basis of the applicable requirements of the Society.

Where the limits of acceptance are exceeded, the defective material and welds are to be discarded or repaired, as deemed appropriate by the Surveyor on a case by case basis.

When any serious or systematic defect is detected either in the welded connections or in the base material, the manufacturer is required to promptly inform the Surveyor and submit the repair proposal.

The Surveyor may require destructive or non-destructive examinations to be carried out for initial identification of the defects found and, in the event that repairs are undertaken, for verification of their satisfactory completion.

### 5.4 Repairs on structures already welded

**5.4.1** In the case of repairs involving the replacement of material already welded on the hull, the procedures to be adopted are to be agreed with the Society on a case by case basis.

# Section 2 Fabrication by Welding

## 1 General

### 1.1 Application

**1.1.1** The requirements of this Section apply to the preparation, execution and inspection of welded connections in steel hull structures.

The preparation, execution and inspection of welded connections in aluminium alloy hull structures are defined in NR561 Hull in Aluminium Alloys.

**1.1.2** The general requirements relevant to fabrication by welding and qualification of welding procedures are given in NR216 Materials and Welding, Chapter 12.

**1.1.3** Weld connections are to be executed according to the reviewed plans. A detail not specifically represented in the plans is, if any, to comply with the applicable requirements.

**1.1.4** It is understood that welding of the various types of steel is to be carried out by means of welding procedures approved for the purpose, even though an explicit indication to this effect may not appear on the reviewed plans.

**1.1.5** The quality standard adopted by the Building Yard is to be submitted to the Society and applies to all constructions unless otherwise specified on a case by case basis.

### 1.2 Base material

**1.2.1** The requirements of this Section apply for the welding of hull structural steels of the types considered in NR216 Materials and Welding or other types accepted as equivalent by the Society.

**1.2.2** The service temperature is intended to be the ambient temperature, unless otherwise stated.

### 1.3 Documentation to be submitted

**1.3.1** The structural plans to be submitted for review according to the relevant Chapters of Part D, are to contain the necessary data relevant to the fabrication by welding of the structures and items represented as far as class is concerned.

For important structures, the main sequences of prefabrication, assembly and welding and non-destructive testing planned are also to be represented in the plans.

**1.3.2** A plan showing the location of the various steel types is to be submitted at least for outer shell, deck and bulkhead structures.

### 1.4 Personnel and equipment

#### 1.4.1 Welders and welding operators

Welders for manual welding and for semi-automatic welding processes are to be properly trained and are to be certified by the Society, as required in the individual applications, unless otherwise agreed.

Welders are to be certified according to the procedures given in Rule Note NR476 Approval Testing of Welders.

The certification is to be in due course of validity.

#### 1.4.2 Automatic welding operators

Personnel manning automatic welding machines and equipment are to be competent and sufficiently trained.

#### 1.4.3 Organisation

The internal organisation of the Building Yard, is to be such as to ensure compliance with the requirements in [1.4.1] and [1.4.2] and to provide for assistance and inspection of welding personnel, as necessary, by means of a suitable number of competent supervisors.

#### 1.4.4 Non-destructive testing (NDT) operators

Non-destructive tests are to be carried out by qualified personnel, certified by the Society, or by recognised bodies in compliance with appropriate standards.

The qualifications are to be appropriate to the specific applications.

Requirements for NDT personnel are given in [3.2].

#### 1.4.5 Technical equipment and facilities

The welding equipment is to be appropriate to the adopted welding procedures, of adequate output power and such as to provide for stability of the arc in the different welding positions.

In particular, the welding equipment for special welding procedures is to be provided with adequate and duly calibrated measuring instruments, enabling easy and accurate reading, and adequate devices for easy regulation and regular feed.

Manual electrodes, wires and fluxes are to be stored in suitable locations so as to ensure their preservation in proper condition. Especially, where consumables with hydrogen-controlled grade are to be used, proper precautions are to be taken to ensure that manufacturer's instructions are followed to obtain (drying) and maintain (storage, maximum time exposed, re-baking,...) hydrogen-controlled grade.

# 2 Welding

## 2.1 General

**2.1.1** All welding is to be carried out by approved welders, in accordance with approved welding procedures, using approved welding consumables, in compliance with NR216 Materials and Welding.

**2.1.2** The various welding procedures and consumables are to be used within the limits of their approval and in accordance with the conditions of use specified in the respective approval documents.

Welding may only be performed on materials whose identity and weld ability under the given fabricating conditions can be unequivocally established by reference to markings, certificates, etc. Only welding consumables and auxiliary materials tested and approved according to the Society's Rules and of a quality grade standards recognized by the Society appropriate to the base material to be welded may be used.

## 2.2 Welding consumables and procedures

#### 2.2.1 Approval of welding consumables and procedures

Welding consumables and welding procedures adopted are to be approved by the Society.

The requirements for the approval of welding consumables are given in NR216 Materials and Welding, Chapter 11.

The requirements for the approval of welding procedures are given in NR216 Materials and Welding, Chapter 12.

**Table 1 : Consumable grades**

| Steel grade | Consumable minimum grade | |
|---|---|---|
| | Butt welding, partial and full T penetration welding | Fillet welding |
| A | 1 | |
| B - D | 2 | 1 |
| E | 3 | |
| AH32 - AH36 - DH32 - DH36 | 2Y | 2Y |
| AH40 | 2Y40 | 2Y40 |
| DH40 | 3Y40 | |

**Note 1:** Welding consumables approved for welding higher strength steels (Y) may be used in lieu of those approved for welding normal strength steels having the same or a lower grade; welding consumables approved in grade Y40 may be used in lieu of those approved in grade Y having the same or a lower grade.
**Note 2:** In the case of welded connections between two hull structural steels of different grades, as regards strength or notch toughness, welding consumables appropriate to one or the other steel are to be adopted.

#### 2.2.2 Consumables

For welding of hull structural steels, the minimum consumable grades to be adopted are specified in Tab 1 depending on the steel grade.

Consumables used for manual or semi-automatic welding (covered electrodes, flux-cored and flux-coated wires) of higher strength hull structural steels are to be at least of hydrogen-controlled grade H15 (H). Where the carbon equivalent Ceq is not more than 0,41% and the thickness is below 30 mm, any type of approved higher strength consumables may be used at the discretion of the Society.

Especially, welding consumables with hydrogen-controlled grade H15 and H10 are to be used for welding hull steel forgings and castings of respectively ordinary strength level and higher strength level.

The condition and remarks of welding consumables manufactures have to be observed.

## 2.3 Welding operations

### 2.3.1 Weather protection

Adequate protection from the weather is to be provided to parts being welded; in any event, such parts are to be dry. In welding procedures using bare, cored or coated wires with gas shielding, the welding is to be carried out in weather protected conditions, so as to ensure that the gas outflow from the nozzle is not disturbed by winds and draughts.

### 2.3.2 Butt connection edge preparation

The edge preparation is to be of the required geometry and correctly performed. In particular, if edge preparation is carried out by flame, it is to be free from cracks or other detrimental notches.

Seam edges (groove faces) prepared by thermal cutting are to be finished by machining (e.g. grinding) if a detrimental effect on the welded joint as a result of the cutting operation cannot be ruled out. Welding edges of steel castings and forgings are always to be ground as a minimum requirement; roll scale or casting skin is to be removed.

### 2.3.3 Surface condition

The surfaces to be welded are to be free from rust, moisture and other substances, such as mill scale, slag caused by oxygen cutting, grease or paint, which may produce defects in the welds.

Effective means of cleaning are to be adopted particularly in connections with special welding procedures; flame or mechanical cleaning may be required.

The presence of a shop primer may be accepted, provided it has been approved by the Society.

Shop primers are to be approved by the Society for a specific type and thickness according to NR216 Materials and Welding.

### 2.3.4 Assembling and gap

The setting appliances and system to be used for positioning are to ensure adequate tightening adjustment and an appropriate gap of the parts to be welded, while allowing maximum freedom for shrinkage to prevent cracks or other defects due to excessive restraint.

The gap between the edges is to comply with the required tolerances or, when not specified, it is to be in accordance with normal good practice.

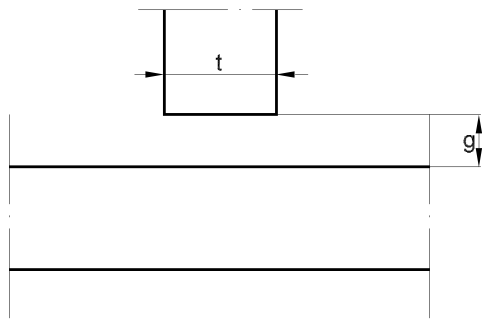
Completed welded joints are to be to the satisfaction of the attending Surveyor. Edge preparations and root gaps are to be in accordance with the approved welding procedure. The gap between the members being joined should not exceed the maximum values given in a recognised fabrication standard approved by the Society. Where the gap between members being joined exceeds the specified values, corrective measures are to be taken in accordance with an approved welding procedure specification.

### 2.3.5 Gap in fillet weld tee connections

In fillet weld tee connections, a gap g, as shown in Fig 1, may not be greater than 2 mm. In the case of a gap greater than 2 mm, the throat thickness is to be increased accordingly, or a single or double-bevel weld is to be made, subject to the consent of the Surveyor. Inserts and wires may not be used as fillers.

In any event, the gap g may not exceed 4 mm.

**Figure 1 : Gap in fillet weld T connections**




### 2.3.6 Plate misalignment in butt connections

The misalignment m, measured as shown in Fig 2, between plates with the same gross thickness t is to be less than 0,15 t, without being greater than 3 mm.

### 2.3.7 Misalignment in cruciform connections

The misalignment m in cruciform connections, measured on the median lines as shown in Fig 3, is to be less than:

- t /2, in general, where t is the gross thickness of the thinner abutting plate for steel grade A, B and D
- t /3, where t is the gross thickness of the thinner abutting plate for steel grade AH32 to DH40.

The Society may require lower misalignment to be adopted for cruciform connections subjected to high stresses.

Figure 2 : Plate misalignment in butt connections

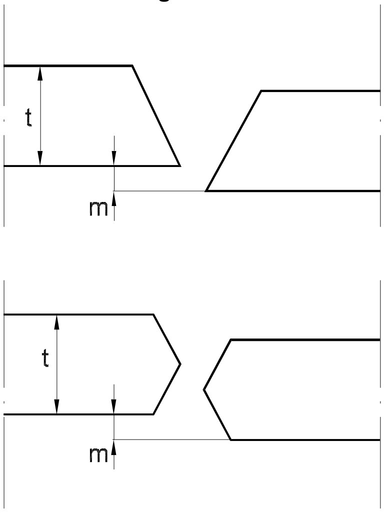
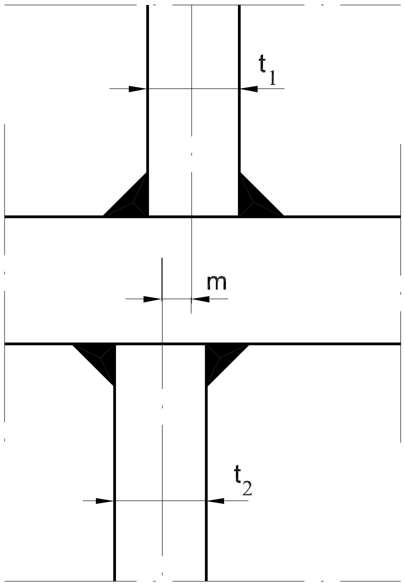



Figure 3 : Misalignment in cruciform connections




### 2.3.8 Assembling of aluminium alloy parts

When welding aluminium alloy parts, particular care is to be taken so as to:

- reduce as far as possible restraint from welding shrinkage, by adopting assembling and tack welding procedures suitable for this purpose
- keep possible deformations within the allowable limits.

Further specifications may be required by the Society on a case by case basis.

### 2.3.9 Preheating and interpass temperatures, welding in cold conditions

The need for and degree of preheating is determined by various factors, such as chemical composition, plate thickness, two or three-dimensional heat dissipation, ambient and work piece temperatures, or heat input during welding.

At low (subzero) temperatures, suitable measures are to be taken to ensure the satisfactory quality of the welds. Such measures include the shielding of components, large area preliminary warming and preheating, especially when welding with a relatively low heat input, e.g. when laying down thin fillet welds or welding thick-walled components. Wherever possible, no welding should be performed at temperatures below –10°C.

Normal-strength hull structural steels do not normally require preheating. In the case of corresponding thick-walled steel castings and forgings, gentle preheating to approximately 80 - 120°C is advisable. The necessary preheating temperatures of other materials (e.g. thick-walled higher tensile steels) have to comply with the applicable Society's Rules for Materials and Welding.

Suitable preheating, to be maintained during welding, and slow cooling may be required by the Society on a case by case basis.

The preheating and interpass temperatures are to be shown in the welding procedures which have to be approved by the Society.

#### 2.3.10 Welding sequences

Consideration is to be given to the assembly sequence and the effect of the overall shrinkage of plate panels, assemblies, etc, resulting from the welding processes employed. Welding is to proceed systematically, with each welded joint being completed in correct sequence, without undue interruption. When practicable, welding is to commence at the centre of a joint and proceed outwards, or at the centre of assembly and progress outwards towards the perimeter so that each part has freedom to move in one or more directions.

Welding sequences and direction of welding are to be determined so as to minimise deformations and prevent defects in the welded connection.

All main connections are generally to be completed before the floating establishment is afloat.

Departures from the above provision may be accepted by the Society on a case by case basis, taking into account any detailed information on the size and position of welds and the stresses of the zones concerned, both during floating establishment launching and with the floating establishment afloat.

#### 2.3.11 Interpass cleaning

After each run, the slag is to be removed by means of a chipping hammer and a metal brush; the same precaution is to be taken when an interrupted weld is resumed or two welds are to be connected.

#### 2.3.12 Stress relieving

It is recommended and in some cases it may be required that special structures subject to high stresses, having complex shapes and involving welding of elements of considerable thickness, are prefabricated in parts of adequate size and stress-relieved in the furnace, before final assembly, at a temperature within the range 550°C ÷ 620°C, as appropriate for the type of steel.

Further specifications may be required by the Society on a case by case basis.

#### 2.3.13 Arrangements at junctions of welds

Welds are to be made flush in way of the faying surface where stiffening members, attached by continuous fillet welds, cross the completely finished butt or seam welds. Similarly, butt welds in webs of stiffening members are to be completed and made flush with the stiffening member before the fillet weld is made. The ends of the flush portion are to run out smoothly without notches or sudden changes of section. Where these conditions can not be complied with, a scallop is to be arranged in the web of the stiffening member. Scallops are to be of the size, and in a position, that a satisfactory return weld can be made.

### 2.4 Crossing of structural elements

**2.4.1** In the case of tee crossing of structural elements (one element continuous, the other physically interrupted at the crossing) when it is essential to achieve structural continuity through the continuous element (continuity obtained by means of the welded connections at the crossing), particular care is to be devoted to obtaining the correspondence of the interrupted elements on both sides of the continuous element. Suitable systems for checking such correspondence are to be adopted.

## 3 Inspections and checks

### 3.1 General

**3.1.1** Materials, workmanship, structures and welded connections are to be subjected, at the beginning of the work, during construction and after completion, to inspections by the Building Yard suitable to check compliance with the applicable requirements, reviewed plans and standards.

**3.1.2** The Building yard is to make available to the Surveyor a list of the manual welders and welding operators and their respective qualifications.

The Building yard's internal organisation is responsible for ensuring that welders and operators are not employed under improper conditions or beyond the limits of their respective qualifications and that welding procedures are adopted within the approved limits and under the appropriate operating conditions.

**3.1.3** The Building yard is responsible for ensuring that the operating conditions, welding procedures and work schedule are in accordance with the applicable requirements, reviewed plans and recognised good welding practice.

**3.1.4** The Building yard is responsible for ensuring that non-destructive testing is planned, carried out and reported in accordance with NR467, Pt B, Ch 13, Sec 4.

### 3.2 Non-destructive testing

**3.2.1** Non-destructive testing is to be carried out according to NR467, Pt B, Ch 13, Sec 4.

# Section 3 Design of Weld Joints

## Symbols

$f_{yd}$ : Coefficient not to be taken less than:

$$f_{yd} = \left(\frac{1}{k}\right)^{0,50}\left(\frac{235}{R_{eHweld}}\right)^{0,75}$$

nor less than 0,71

k : Material factor of the abutting members

$\ell_{dep}$ : Total length of deposit of weld metal, in mm, taken as: $\ell_{dep} = 2\ \ell_{weld}$

$\ell_{weld}$ : Length of the welded connection, in mm

$R_{eH-weld}$ : Specified minimum yield stress for the weld deposit, in N/mm², not to be less than:

- 305 N/mm² for welding of normal strength steel with $R_{eH}$ = 235 N/mm²
- 375 N/mm² for welding of higher strength steel with $R_{eH}$ from 265 to 355 N/mm²
- 400 N/mm² for welding of higher strength steel with $R_{eH}$ = 390N/mm²

$t_T$ : Throat thickness, in mm, defined in [3.2.7]

$w_F$ : Weld factor

## 1 General

### 1.1 Application

#### 1.1.1 General

The type of connection and the edge preparation are to be appropriate to the welding procedure adopted, the structural elements to be connected and the stresses to which they are subjected.

**1.1.2** For the various structural details typical of welded construction in shipbuilding and not dealt with in this Section, the rules of good practice, recognised standards and past experience are to apply as agreed by the Society.

#### 1.1.3 Weld type, size and materials

The requirements of this Section apply to the design of welded connections in hull structures and are based on the following considerations:

- joint type
- criticality of the joint
- magnitude, type and direction of the stress in the joint
- material properties of the parent and weld material
- weld gap size.

**1.1.4** The requirements given in this Section are considered minimum for electric-arc welding in hull construction, but alternative methods, arrangements and details will be specially considered for approval.

**1.1.5** Plans and/or specifications showing weld sizes and weld details are to be submitted for approval.

### 1.2 Arrangement

#### 1.2.1 Plate orientation

The plates of the shell and strength deck are generally to be arranged with their length in the fore-aft direction. Possible exceptions to the above will be considered by the Society on a case-by-case basis; tests as deemed necessary (for example, transverse impact tests) may be required by the Society.

#### 1.2.2 Overall arrangement

Particular consideration is to be given to the overall arrangement and structural details of highly stressed parts of the hull.

Plans relevant to the special details are to be submitted.

#### 1.2.3 Prefabrication sequences

Prefabrication sequences are to be arranged so as to facilitate positioning and assembling as far as possible.

The amount of welding to be performed on board is to be limited to a minimum and restricted to easily accessible connections.

### 1.2.4 Local clustering of welds, minimum spacing, socket weldments

The local clustering of welds and short distances between welds are to be avoided.

- Adjacent butt welds are to be separated from each other by a distance of at least:

  50 mm + 4 t

- Fillet welds are to be separated from each other and from butt welds by a distance of at least:

  30 mm + 2 t,

where t is the plate thickness, in mm.

The width of replaced or inserted plates (strips) are, however, to be at least 300 mm or ten times the plate thickness, whichever is the greater.

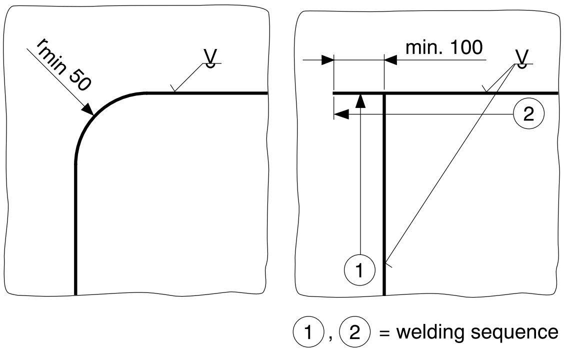
Reinforcing plates, welding flanges, mountings and similar components socket welded into plating are to be of the following minimum size:

D = 120 + 3 (t – 10), without being less than 120 mm.

The corners of angular socket weldments are to be rounded to a radius of at least 50 mm unless the longitudinal butt welds are extended beyond the transverse butt weld as shown in Fig 1. The socket welding sequence are then to comprise firstly the welding of the transverse seams (1) following by cleaning of the ends of these and then the welding of the longitudinal seams (2).

The socket welding of components with radiused corners are to proceed in accordance with the relevant welding sequence description.

**Figure 1 : Corners of socket weldments**




## 2 Butt joint

### 2.1 General

**2.1.1** In general, butt connections of plating are to be full penetration, welded on both sides except where special procedures or specific techniques, considered equivalent by the Society, are adopted.

Connections different from the above may be accepted by the Society on a case by case basis; in such cases, the relevant detail and workmanship specifications are to be approved.

### 2.1.2 Welding of plates with different thicknesses

In the case of welding of plates with a difference in gross thickness z equal to or greater than (see Fig 2):

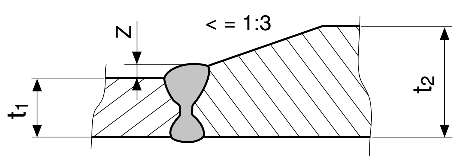
- 3 mm if $t_1 \leq 10$ mm
- 4 mm if $t_1 > 10$ mm,

a taper having a length of not less than 4 times the difference in gross thickness is to be adopted for connections of plating perpendicular to the direction of main stresses. For connections of plating parallel to the direction of main stresses, the taper length may be reduced to 3 times the difference in gross thickness.

The transition between different component dimensions shall be smooth and gradual.

When the difference in thickness is less than the above values, it may be accommodated in the weld transition between plates.

**Figure 2 : Transition between different component dimensions**



### 2.1.3 Edge preparation, root gap

Typical butt weld plate edge preparation for manual welding is specified in Tab 1and Tab 2.

The acceptable root gap is to be in accordance with the adopted welding procedure and relevant bevel preparation.

**Table 1 : Typical butt weld plate edge preparation (manual welding) - See Note 1**

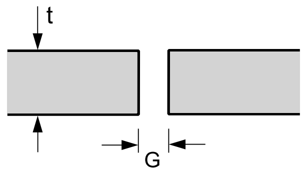
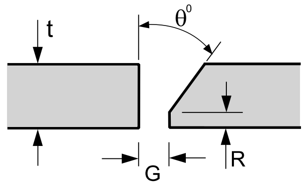
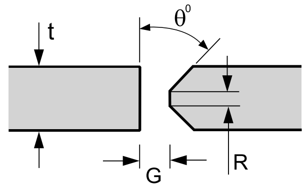
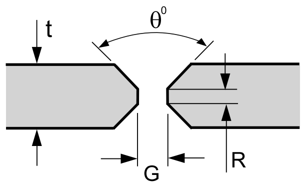
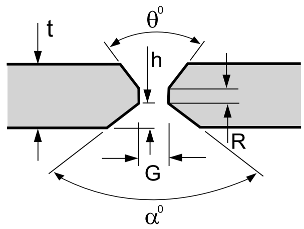
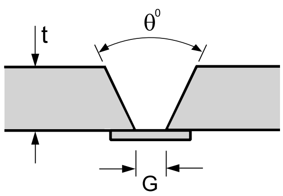
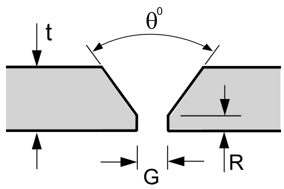
| Detail | Dimensions | Detail | Dimensions |
| --- | --- | --- | --- |
| **Square butt**<br> | t ≤ 5 mm<br>G = 3 mm | | |
| **Single bevel butt**<br> | t > 5 mm<br>G ≤ 3 mm<br>R ≤ 3 mm<br>50° ≤ θ ≤ 70° | **Double bevel butt**<br> | t > 19 mm<br>G ≤ 3 mm<br>R ≤ 3 mm<br>50° ≤ θ ≤ 70° |
| **Double vee butt, uniform bevels**<br> | G ≤ 3 mm<br>R ≤ 3 mm<br>50° ≤ θ ≤ 70° | **Double vee butt, non-uniform bevels**<br> | G ≤ 3 mm<br>R ≤ 3 mm<br>6 ≤ h ≤ t/3 mm<br>θ = 50°<br>α = 90° |
| **Note 1:** Different plate edge preparation may be accepted by the Society on the basis of an appropriate welding procedure specification. | | | |

**Table 2 : Typical butt weld plate edge preparation (manual welding) - See Note 1**

| Detail | Dimensions | Detail | Dimensions |
| --- | --- | --- | --- |
| **Single vee butt, one side welding with backing strip (temporary or permanent)**<br> | 3 ≤ G ≤ 9 mm<br>30° ≤ θ ≤ 45° | **Single vee butt**<br> | G ≤ 3 mm<br>50° ≤ θ ≤ 70°<br>R ≤ 3 mm |
| **Note 1:** Different plate edge preparation may be accepted by the Society on the basis of an appropriate welding procedure specification. | | | |

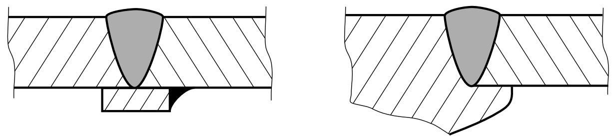
#### 2.1.4 Welding on permanent backing

Butt welding on permanent backing, i.e. butt welding assembly of two plates backed by the flange or the face plate of a stiffener, may be accepted where back welding is not feasible or in specific cases deemed acceptable by the Society.

The type of bevel and the gap between the members to be assembled are to be such as to ensure a full penetration of the weld on its backing and an adequate connection to the stiffener as required.

See Fig 3.

**Figure 3 : Butt welding on permanent backing**



#### 2.1.5 Section, bulbs and flat bars

When lengths of longitudinals of the shell plating and strength deck within 0,6 L amidships, or elements in general subject to high stresses, are to be connected together by butt joints, these are to be full penetration. Other solutions may be adopted if deemed acceptable by the Society on a case by case basis.

The work is to be done in accordance with an approved procedure; in particular, this requirement applies to work done on board or in conditions of difficult access to the welded connection. Special measures may be required by the Society.

Welding of bulbs without a doubler is to be performed by welders specifically certified by the Society for such type of welding.

## 3 Tee or cross joints

### 3.1 Application

**3.1.1** The connection of primary supporting members, stiffener webs to plating as well as the plating abutting on another plating, are to be made by fillet or penetration welding.

**3.1.2** Where the connection is highly stressed or otherwise considered critical, a partial or full penetration weld is to be achieved by bevelling the edge of the abutting plate.

### 3.2 Fillet welding

#### 3.2.1 General

Ordinary fillet welding may be adopted for tee connections of the various simple and composite structural elements, where they are subjected to low tensile stress or where they are not critical for fatigue.

Where this is not the case, partial or full tee penetration welding according to [3.3] is to be adopted.

**3.2.2** The required weld sizes are to be rounded to the nearest half millimetre.

#### 3.2.3 Direct calculation of fillet welds

As an alternative to the determination of the necessary fillet weld throat thicknesses according to this Sub-article, a direct calculation may be performed in accordance with NR217, Pt B, Ch 2, Sec 8, [3], e.g. in order to optimize the weld thicknesses in relation to the loads.

#### 3.2.4 Fillet welding types

Fillet welding may be of the following types:

- continuous fillet welding, where the weld is constituted by a continuous fillet on each side of the abutting plate (see [3.2.5])
- intermittent fillet welding, which may be subdivided (see [3.2.6]) into:
  - chain welding
  - scallop welding
  - staggered welding.

#### 3.2.5 Continuous fillet welding

Continuous fillet welding is to be adopted:

- for watertight connections
- for connections of brackets, lugs and scallops
- at the ends of connections for a length of at least 75 mm
- for connections of stiffeners subject to wheeled loads

Continuous fillet welding may also be adopted in lieu of intermittent welding wherever deemed suitable, and it is recommended where the spacing p, calculated according to [3.2.6], is low.

Continuous welding is to be adopted in the following locations:

a) Connection of the web to the face plate for all members

b) All fillet welds where higher strength steel is used

c) Boundaries of weathertight decks and erections, including hatch coamings, companionways and other openings

d) Boundaries of tanks and watertight compartments

e) All structures inside tanks and cargo holds

f) Stiffeners and primary supporting members at tank boundaries

g) All structures in the peaks and stiffeners and primary supporting members of the peak bulkhead

h) Welding in way of all end connections of stiffeners and primary supporting members, including end brackets, lugs, scallops, and at orthogonal connections with other members

i) All lap welds in the main hull

j) Flat bar longitudinals to plating

k) The attachment of minor fittings to higher strength steel plating and other connections or attachments

l) Pillars to heads and heels

m) Hatch coaming stay webs to deck plating.

### 3.2.6 Intermittent welding

Where continuous welding is not required, intermittent welding may be applied.

Where beams, stiffeners, frames, etc, are intermittently welded and pass through slotted girders, shelves or stringers, there is to be a pair of matched intermittent welds (double continuous welds having the length of an intermittent fillet weld) on each side of every intersection. In addition, the beams, stiffeners and frames are to be efficiently attached to the girders, shelves and stringers.

Where intermittent welding or one side continuous welding is permitted, double continuous welds are to be applied for one tenth of their shear span at each end, in accordance with [3.2.7] and [3.2.8].

In water, fuel and cargo tanks, in the bottom area of fuel oil tanks and of spaces where condensed or sprayed water may accumulate and in hollow components threatened by corrosion, only continuous or intermittent scallop welding is to be used.

Where the plating is liable to be subjected to locally concentrated loads (e.g. due to impacts) intermittent welding with scallops is not to be used.

The spacing p and the length d, in mm, of an intermittent weld, shown in:

- Fig 4 for chain welding
- Fig 5 for scallop welding
- Fig 6 for staggered welding,

are to be such that:

$p / d \leq \varphi$

where the coefficient φ is defined in Tab 3 and Tab 4 for the different types of intermittent welding, depending on the type and location of the connection.

In general, staggered welding is not allowed for connections subjected to high alternate stresses.

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

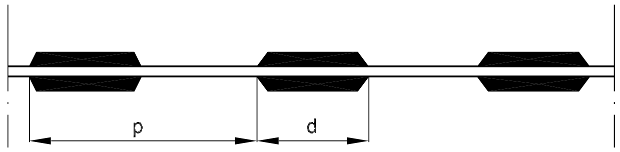
In addition, the following limitations are to be complied with:

- chain welding (see Fig 4):

  $d \geq 75$ mm

  $p - d \leq 200$ mm

**Figure 4 : Intermittent chain welding**



- scallop welding (see Fig 5):

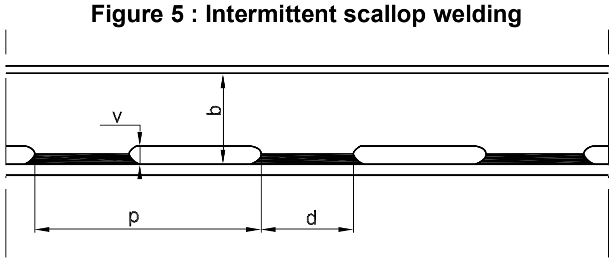
  $d \geq 75$ mm

  $p - d \leq 25\ t$   and $p - d \leq 150$ mm,

  where t is the lesser thickness of parts to be welded

  $v \leq 0{,}25\ b$, without being greater than 75 mm

**Figure 5 : Intermittent scallop welding**



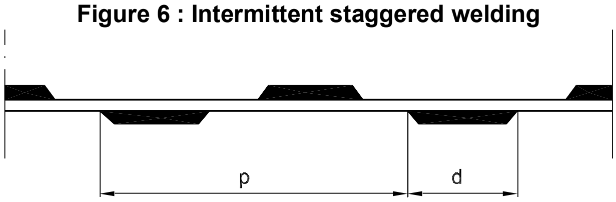

- staggered welding (see Fig 6):

  $d \geq 75$ mm

  $p - 2\ d \leq 300$ mm

  $p \leq 2\ d$ for connections subjected to high alternate stresses.

**Figure 6 : Intermittent staggered welding**




### 3.2.7 Throat size

Fillet welds are normally to be made on both sides, and exceptions to this rule (as in the case of closed box girders and predominant shear stresses parallel to the weld) are subject to approval in each individual case.

The minimum throat thickness of fillet weld tee connections is to be obtained, in mm, from the following formula:

$$t_T = w_F t \frac{p}{d}$$

where:

$w_F$ : Welding factor, defined in Tab 3 for the various hull structural connections; for connections of primary supporting members belonging to single skin structures and not mentioned in Tab 3, $w_F$ is defined in Tab 4

t : Actual gross thickness, in mm, of the structural element which constitutes the web of the T connection

p, d : Spacing and length, in mm, of an intermittent weld, defined in [3.2.6].

For continuous fillet welds, p / d is to be taken equal to 1.

Unless otherwise agreed (e.g. for the fully mechanised welding of smaller plate thicknesses in appropriate clamping jigs), the minimum fillet weld throat thickness shall be the greater of:

- $t_{T-min} = \sqrt{\frac{t_1 + t_2}{3}}$

and:

- 3,0 mm   for $t_1 \leq 6$ mm

  3,5 mm   for $t_1 > 6$ mm,

where:

$t_1$, $t_2$ : Thicknesses of connected plates with $t_1 < t_2$.

In the case of automatic or semi-automatic deep penetration weld, the throat thickness may be reduced according to [3.2.14]. Prior to start fabrication welding with deep penetration a production test has to be conducted to ensure the relevant weld quality. The kind of tests and the test scope has to be agreed with the Society.

The throat thickness may be required by the Society to be increased, depending on the results of structural analyses.

**Table 3 : Weld factors $w_F$ and coefficient φ for the various hull structural connections**

| Hull area | Connection: of | Connection: to | | $w_F$ **(1)** | φ **(2) (3)**: CH | SC | ST | $p_1$, in mm (see [3.2.9]) **(3)** |
|---|---|---|---|---|---|---|---|---|
| General, unless otherwise specified in the table | watertight plates | boundaries | | 0,35 | | | | |
| | webs of ordinary stiffeners | plating | at ends **(4)** | 0,13 | | | | |
| | | | elsewhere | 0,13 | 3,5 | 3,0 | 4,6 | ST 260 |
| | | face plate of fabricated stiffeners | at ends **(4)** | 0,13 | | | | |
| | | | elsewhere | 0,13 | 3,5 | 3,0 | 4,6 | ST 260 |
| Bottom and double bottom | longitudinal ordinary stiffeners | bottom and inner bottom plating **(5)** | | 0,13 | 3,5 | 3,0 | 4,6 | ST 260 |
| | centre girder | keel | | 0,25 | 1,8 | 1,8 | | CH/SC 130 |
| | | inner bottom plating | | 0,20 | 2,2 | 2,2 | | CH/SC 160 |
| | side girders | bottom and inner bottom plating | | 0,13 | 3,5 | 3,0 | 4,6 | ST 260 |
| | | floors (interrupted girders) | | 0,20 | 2,2 | | | CH 160 |
| | floors | bottom and inner bottom plating | in general | 0,13 | 3,5 | 3,0 | 4,6 | ST 260 |
| | | | at ends (20% of span) for longitudinally framed double bottom | 0,25 | 1,8 | | | CH 130 |
| | | inner bottom plating in way of brackets of primary supporting members | | 0,25 | 1,8 | | | CH 130 |
| | | girders (interrupted floors) | | 0,20 | 2,2 | | | CH 160 |
| | partial side girders | floors | | 0,25 | 1,8 | | | CH 130 |
| | web stiffeners | floor and girder webs | | 0,13 | 3,5 | 3,0 | 4,6 | ST 260 |
| Side and inner side | ordinary stiffeners | side and inner side plating | | 0,13 | 3,5 | 3,0 | 4,6 | ST 260 |
| | girders and web frames in double side skin units | side and inner side plating | | 0,35 | | | | |
| Deck | strength deck | side plating | | $w_F$ = 0,45 if t ≤ 15 mm<br>Partial penetration welding if t >15mm | | | | |
| | non-watertight decks | side plating | | 0,20 | 2,2 | | | CH 160 |
| | ordinary stiffeners and intercostal girders | deck plating | | 0,13 | 3,5 | 3,0 | 4,6 | ST 260 |
| | hatch coamings | deck plating | in general | 0,35 | | | | |
| | | | at corners of hatchways for 15% of the hatch length | 0,45 | | | | |
| | web stiffeners | coaming webs | | 0,13 | 3,5 | 3,0 | 4,6 | ST 260 |
| Bulkheads | tank bulkhead structures | tank bottom | plating and ordinary stiffeners (plane bulkheads) | 0,45 | | | | |
| | | | vertical corrugations (corrugated bulkheads) | Full penetration welding, in general | | | | |
| | | boundaries other than tank bottom | | 0,35 | | | | |
| | watertight bulkhead structures | boundaries | | 0,35 | | | | |
| | non-watertight bulkhead structures | boundaries | wash bulkheads | 0,20 | 2,2 | 2,2 | | CH/SC 160 |
| | | | others | 0,13 | 3,5 | 3,0 | 4,6 | ST 260 |
| | ordinary stiffeners | bulkhead plating | in general **(5)** | 0,13 | 3,5 | 3,0 | 4,6 | ST 260 |
| | | | at ends (25% of span), where no end brackets are fitted | 0,35 | | | | |

| Hull area | Connection of | Connection to | | $w_F$ **(1)** | φ **(2) (3)** CH | SC | ST | $p_1$, in mm (see [3.2.9]) **(3)** |
|---|---|---|---|---|---|---|---|---|
| Peaks **(6)** | internal structures | each other | | 0,20 | | | | |
| | side ordinary stiffeners | side plating | | 0,20 | | | | |
| | floors | bottom and inner bottom plating | | 0,20 | | | | |
| Machinery space **(6)** | centre girder | keel and inner bottom plating | in way of seating of auxiliary machinery and boilers | 0,35 | | | | |
| | | | elsewhere | 0,25 | 1,8 | 1,8 | | CH/SC 130 |
| | side girders | bottom and inner bottom plating | in way of seating of auxiliary machinery and boilers | 0,35 | | | | |
| | | | elsewhere | 0,20 | 2,2 | 2,2 | | CH/SC 160 |
| | floors | bottom and inner bottom plating | in way of seating of auxiliary machinery and boilers | 0,35 | | | | |
| | | | elsewhere | 0,20 | 2,2 | 2,2 | | CH/SC 160 |
| | floors | centre girder | single bottom | 0,45 | | | | |
| | | | double bottom | 0,25 | 1,8 | 1,8 | | CH/SC 130 |
| Superstructures and deckhouses | external bulkheads | deck | in general | 0,35 | | | | |
| | | | engine and boiler casings at corners of openings (15% of opening length) | 0,45 | | | | |
| | internal bulkheads | deck | | 0,13 | 3,5 | 3,0 | 4,6 | ST 260 |
| | ordinary stiffeners | external and internal bulkhead plating | | 0,13 | 3,5 | 3,0 | 4,6 | ST 260 |
| Hatch covers | ordinary stiffener | plating | | 0,13 | 3,5 | 3,0 | 4,6 | ST 260 |
| Pillars | elements composing the pillar section | each other (fabricated pillars) | | 0,13 | | | | |
| | pillars | deck | pillars in compression | 0,35 | | | | |
| | | | pillars in tension | See [5.4] | | | | |
| Ventilators | coamings | deck | | 0,35 | | | | |

**(1)** In connections for which $w_F \geq 0,35$, continuous fillet welding is to be adopted.

**(2)** For coefficient φ, see [3.2.6]. In connections for which no φ value is specified for a certain type of intermittent welding, such type is not permitted and continuous welding is to be adopted.

**(3)** CH = chain welding, SC = scallop welding, ST = staggered welding.

**(4)** The web at the end of intermittently welded girders or stiffeners is to be continuously welded to the plating or the flange plate, as applicable, over a distance d at least equal to the depth h of the girder or stiffeners, with 300 mm ≥ d ≥ 75 mm. Where end brackets are fitted, ends means the area extended in way of brackets and at least 50 mm beyond the bracket toes.

**(5)** In tanks intended for the carriage of ballast or fresh water, continuous welding with $w_F = 0,35$ is to be adopted.

**(6)** For connections not mentioned, the requirements for the central part apply.

**Table 4 : Weld factors $w_F$ and coefficient φ for connections of primary supporting members**

| Primary supporting member | Connection | | | $w_F$ **(1)** | φ **(2) (3)** | | | $p_1$, in mm (see [3.2.9]) **(3)** |
|---|---|---|---|---|---|---|---|---|
| | of | to | | | CH | SC | ST | |
| General **(4)** | web, where A < 65 cm² | plating and face plate | at ends | 0,20 | | | | |
| | | | elsewhere | 0,15 | 3,0 | 3,0 | | CH/SC 210 |
| | web, where A ≥ 65 cm² | plating | | 0,35 | | | | |
| | | face plate | at ends | 0,35 | | | | |
| | | | elsewhere | 0,25 | 1,8 | 1,8 | | CH/SC 130 |
| | end brackets | face plate | | 0,35 | | | | |
| In tanks, where A < 65 cm² **(5)** | web | plating | at ends | 0,25 | | | | |
| | | | elsewhere | 0,20 | 2,2 | 2,2 | | CH/SC 160 |
| | | face plate | at ends | 0,20 | | | | |
| | | | elsewhere | 0,15 | 3,0 | 3,0 | | CH/SC 210 |
| | end brackets | face plate | | 0,35 | | | | |
| In tanks, where A ≥ 65 cm² | web | plating | at ends | 0,45 | | | | |
| | | | elsewhere | 0,35 | | | | |
| | | face plate | | 0,35 | | | | |
| | end brackets | face plate | | 0,45 | | | | |

**(1)** In connections for which $w_F \geq 0,35$, continuous fillet welding is to be adopted.
**(2)** For coefficient φ, see [3.2.6]. In connections for which no φ value is specified for a certain type of intermittent welding, such type is not permitted.
**(3)** CH = chain welding, SC = scallop welding, ST = staggered welding.
**(4)** For cantilever deck beams, continuous welding is to be adopted.
**(5)** For primary supporting members in tanks intended for the carriage of ballast or fresh water, continuous welding is to be adopted.

**Note 1:**
A is the face plate sectional area of the primary supporting member, in cm².

**Note 2:**
Ends of primary supporting members means the area extended 20% of the span from the span ends. Where end brackets are fitted, ends means the area extended in way of brackets and at least 100 mm beyond the bracket toes.

### 3.2.8 Leg length

The leg length of fillet weld tee connections is to be not less than 1,41 times the required throat thickness.

### 3.2.9 Weld dimensions in a specific case

Where intermittent fillet welding is adopted with:

- length d = 75 mm
- throat thickness $t_T$ specified in Tab 5 depending on the thickness t defined in [3.2.7],

the weld spacing may be taken equal to the value $p_1$ defined in Tab 3. The values of $p_1$ in Tab 3 may be used when $8 \leq t \leq 16$ mm.

**Table 5 : Required throat thickness**

| t, in mm | $t_T$ , in mm | t, in mm | $t_T$ , in mm |
|---|---|---|---|
| 6 | 3,0 | 17 | 7,0 |
| 8 | 3,5 | 18 | 7,0 |
| 9 | 4,0 | 19 | 7,5 |
| 10 | 4,5 | 20 | 7,5 |
| 11 | 5,0 | 21 | 8,5 |
| 12 | 5,5 | 22 | 8,5 |
| 13 | 6,0 | 23 | 9,0 |
| 14 | 6,0 | 24 | 9,0 |
| 15 | 6,5 | 25 | 10,0 |
| 16 | 6,5 | 26 | 10,0 |

For thicknesses t less than 8 mm, the values of $p_1$ may be increased, with respect to those in Tab 3, by:

- 10 mm for chain or scallop welding
- 20 mm for staggered welding,

without exceeding the limits in [3.2.6].

For thicknesses t greater than 16 mm, the values of $p_1$ are to be reduced, with respect to those in Tab 3, by:

- 10 mm for chain or scallop welding
- 20 mm for staggered welding.

#### 3.2.10 Throat thickness of welds between cut-outs

The throat thickness of the welds between the cut-outs in primary supporting member webs for the passage of ordinary stiffeners is to be not less than the value obtained, in mm, from the following formula:

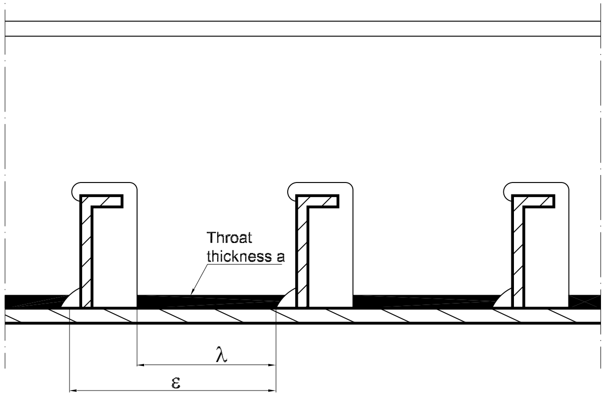
$$t_{TC} = t_T \frac{\varepsilon}{\lambda}$$

where:

$\varepsilon$, $\lambda$ : Dimensions, in mm, to be taken as shown in:

- Fig 7 for continuous welding
- Fig 8 for intermittent scallop welding.

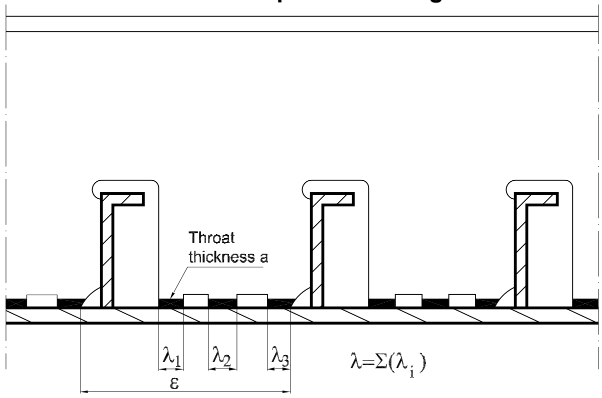
**Figure 7 : Continuous fillet welding between cut-outs**




#### 3.2.11 Throat thickness of welds connecting ordinary stiffeners with primary supporting members

The throat thickness of fillet welds connecting ordinary stiffeners and collar plates, if any, to the web of primary supporting members is to be not less than 0,35 $t_W$, where $t_W$ is the web gross thickness, in mm.

**Figure 8 : Intermittent scallop fillet welding between cut-outs**




#### 3.2.12 Shear area of primary supporting member end connections

Welding of the end connections of primary supporting members (PSM) is to be such that the weld area is to be equivalent to the gross cross-sectional area of the member. The weld throat size, in mm, is to be taken as:

$$t_T = f_{yd} \frac{h_w t_{req}}{\ell_{dep}}$$

where:

$h_w$ : Web height of primary supporting members, in mm

$t_{req}$ : Required gross thickness, in mm, of the web in way of the end connection, including 10% of shear span, based on the shear area requirement for PSM outside central part

### 3.2.13 Longitudinal continuity provided by brackets

Where the longitudinal continuity of a member contributing to the longitudinal strength of the floating establishment is provided by brackets, the weld area $A_{weld}$ is not to be less than the gross cross-sectional area of the member. The weld area $A_{weld}$ , in cm$^2$, is to be determined by the following formula:

$$A_{weld} = \frac{f_{yd} t_T \ell_{dep}}{100}$$

### 3.2.14 Reduced weld size of deep penetration fillet welding

Where an approved automatic deep penetration procedure is used and where the gap between the assembled members can be controlled to be not more than 1 mm, the weld factors given in Tab 3 may be reduced by 15%, without leading to throat size reduction of more than 1,5 mm. Reductions of up to 20%, without leading to throat size reduction of more than 1,5 mm, will be accepted provided that the Building Yard is able to demonstrate that the following requirements are consistently met:

a) The welding is performed in accordance with welding procedure tests covering both minimum and maximum root gaps

b) The weld penetration at the root is at least equivalent to the granted throat size reduction.

c) An established quality control system is in place.

The same reduction applies also for semi-automatic procedures where the welding is carried out in the downhand position.

### 3.2.15 Reduced weld size justification

Where any of the methods for reduction of the weld size are adopted, the specific requirements allowing the reduction are to be indicated on the drawings. The drawings are to document the weld design and dimensioning requirements for the reduced weld length and the required weld leg length given by [3.2.8] without the leg length reduction. Also, notes are to be added to the drawings to describe the difference in the two leg lengths and the requirements for their application.

## 3.3 Partial and full tee penetration welding

### 3.3.1 General

Partial or full tee penetration welding is to be adopted for connections subjected to high stresses for which fillet welding is considered unacceptable by the Society.

Typical edge preparations are indicated in:

- for partial penetration welds: Fig 9, in which f, in mm, is to be taken between 3 mm and t / 3, and α between 45° and 60°
- for full penetration welds: Fig 10, in which f, in mm, is to be taken between 0 and 3 mm, and α between 45° and 60°.

  Back gouging is generally required for full penetration welds.

**Figure 9 : Partial penetration weld**

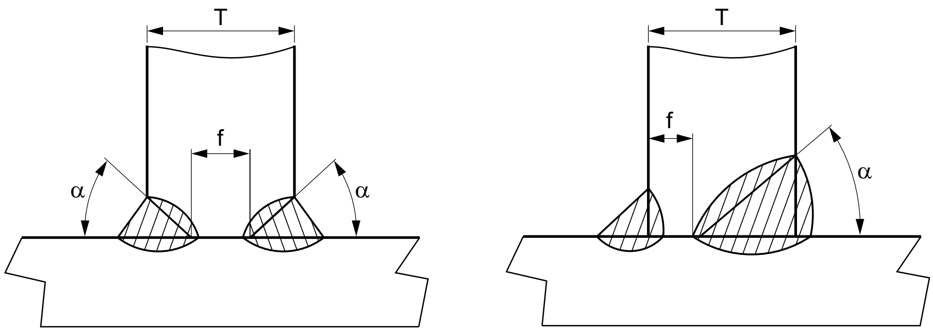
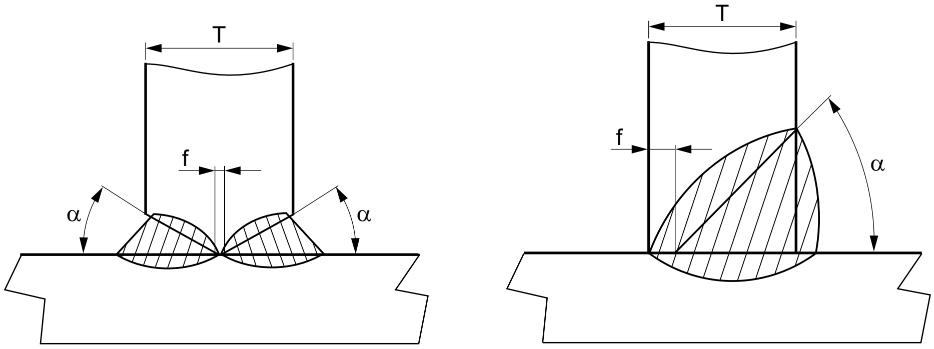



**Figure 10 : Full penetration weld**



#### 3.3.2 Lamellar tearing

Precautions are to be taken in order to avoid lamellar tears, which may be associated with:

- cold cracking when performing tee connections between plates of considerable thickness or high restraint
- large fillet welding and full penetration welding on higher strength steels.

Additional provisions may be required by the Society on a case by case basis.

## 4 Other types of joints

### 4.1 Lapped joint

#### 4.1.1 General

Lap joint welds may be adopted in very specific cases subject to the approval of the Society. Lap-joint weld may be adopted for the following:

- peripheral connection of doubler plates
- internal structural elements subjected to very low stresses.

Elsewhere, lap-joint welding may be allowed by the Society on a case by case basis, if deemed necessary under specific conditions.

Continuous welding is generally to be adopted.

#### 4.1.2 Gap

The surfaces of lap-joints are to be in sufficiently close contact.

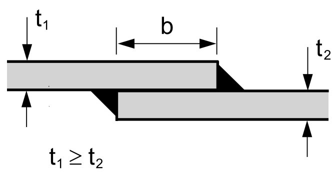
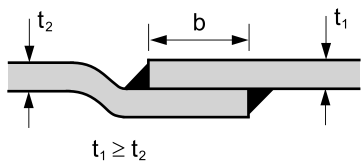
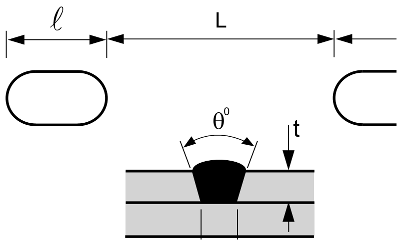
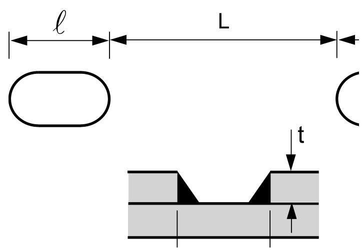
#### 4.1.3 Dimensions

The dimensions of the lap-joint are to be specified and are considered on a case by case basis. Typical details are given in Tab 6.

#### 4.1.4 Overlaps for lugs

The overlaps for lugs and collars in way of cut-outs for the passage of stiffeners through webs and bulkhead plating are not to be less than three times the thickness of the lug and not be greater than 50 mm.

**Table 6 : Typical lap joint, plug and slot welding (manual welding)**

| **Fillet weld in lap joint** | **Fillet weld in joggled lap joint** |
|---|---|
| <br>$b = 2\ t_2 + 25$ mm<br>Remark: location of lap joint to be approved by the Society | <br>$b \geq 2\ t_2 + 25$ mm<br>Remark: location of lap joint to be approved by the Society |
| **Plug welding** | **Slot welding** |
| <br>• $t \leq 12$ mm<br>$\ell = 60$ mm<br>R = 6 mm<br>$40° \leq \theta \leq 50°$<br>G = 12 mm<br>$L > 2\ \ell$<br>• $12\text{ mm} < t \leq 25$ mm<br>$\ell = 80$ mm<br>R = 0,5 t mm<br>$\theta = 30°$<br>G = t mm<br>$L > 2\ \ell$ | <br>• $t_{as\text{-}built} \leq 12$ mm<br>G = 20 mm<br>$\ell = 80$ mm<br>$2\ \ell \leq L \leq 3\ \ell$, max 250 mm<br>• $t > 12$ mm<br>G = 2 t<br>$\ell = 100$ mm<br>$2\ \ell \leq L \leq 3\ \ell$, max 250 mm |

## 4.2 Slot welding

### 4.2.1 General

Slot welds may be adopted in very specific cases subject to the special agreement of the Society. However, slot welding of doublers on the outer shell and strength deck is not permitted within 0,6L amidships.

### 4.2.2 Dimensions

Slot welds are to be of appropriate shape (in general oval) and dimensions, depending on the plate thickness, and may not be completely filled by the weld.

Typical dimensions of the slot weld and the throat thickness of the fillet weld are given in Tab 6.

The distance between two consecutive slot welds is to be not greater than a value which is defined on a case by case basis taking into account:

- the transverse spacing between adjacent slot weld lines
- the stresses acting in the connected plates
- the structural arrangement below the connected plates.

### 4.2.3 Closing plates

For the connection of plating to internal webs, where access for welding is not practicable, the closing plating may be attached by slot welds to face plates fitted to the webs.

Slots are to be well-rounded and have a minimum slot length of 90 mm and a minimum width G of twice the as-built plate thickness. Slots cut in plating are to have smooth, clean and square edges and are in general to be spaced a distance L not greater than 140 mm. Slots are not to be filled with welding.

## 4.3 Stud and lifting lugs welds

**4.3.1** Where permanent or temporary studs or lifting lugs are to be attached by welding to main structural parts in areas subject to high stress, the proposed locations are to be submitted for approval.

## 4.4 Plug welding

**4.4.1** Plug welding may be adopted only when accepted by the Society on a case by case basis, according to specifically defined criteria. Typical details are given in Tab 6.

# 5 Specific weld connections

## 5.1 Corner joint welding

**5.1.1** Corner joint welding, as adopted in some cases at the corners of tanks, performed with ordinary fillet welds, is permitted provided the welds are continuous and of the required size for the whole length on both sides of the joint.

**5.1.2** Alternative solutions to corner joint welding may be considered by the Society on a case by case basis.

## 5.2 Struts connecting ordinary stiffeners

**5.2.1** In case of a strut connected by lap joint to the ordinary stiffener, the throat thickness of the weld is to be obtained, in mm, from the following formula:

$$t_T = \frac{\eta F}{n_W \ell_W \tau} 10^3$$

where:

F : Maximum force transmitted by the strut, in kN

$\eta$ : Safety factor, to be taken equal to 2

$n_W$ : Number of welds in way of the strut axis

$\ell_W$ : Length of the weld in way of the strut axis, in mm

$\tau$ : Permissible shear stress, to be taken equal to 100 N/mm$^2$.

## 5.3 Deck subjected to wheeled loads

**5.3.1** Double continuous fillet welding is to be adopted for the connections of ordinary stiffeners with deck plating.

## 5.4 Pillars connection

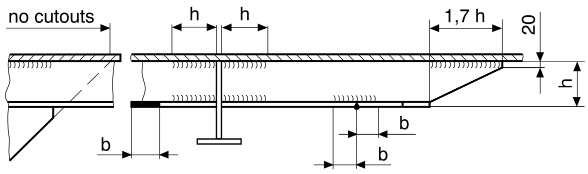
**5.4.1** For pillars in tension, continuous fillet welding may be accepted provided that the tensile stress in welds does not exceed 50/k N/mm$^2$, where k is the greatest material factor of the welded elements and the filler metal.

For pillars subjected to higher tensile stress, full penetration welding is to be adopted.

## 5.5 Welds at the ends of structural members

**5.5.1** As shown in Fig 11, the web at the end of intermittently welded girders or stiffeners is to be continuously welded to the plating or the flange plate, as applicable, over a distance at least equal to the depth h of the girder or stiffener, subject to a maximum of 300 mm and minimum of 75 mm.

**Figure 11 : Welds at the ends of girders and stiffeners**




**5.5.2** The areas of bracket plates are to be continuously welded over a distance at least equal to the length of the bracket plate. Scallops are to be located only beyond a line imagined as an extension of the free edge of the bracket plate.

**5.5.3** Wherever possible, the free ends of stiffeners are to abut against the transverse plating or the webs of sections and girders so as to avoid stress concentrations in the plating. Failing this, the ends of the stiffeners are to be cut off obliquely and are to be continuously welded over a distance of at least 1,7 h, subject to a maximum of 300 mm.

**5.5.4** Where butt joints occur in flange plates, the flange is to be continuously welded to the web on both sides of the joint over a distance at least equal to the width of the flange.

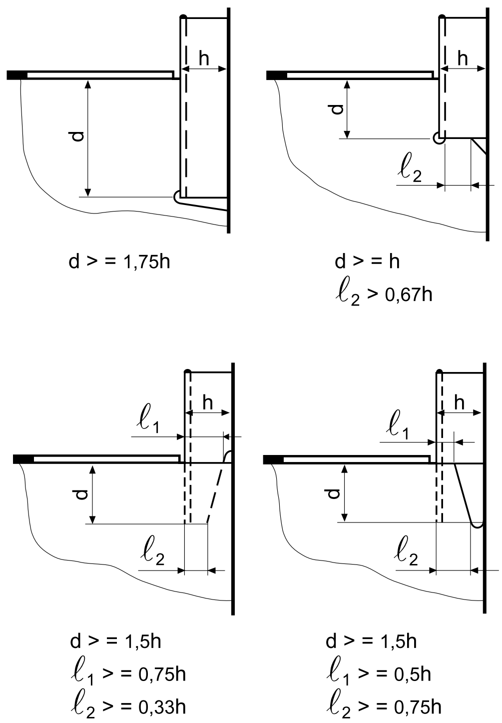
## 5.6 Joints between section ends and plates

**5.6.1** Welded joints uniting section ends and plates (e.g. at lower ends of frames) may be made in the same plane or lapped.

Where no design calculations have been carried out or stipulated for the welded connections, the joints may be made analogously to those shown in Fig 12.

If the thickness $t_1$ of the section web is greater than the thickness t of the plate to be connected, the length of the joint d must be increased in the ratio $t_1$ / t.

**Figure 12 : Joints between section ends and plates**



**5.6.2** Where the joint lies in the plane of the plate, it may conveniently take the form of a single-bevel butt weld with fillet. Where the joint between the plate and the section end overlaps, the fillet weld must be continuous on both sides and must meet at the ends. The necessary a dimension is to be calculated in accordance with NR217, Pt B, Ch 2, Sec 8, [3.7] but need not exceed 0,6 t. The fillet weld throat thickness is not to be less than the minimum specified in [3.2.7].

## 5.7 Deck subjected to wheeled loads

**5.7.1** Double continuous fillet welding is to be adopted for the connections of ordinary stiffeners with deck plating.

# Section 4 Testing and Protection of Hull Metallic Structures

## Symbols

L : Rule length, in m, defined in Ch 1, Sec 2, [3.1]

s : Spacing, in m, of ordinary stiffeners

t : Thickness, in mm.

## 1 Protection of hull metallic structures

### 1.1 Protection by coating

#### 1.1.1 General

It is the responsibility of the Building Yard and the Owner to choose the coating and have it applied in accordance with the manufacturer’s requirements.

Information and recommendations aiming to fulfilling the requirements of this Section are developed in NI607 Guidelines for Corrosion Protection Applicable to Inland Navigation Vessels.

#### 1.1.2 Structures to be protected

All areas endangered by corrosion are to be protected by a suitable corrosion protective coating.

All brackish water ballast spaces with boundaries formed by the hull envelope are to have a corrosion protective coating, epoxy or equivalent, applied in accordance with the manufacturer's requirements.

Corrosion protective coating is not required for internal surfaces of spaces intended for the carriage of fuel oil.

Narrow spaces are generally to be filled by an efficient protective product, particularly at the ends of the floating establishment where inspections and maintenance are not easily practicable due to their inaccessibility.

### 1.2 Protection against galvanic corrosion

**1.2.1** Suitable protection measures are to take place, where the danger of galvanic corrosion exists.

**1.2.2** Non-stainless steel is to be electrically insulated from stainless steel or from aluminium alloys.

**1.2.3** Where stainless steel or aluminium alloys are fitted in the same tank as non-stainless steel, a protective coating is to cover both materials.

### 1.3 Cathodic protection of tanks

**1.3.1** Ballast water tanks or other internal spaces endangered by corrosion due to brackish or harbour water may be provided with cathodic protection.

Cathodic protection may be fitted in addition to the required corrosion protective coating, if any.

**1.3.2** Uncoated stainless steels are not to be protected cathodically if they are suitable for withstanding the corrosion stress.

Coated stainless steels must be cathodically protected in the submerged zone.

**1.3.3** Where fitted, cathodic protection shall comply with the manufacturer’s instructions / recommendations.

### 1.4 Protection of bottom by ceiling

#### 1.4.1 General

In single bottom floating establishments, ceiling is to be laid on the floors from side to side up to the upper bilge.

In double bottom floating establishments, ceiling is to be laid over the inner bottom and lateral bilges, if any.

#### 1.4.2 Arrangement

Planks forming ceiling over the bilges and on the inner bottom are to be easily removable to permit access for maintenance.

Where the double bottom is intended to carry fuel oil, ceiling on the inner bottom is to be separated from the plating by means of battens 30 mm high, in order to facilitate the drainage of oil leakages to the bilges.

Where the double bottom is intended to carry water, ceiling on the inner bottom may lie next to the plating, provided a suitable corrosion protection is applied beforehand.

The Building Yard is to take care that the attachment of ceiling does not affect the tightness of the inner bottom.

In single bottom floating establishments, ceiling is to be fastened to the reversed frames by galvanised steel bolts or any other equivalent detachable connection. A similar connection is to be adopted for ceiling over the lateral bilges in double bottom floating establishments.

#### 1.4.3 Scantling

The thickness of ceiling boards, in mm, is to be at least equal to the smaller of the following values:

- floating establishments intended to carry concentrated loads, and not fitted with a double bottom:
  - $t = 50$
  - $t = 0,45\ s\ (L + 160)$
- other floating establishments:
  - $t = 25$
  - $t = 0,3\ s\ (L + 160)$

with:

s : Floor spacing, in m.

Where the floor spacing is large, the thicknesses may be considered by the Society on a case by case basis.

Under cargo hatchways, the thickness of ceiling is to be increased by 15 mm.

Where a side ceiling is provided, it is to be secured every 4 frame spacings to the side frames by an appropriate system. Its thickness may be taken equal to 0,7 times that of the bottom ceiling, without being less than 20 mm.

The batten spacing is not, as a rule, to exceed 0,2 m.

### 1.5 Protection of decks by wood sheathing

#### 1.5.1 Deck not entirely plated

The wood used for sheathing is to be of good quality dry teak or pine, without sapwood or knots. The sheathing thickness, in mm, is not to be less than:

- teak: $t = (L + 55) / 3 \geq 40$
- pine: $t = (L + 100) / 3$

The width of the planks is not to exceed twice their thickness. Their butts are to be adequately shifted so that, if two butts occur in the same frame spacing, they are separated by at least three planks.

Planks are to be secured to every other frame by means of 12 mm bolts. On small floating establishments, galvanized steel screws are permitted.

Wooden decks are to be carefully caulked, to the satisfaction of the Surveyor.

#### 1.5.2 Wood sheathed plate deck

As far as practicable, plate decks above public or staff cabins are to be sheathed with wood planks.

The plank thickness, in mm, is not to be less than 40 nor than:

- teak: $t = (L + 40) / 3$
- pine: $t = (L + 85) / 3$.

## 2 Testing procedures of watertight compartments

### 2.1 Application

**2.1.1** These test procedures are to confirm the watertightness of tanks and watertight boundaries, and the structural adequacy of tanks forming a part of the watertight subdivisions of floating establishments. These procedures may also be applied to verify the weathertightness of structures and onboard outfitting.

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

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

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

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

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

**2.1.3** Testing of structures not listed in Tab 2 is to be specially considered by the Society.

## 2.2 Definitions

### 2.2.1 Structural test

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

### 2.2.2 Leak test

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

**2.2.3** Each type of structural and leak test is defined in Tab 1.

## 2.3 General requirements

**2.3.1** Tests are to be carried out in the presence of a Surveyor at a stage sufficiently close to the completion of work, with all the hatches, doors, windows, etc., installed and all the penetrations including pipe connections fitted, and before any ceiling and cement work is applied over the joints. Specific test requirements are given in [2.6] and Tab 2. For the timing of the application of coating and the provision of safe access to joints, see [2.7], [2.8] and Tab 3.

**2.3.2** For leak tests, a safe access to all joints under examination is to be provided. See also Tab 3.

**2.3.3** In cases where the hydrostatic or hydropneumatic tests are applied instead of a specific leak test, the examined boundaries are to be dew-free, otherwise small leaks are not visible.

## 2.4 Structural test procedures

### 2.4.1 Type and time of test

Where a structural test is specified in Tab 2, a hydrostatic test in accordance with [2.6.1] is acceptable. Where practical limitations (strength of building berth, light density of liquid, etc.) prevent the performance of a hydrostatic test, a hydropneumatic test in accordance with [2.6.2] may be accepted instead.

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

### 2.4.2 Testing schedule for new construction and major structural conversion or repair

a) Tanks which are intended to hold liquids, and which form part of the watertight subdivision of the harbour equipment, are to be tested for tightness and structural strength as indicated in Tab 2.

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

c) Watertight boundaries of spaces other than tanks may be exempted from the structural test, provided that the boundary watertightness of the exempted spaces is verified by leak tests and inspections. The tank structural test is to be carried out and the requirements of item a) and item b) hereabove are to be applied for ballast holds, chain lockers.

d) Tanks which do not form part of the watertight subdivision of the floating establishment, may be exempted from structural testing provided that the boundary watertightness of the exempted spaces is verified by leak tests and inspections.

## 2.5 Leak test procedures

**2.5.1** For the leak tests specified in Tab 2, tank air tests, compressed air fillet weld tests and vacuum box tests, in accordance respectively with [2.6.4], [2.6.5] and [2.6.6], or their combinations, are acceptable. Hydrostatic or hydropneumatic tests may be also accepted as leak tests, provided [2.7], [2.8] and [2.9] are complied with. Hose tests, in accordance with [2.6.3], are also acceptable for items 10 to 13 referred to in Tab 2, taking footnote **(2)** into account.

**2.5.2** Air tests of joints may be carried out at the block stage, provided that all work on the block that may affect the tightness of a joint is completed before the test. The application of the leak test for each type of welded joint is specified in Tab 3. See also [2.7.1] for the application of final coatings, [2.8] for the safe access to joints, and Tab 3 for the summary.

## 2.6 Test method

### 2.6.1 Hydrostatic test

Unless another liquid is approved, hydrostatic tests are to consist in filling the space with fresh water or river/sea water, whichever is appropriate for testing, to the level specified in Tab 2. See also [2.9].

In case where a tank is intended for cargoes having a density higher than the density of the liquid used for the test, the testing pressure height is to be adjusted is to simulate the actual loading as far as practicable.

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

#### 2.6.2 Hydropneumatic test

Hydropneumatic tests, where approved, are to be such that the test condition, in conjunction with the approved liquid level and supplemental air pressure, simulates the actual loading as far as practicable. The requirements and recommendations in [2.6.4] for tank air tests apply also to hydropneumatic tests. See also [2.9].

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

#### 2.6.3 Hose test

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

Where a hose test is not practical because of possible damage to machinery, electrical equipment insulation, or outfitting items, it may be replaced by a careful visual examination of the welded connections, supported where necessary by means such as a dye penetrant test or an ultrasonic leak test, or equivalent.

#### 2.6.4 Tank air test

All boundary welds, erection joints and penetrations including pipe connections are to be examined in accordance with approved procedures and under a stabilized pressure differential above atmospheric pressure not less than $0{,}15 \cdot 10^5$ Pa, with a leak-indicating solution (such as soapy water/detergent or a proprietary solution) applied.

A U-tube having a height sufficient to hold a head of water corresponding to the required test pressure is to be arranged. The cross-sectional area of the U-tube is not to be less than that of the pipe supplying air to the tank. Arrangements involving the use of two calibrated pressure gauges to verify the required test pressure may be accepted taking into account appropriate safe precautions.

A double inspection of the tested welds is to be carried out. The first inspection is to be made immediately upon application of the leak indication solution; the second one is to be made approximately four or five minutes after, in order to detect those smaller leaks which may take time to appear.

#### 2.6.5 Compressed air fillet weld test

In this air test, compressed air is injected from one end of a fillet welded joint, and the pressure verified at the other end of the joint by a pressure gauge. Pressure gauges are to be arranged so that an air pressure of at least $0{,}15 \cdot 10^5$ Pa can be verified at each end of any passage within the portion being tested.

Note 1: Where a leak test is required for fabrication involving partial penetration welds, a compressed air test is also to be carried out in the same manner as to fillet weld where the root face is large, i.e. 6-8 mm.

#### 2.6.6 Vacuum box test

A box (vacuum testing box) with air connections, gauges and an inspection window is placed over the joint with a leak-indicating solution applied to the weld cap vicinity. The air within the box is removed by an ejector to create a vacuum of $0{,}20 \cdot 10^5$ to $0{,}26 \cdot 10^5$ Pa inside the box.

#### 2.6.7 Ultrasonic test

An ultrasonic echo transmitter is to be arranged on the inside of a compartment, and a receiver on the outside. The watertight/weathertight boundaries of the compartment are scanned with the receiver, in order to detect an ultrasonic leak indication. Any leakage in the sealing of the compartment is indicated at a location where sound is detectable by the receiver.

#### 2.6.8 Penetration test

For the test of butt welds or other weld joints, a low surface tension liquid is applied on one side of a compartment boundary or a structural arrangement. If no liquid is detected on the opposite sides of the boundaries after the expiration of a defined period of time, this indicates tightness of the boundaries. In certain cases, a developer solution may be painted or sprayed on the other side of the weld to aid leak detection.

#### 2.6.9 Other test

Other methods of testing may be considered by the Society upon submission of full particulars prior to the commencement of the tests.

**Table 1 : Types of test**

| Test types | Procedure |
|---|---|
| Hydrostatic test (leak and structural) | The space to be tested is filled with a liquid to a specified head |
| Hydropneumatic test (leak and structural) | Combination of a hydrostatic test and an air test, the space to be tested being partially filled with liquid and pressurized with air |
| Hose test (leak) | Tightness check of the joint to be tested by means of a jet of water, the joint being visible from the opposite side |
| Air test (leak) | Tightness check by means of an air pressure differential and a leak-indicating solution. It includes tank air tests and joint air tests, such as compressed air fillet weld tests and vacuum box tests |
| Compressed air fillet weld test (leak) | Air test of fillet welded tee joints, by means of a leak indicating solution applied on fillet welds |
| Vacuum box test (leak) | A box over a joint with a leak indicating solution applied on the welds. A vacuum is created inside the box to detect any leaks |
| Ultrasonic test (leak) | Tightness check of the sealing of closing devices such as hatch covers, by means of ultrasonic detection techniques |
| Penetration test (leak) | Check, by means of low surface tension liquids (i.e. dye penetrant test), that no visual dye penetrant indications of potential continuous leakages exist in the boundaries of a compartment |

**Table 2 : Test requirements for tanks and boundaries**

| Item | Tank or boundaries to be tested | Test type | Test head or pressure |
|---|---|---|---|
| 1 | Double bottom tanks | Leak and structural **(1)** | See Pt D, Ch 1, Sec 2, Tab 3 Pt D, Ch 2, Sec 2, Tab 7 Pt D, Ch 3, Sec 2, Tab 2; Pt D, Ch 4, Sec 2, Tab 2; Pt D, Ch 5, Sec 2, Tab 2; Pt D, Ch 6, Sec 2, Tab 2; Pt D, Ch 7, Sec 2, Tab 2. |
| 2 | Double bottom voids | Leak | See [2.6.4] to [2.6.6], as applicable |
| 3 | Double side tanks | Leak and structural **(1)** | See Pt D, Ch 1, Sec 2, Tab 3 Pt D, Ch 2, Sec 2, Tab 7 Pt D, Ch 3, Sec 2, Tab 2; Pt D, Ch 4, Sec 2, Tab 2; Pt D, Ch 5, Sec 2, Tab 2; Pt D, Ch 6, Sec 2, Tab 2; Pt D, Ch 7, Sec 2, Tab 2. |
| 4 | Double side voids | Leak | See [2.6.4] to [2.6.6], as applicable |
| 5 | Peak tanks | Leak and structural **(1)** | See Pt D, Ch 1, Sec 2, Tab 3 Pt D, Ch 2, Sec 2, Tab 7 Pt D, Ch 3, Sec 2, Tab 2; Pt D, Ch 4, Sec 2, Tab 2; Pt D, Ch 5, Sec 2, Tab 2; Pt D, Ch 6, Sec 2, Tab 2; Pt D, Ch 7, Sec 2, Tab 2. |
| 6 | a) Peak spaces with equipment | Leak | See [2.6.3] to [2.6.6], as applicable |
| | b) Peak voids | Leak | See [2.6.4] to [2.6.6], as applicable |
| 7 | Cofferdams | Leak | See [2.6.4] to [2.6.6], as applicable |
| 8 | a) Watertight bulkheads | Leak | See [2.6.3] to [2.6.6], as applicable **(4)** |
| | b) Superstructure end bulkheads | Leak | See [2.6.3] to [2.6.6], as applicable |
| 9 | Watertight doors below freeboard or bulkhead deck | Leak **(3)** **(4)** | See [2.6.3] to [2.6.6], as applicable |
| 10 | Shell doors | Leak **(2)** | See [2.6.3] to [2.6.6], as applicable |
| 11 | Weathertight hatch covers and closing appliances | Leak **(2)** **(4)** | See [2.6.3] to [2.6.6], as applicable |
| 12 | Chain lockers | Leak and structural | Head of water up to top of chain pipe |
| 13 | Ballast ducts | Leak and structural **(1)** | The greater of:<br>• ballast pump maximum pressure<br>• setting of any pressure relief valve |
| 14 | Fuel oil tanks | Leak and structural **(1)** | See NR217, Pt B, Ch 3, Sec 4, Tab 15 |

**(1)** See [2.4.2], item b).
**(2)** Hose test may be also considered as a medium of the leak test. See [2.2.2].
**(3)** Where watertightness of watertight doors has not been confirmed by a prototype test, a hydrostatic test (filling of the watertight spaces with water) is to be carried out.
**(4)** As an alternative to the hose test, other testing methods listed in [2.6.7] to [2.6.9] may be acceptable, subject to adequacy of such testing methods being verified. For watertight bulkheads (item 8 a)), alternatives to the hose test may be used only where the hose test is not practicable.

## 2.7 Application of coating

### 2.7.1 Final coating

For butt joints welded by means of an automatic process, the final coating may be applied at any time before completion of a leak test of the spaces bounded by the joints, provided that the welds have been visually inspected with care, to the satisfaction of the Surveyor.

The Surveyors reserve the right to require a leak test prior to the application of a final coating over automatic erection butt welds.

For all the other joints, the final coating is to be applied after the completion of the joint leak test. See also Tab 3.

### 2.7.2 Temporary coating

Any temporary coating which may conceal defects or leaks is to be applied at the same time as for a final coating (see [2.7.1]. This requirement does not apply to shop primers.

## 2.8 Safe access to joints

**2.8.1** For leak tests, a safe access to all joints under examination is to be provided. See also Tab 3.

## 2.9 Hydrostatic or hydropneumatic tightness test

**2.9.1** In cases where the hydrostatic or hydropneumatic tests are applied instead of a specific leak test, the examined boundaries are to be dew-free, otherwise small leaks are not visible.

# 3 Miscellaneous

## 3.1 Watertight decks, trunks, etc.

**3.1.1** After completion, a hose or flooding test is to be applied to watertight decks and a hose test to watertight trunks, tunnels and ventilators.

**Table 3 : Application of leak test, coating, and provision of safe access for the different types of welded joints**

| Type of welded joints | | Leak test | Coating **(1)** | | Safe access **(2)** | |
|---|---|---|---|---|---|---|
| | | | Before leak test | After leak test but before structural test | Leak test | Structural test |
| Butt | Automatic | not required | allowed **(3)** | not applicable | not required | not required |
| | Manual or semi-automatic **(4)** | required | not allowed | allowed | required | not required |
| Fillet | Boundary including penetrations | required | not allowed | allowed | required | not required |

**(1)** Coating refers to internal (tank/hold) coating, where applied, and external (shell/deck) painting. It does not refer to shop primer.
**(2)** Temporary means of access for verification of the leak test.
**(3)** The condition applies provided that the welds have been visually inspected with care, to the satisfaction of the Surveyor.
**(4)** Flux Core Arc Welding (FCAW) semi-automatic butt welds need not be tested, provided careful visual inspections show continuous and uniform weld profile shape, free from repairs, and the results of non-destructive testing show no significant defects.

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# RULES FOR THE CLASSIFICATION OF HARBOUR EQUIPMENT

## Part C
## Machinery, Systems and Electricity

Chapter 1 General Requirements

March 2023

Part C
Machinery, Systems and Electricity

# CHAPTER 1
# GENERAL REQUIREMENTS

# Section 1 General Requirements

## 1 General

### 1.1 Applicable requirements

**1.1.1** The design, construction, installation, tests and trials of machinery systems and equipment intended for essential services installed on board classed harbour equipment are to comply with applicable requirements of:

- NR217, Part C, Chapter 1, for auxiliary machinery systems and associated equipment, and piping systems
- NR217, Part C, Chapter 2, for electrical installations and equipment
- NR217, Part C, Chapter 3, for automation systems
- NR217, Part C, Chapter 4, for fire protection, fire detection and fire extinguishing equipment.

**1.1.2** Where available, statutory Regulations in the operating area of the harbour equipment take precedence over the class requirements.

### 1.2 Additional requirements

**1.2.1** Additional requirements for machinery are given in Part D, for the assignment of the service notations, additional service features and additional class notations.

### 1.3 Essential services

**1.3.1** Essential services are defined in Pt A, Ch 1, Sec 1, [1.3].

### 1.4 Electrical installations

#### 1.4.1 Supply systems

Supply systems using the hull as neutral conductor are not permitted:

- on **Floating storage** assigned the additional service feature **DG-S** intended for liquids or liquefied gases
- on **Floating plant** where flammable products, according to the ADN (see Note 1) classification of dangerous goods, are involved

Note 1: ADN means European agreement concerning the international carriage of dangerous goods by inland waterways.

- on harbour equipment whose hull can be dismantled.

### 1.5 Fire safety

#### 1.5.1 Application criteria

Depending on the availability of the rescue access routes and the time required for the firemen to arrive on site, the Society may waive some of the requirements covered by [1.1.1] or accept alternative measures if the following criteria are fulfilled:

a) The harbour equipment is located at a distance to a shore rescue access route not exceeding 60 m and an access footbridge, having a minimum clear width of 1,40 m and designed in compliance with applicable standards, is provided for

b) If the distance of the unit to a shore rescue access route exceeds 60 m, a fire vessel is available in the operating area of the harbour equipment

c) Availability of a warning system

   It is to be possible to alert immediately the public service of assistance and fire fighting.

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# RULES FOR THE CLASSIFICATION OF HARBOUR EQUIPMENT

## Part D
## Additional Requirements for Notations



March 2023

Part D
Additional Requirements for Notations

# CHAPTER 1
# FLOATING DOCK

# Section 1 General

## 1 General

### 1.1 Application

**1.1.1** Harbour equipment complying with the requirements of this Chapter are eligible for the assignment of the service notation **Floating dock**, as defined in Pt A, Ch 1, Sec 3, [2].

**1.1.2** Harbour equipment assigned the service notation **Floating dock** are to comply, as applicable, with Part A of the Rules and with the requirements indicated in Tab 1.

**1.1.3** The mooring equipment of the dock (moorings, chain cables, anchors, attachment devices, etc.) are not included in the scope of classification.

A distinct examination of the mooring system may be carried out by the Society, if requested by the Designer or by the Owner.

**1.1.4** Examination of the towing conditions is not covered by this Rule Note.

### 1.2 Measurement systems

**1.2.1** Floating dock is to be fitted with devices for measuring deflections, water tank level, draft and trim.

**Table 1 : Applicable requirements**

| Item | Reference |
| --- | --- |
| Unit arrangement | Part B<br>[1.2], [2], [3] |
| Hull | Part B<br>Ch 1, Sec 2 |
| Stability | Ch 1, Sec 2, [8] |
| Freeboard | Ch 1, Sec 2, [9] |
| Machinery and systems | Pt C, Ch 1, Sec 1<br>NR217, Pt C, Chap 1<br>Ch 1, Sec 3 |
| Electrical installations | Pt C, Ch 1, Sec 1<br>NR217, Pt C, Chap 2<br>Ch 1, Sec 3 |
| Automation | Pt C, Ch 1, Sec 1<br>NR217, Pt C, Chap 3<br>Ch 1, Sec 3 |
| Fire protection, detection and extinction | Pt C, Ch 1, Sec 1<br>NR217, Pt C, Chap 4 |

## 2 Definitions

### 2.1 Fore perpendicular

**2.1.1** The fore perpendicular is the perpendicular to the load waterline at the fore bulkhead of the foremost pontoon, disregarding the platforms outside the fore end pontoons.

### 2.2 Aft perpendicular

**2.2.1** The aft perpendicular is the perpendicular to the load waterline at the aft bulkhead of the aftermost pontoon, disregarding the platforms outside the aft end pontoons.

### 2.3 Lifting capacity

**2.3.1** The lifting capacity P, in ton, is the maximum weight of the vessel that the floating dock can lift with all service tanks full and operating equipment installed.

### 2.4 Safety deck

**2.4.1** The safety deck is the continuous deck situated below the upper deck and bounding the minimum volume of buoyancy.

### 2.5 Self docking dock

**2.5.1** A self docking dock consists, in general, of two continuous wing walls and a pontoon deck composed of longitudinally independent transverse detachable members connected to the lower flange of the wing walls by bolting or any other similar device.

### 2.6 Pontoon deck

**2.6.1** The pontoon deck is the deck of the pontoon structure supporting the docking blocks.

### 2.7 Floating dock with uniform ballast

**2.7.1** A floating dock with uniform ballast is such that the tanks are loaded with ballast simultaneously at the same level. The adjustment of the loaded dock is not possible with this system of ballast.

### 2.8 Floating dock with controllable ballast

**2.8.1** A floating dock with controllable ballast is such that the tanks can be ballasted independently. This arrangement gives the possibility of adjusting the trim, the deflection and the still water bending moment of the loaded dock.

## 3 Swing bridges

### 3.1 General

**3.1.1** The requirements of this Article apply to the arrangement and scantling of swing bridges.

### 3.2 Design

**3.2.1** If fitted, swing bridges are to be designed in compliance with applicable recognised standards, taking into account the following:

- minimum design vertical load: 3,5 kN/m$^2$
- minimum design lateral load: 1,5 kN/m$^2$.

### 3.3 Arrangement

**3.3.1** Swing bridges are to be anti-slip and fitted with guard rails complying with Pt B, Ch 5, Sec 3, [1].

# Section 2 Hull and Stability

## Symbols

$\Delta$ : Displacement, in t, at draught T

B : Breadth, in m, defined in Pt B, Ch 1, Sec 2, [3.3]

$d_{AP}$ : Distance from the top of the air pipe of the top of the tank, in m (see Pt B, Ch 1, Sec 2, Fig 1)

$F_{MT}$ : Vertical bending moment distribution factor defined in Pt B, Ch 4, Sec 1, [4]

g : Gravity acceleration, in $m/s^2$

$g = 9{,}81\ m/s^2$

k : Material factor, as defined in Pt B, Ch 2, Sec 2, [2.3]

L : Rule length, in m, defined in Pt B, Ch 1, Sec 2, [3.1]

$M_H$ : Design still water bending moment in hogging condition, in kN.m

$M_S$ : Design still water vertical bending moment in sagging condition, in kN.m

$M_{WV}$ : Design wave vertical bending moment, in kN.m, to be determined according to Pt B, Ch 4, Sec 1, [4]

P : Lifting capacity, in ton, defined in Ch 1, Sec 1, [2.3.1]

$p_{PV}$ : Setting pressure, in $kN/m^2$, of safety valves, if any

$Q_H$ : Design still water shear force in hogging condition, in kN.m

$Q_S$ : Design still water vertical shear force in sagging condition, in kN

$Q_{WV}$ : Design wave vertical shear force, in kN, to be determined according to Pt B, Ch 4, Sec 1, [4]

$r_L$ : Density, in $t/m^3$, of the liquid carried

T : Draught, in m, defined in Pt B, Ch 1, Sec 2, [3.5]

$T_1$ : Draught associated with each loading condition, in m, defined in [4.1.2]

z : Z co-ordinate of the calculation point of a structural element

$z_{TOP}$ : Z co-ordinate of the highest point of the tank or compartment, in m (see Pt B, Ch 1, Sec 2, Fig 1)

## 1 General

### 1.1 Application

**1.1.1** The requirements of this Section apply to floating docks intended to be loaded with one vessel or two vessels placed one behind the other. Floating docks intended to receive two vessels side by side will be specially considered by the Society.

### 1.2 Documents to be submitted

**1.2.1** The plans and documents to be submitted to the Society for review are listed in Tab 1.

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.

**1.2.2** If direct calculation analyses are carried out, calculation notes are to be submitted to the Society for review.

**1.2.3** In addition to those in [1.2.1], the following plans and documents are to be submitted to the Society for information:

- justificative calculation of forces induced by mooring equipment and cranes, if any
- general arrangement plan.

**1.2.4** The floating dock operating manual including the weights and associated locations of center of gravity of the vessels intended to be docked are to be submitted.

**1.2.5** The Society may require any other necessary guidance for the safe operation of the floating dock.

# 2 Strength principles

## 2.1 General

**2.1.1** The floating dock girder stiffness is not covered by this Rule Note. The longitudinal deflection is to be maintained within limits compatible with the floating dock strength and service ability.

**Table 1 : Plans and documents to be submitted for review**

| Plan or document | Containing also information on |
|---|---|
| Transverse sections<br>Shell expansion<br>Decks and profiles<br>Pontoon deck<br>Bulkheads<br>Machinery space<br>Coupling system, if self docking floating dock | Main dimensions and maximum draft<br>Lifting capacity<br>Frame spacing<br>Design loads on decks, platforms and pontoon deck<br>Steel grades<br>Openings in decks and shell and relevant compensations<br>Details of structural reinforcement and/or discontinuities<br>Setting pressure of safety relief valves, if any<br>Corrosion protection<br>Details related to welding<br>Calculations and data for longitudinal and transverse strength analysis<br>Block loading data |
| Plan of tank testing | Testing procedures for the various compartments<br>Height of pipes for testing |
| Arrangements and details of guard rails, windows and side scuttles | |
| Mooring equipment and cranes, if any | Forces and moments induced by mooring equipment and cranes<br>Loads and arrangement of wheels and rails of cranes<br>Connections of mooring equipment and cranes to the dock structures |
| Compartment arrangements | Use of space with indication of compartments not intended for filling<br>Location and height of air vent outlets |
| Stability documentation | See NR217, Pt B, Ch 2, Sec 2, [2.1] |
| Calculations relevant to intact stability | |

# 3 Hull arrangements

## 3.1 General arrangement

### 3.1.1 Safety deck

A safety deck as defined in Ch 1, Sec 1 is to be so fitted that the floating dock remains afloat in all operating conditions. Alternative arrangements will be specially considered by the Society.

### 3.1.2 Ventilation

Air pipes with open ends led above the uppermost wing deck are to be fitted to all tanks and other compartments which are not fitted with alternative ventilation arrangements, in compliance with Pt C, Ch 1, Sec 1.

### 3.1.3 Manholes and openings

All compartments are to be fitted with access manholes complying with Pt B, Ch 2, Sec 1, [3].

Openings are to be provided in the structural elements within compartments to ensure the free passage of air and liquids.

## 3.2 Framing system

**3.2.1** The framing of the walls and the deck is preferably to be longitudinal.

**3.2.2** The framing of the pontoon deck is preferably to be transversal to reduce buckling risks in transverse bending.

## 3.3 Supports for vessel docking

**3.3.1** A centreline girder is to be fitted to provide adequate support for the keel blocks.

Side blocks are to be supported by side girders or equivalent transverse structural members.

#### 3.3.2 Truss arrangements

Where truss arrangements are used as supports of the pontoon deck loads, including top and bottom girders in association with pillars and diagonal bracing, the diagonal members are generally to have angles of inclination with respect to the horizontal of about 45° and a cross-sectional area of about 50% that of the adjacent pillars.

### 3.4 Strength continuity

**3.4.1** At the lower part of the wings on a self docking dock, a thick horizontal plating is to be provided over the full width of the wing, on a level with the pontoon deck, in order to ensure continuity of the pontoon deck at the joints of the pontoons.

## 4 Loads and loading conditions

### 4.1 General

#### 4.1.1 Loading conditions

The following loading conditions are to be considered:

a) light floating dock with ballast evenly/unevenly distributed

b) fully loaded floating dock - one ship/two vessels one behind the other, with ballast unevenly distributed

c) fully loaded floating dock - one ship/two vessels one behind the other, with undrained ballast water evenly distributed

d) floating dock in towing condition, if relevant

e) any other special loading condition.

#### 4.1.2 Draught $T_1$ associated with each loading condition

Local loads are to be calculated on the basis of the floating dock's draught $T_1$ corresponding to each loading condition according to [4.1.1].

### 4.2 Lateral load in service conditions

**4.2.1** The lateral pressure in service conditions is to be determined in compliance with [4.2.2] to [4.2.5].

#### 4.2.2 External pressure on wings and pontoon

a) External design pressure

- for $z \le T_1$: $p_E = \rho g (T_1 - z + 0,3)$
- for $z > T_1$: $p_E = 0,3 \rho g$

b) External counter pressure

- for $z \le T_1$: $p_{Em} = \rho g (T_1 - z - 0,3)$
- for $z > T_1$: $p_{Em} = 0$

#### 4.2.3 Internal pressure

For capacities containing liquids, the internal design pressure $p_{In}$ at any point of the hull, in kN/m², is given by the following formulae, as applicable:

$p_{In} = \rho_L \, g \, (z_{TOP} - z) + d_{AP}$

$p_{In} = \rho_L \, g \, (z_{TOP} - z) + 1,15 p_{PV}$

#### 4.2.4 Loads on decks and platforms

The pressure $p_D$ on decks and platforms structures is to be defined by the Designer. As a rule, $p_D$ is not to be taken less than the values given in Tab 2.

#### 4.2.5 Wheeled loads

Wheeled loads on pontoon deck and upper deck are to be determined according to NR 217, Pat B, Ch3, Sec 4, [3.5]. Inertial forces may be neglected.

**Table 2 : Loads on decks and platforms**

| Location | $p_D$, in kN/m² |
|---|---|
| Upper deck | 5 |
| Safety deck | 3,5 |
| Platforms | 6 |

## 4.3 Lateral pressure in testing conditions

**4.3.1** The lateral pressure $p_{ST}$ to be considered as acting on platings and structural members subject to tank testing are specified in Tab 3.

**Table 3 : Lateral pressure in testing conditions**

| Compartment or structure to be tested | Water pressure, in kN/m² |
|---|---|
| Ballast tanks | The greater of the following:<br>$P_{ST} = g\,[(z_{TOP} - z) + d_{AP}]$<br>$P_{ST} = g\,[(z_{TOP} - z) + 1]$<br>$P_{ST} = g\,[(z_{TOP} - z) + 1{,}3p_{PV}]$ |
| Watertight compartments not used as tank | $P_{ST} = g\,(z_{AP} - z)$ |
| Other tanks | $P_{ST} = g\,[(z_{TOP} - z) + d_{AP}]$ |

## 4.4 Hull girder loads

**4.4.1** The values of still water hull girder loads are to be provided by the Designer for all loading conditions foreseen in the operating manual, as specified in [4.1.1], considering a total mass of the vessel(s) corresponding to the lifting capacity of the floating dock. All calculation details are to be submitted to the Society for information.

### 4.4.2 Still water vertical bending moments

The design still water bending moments $M_H$ and $M_S$ at any hull transverse section are the maximum still water bending moments calculated, in hogging and sagging conditions, respectively, at that hull transverse section.

For the loading conditions [4.1.1] a), [4.1.1] b) and [4.1.1] c), if the design still water bending moments are not available at a preliminary design stage, the values given in Tab 4 may be used, considering:

- a longitudinal distribution factor FMT as defined in Pt B, Ch 4, Sec 1, Tab 7 and Pt B, Ch 4, Sec 1, Fig 1
- an uniform distribution for the light displacement of the floating dock
- vessel weight distributions for hull girder load case 1 shown in Fig 2 and hull girder load case 2 shown in Fig 3
- ballast weight distributions for hull girder load case 1 shown in Fig 4 and hull girder load case 2 shown in Fig 5

### 4.4.3 Still water vertical shear force

The design still water vertical shear force at any hull transverse section is the maximum positive or negative shear force calculated, at that hull transverse section.

For the loading conditions [4.1.1] a), [4.1.1] b) and [4.1.1] c), if the design still water shear forces $Q_S$ and $Q_H$ are not available at a preliminary design stage, their absolute values, in kN, may be estimated using the following formula, in sagging and hogging conditions:

$$Q_S = Q_H = F_{QSW}|Q_1 + Q_2|$$

where:

$Q_1$, $Q_2$ : Net loads, in kN, on floating dock to be obtained from Tab 5.

$F_{QSW}$ : Vertical shear force distribution factor defined in Tab 6 and Fig 1

**Table 4 : Still water hull girder bending moments**

| Loading condition | Hull girder load case 1 | Hull girder load case 2 |
|---|---|---|
| 4.1.1a) | $M_H = F_{MT}\left(\frac{LQ_1}{4} + \frac{aQ_2}{2} + \frac{Q_1(0,5L - a)^2}{2(L - 2a)}\right)$ | $M_S = F_{MT}\left(\frac{Q_1(0,5L - a)^2}{2(L - 2a)} - \frac{LQ_1}{4} - \frac{aQ_2}{2}\right)$ |
| 4.1.1b)<br>4.1.1c) | $M_S = F_{MT}\left(\frac{Q_1(0,5L - a)^2}{2(L - 2a)} - \frac{LQ_1}{4} - \frac{aQ_2}{2}\right)$ | $M_H = F_{MT}\left(\frac{LQ_1}{4} + \frac{aQ_2}{2} + \frac{Q_1(0,5L - a)^2}{2(L - 2a)}\right)$ |
| **Note 1:** Parameters used in the formulae are defined as follows:<br>$Q_1$ : Net load, in kN, on floating dock central span, to be obtained from Tab 5<br>$Q_2$ : Net load, in kN, on floating dock end spans, to be obtained from Tab 5<br>a : Length of loaded or unloaded floating dock end spans, in m, to be obtained from Tab 5 | | |

**Table 5 : Still water hull girder loads - Parameters definitions**

| Loading condition | Hull girder load case 1 | Hull girder load case 2 |
|---|---|---|
| 4.1.1a) | $Q_1 = 0,7g(\Delta_0 - \Delta)$ | $Q_1 = g(0,3(\Delta_0 - \Delta) + P_{ba})$ |
| | $Q_2 = g(0,15(\Delta_0 - \Delta) + 0,5P_{ba})$ | $Q_2 = 0,35g(\Delta_0 - \Delta)$ |
| | a = 0,15L (See Fig 4) | a = 0,35 L (See Fig 5) |
| 4.1.1 b) and 4.1.1c) | $Q_1 = g(P + 0,7(\Delta_0 - \Delta))$ | $Q_1 = g(0,3(\Delta_0 - \Delta) + P_{ba})$ |
| | $Q_2 = g(0,15(\Delta_0 - \Delta) + 0,5P_{ba})$ | $Q_2 = 0,5g(P + 0,7(\Delta_0 - \Delta))$ |
| | a = 0,15L (See Fig 2 and Fig 4) | a = 0,35 L (See Fig 3 and Fig 5) |

**Note 1:** Parameters used in the formulae are defined as follows:
$\Delta_0$ : Light displacement of the floating dock, in t
$P_{ba}$ : Ballast weight, in t

**Table 6 : Distribution factor $F_{QSW}$**

| Transverse section location | Distribution factor $F_{QSW}$ |
|---|---|
| $0 \le x < 0,15\ L$ | $6,67\frac{x}{L}$ |
| $0,15\ L \le x \le 0,3\ L$ | 1 |
| $0,3\ L < x < 0,4\ L$ | $3\left(0,4 - \frac{x}{L}\right) + 0,7$ |
| $0,4\ L \le x \le 0,6\ L$ | 0,7 |
| $0,6\ L < x < 0,7\ L$ | $3\left(\frac{x}{L} - 0,6\right) + 0,7$ |
| $0,7\ L \le x \le 0,85\ L$ | 1 |
| $0,85\ L < x \le L$ | $6,67\left(1 - \frac{x}{L}\right)$ |

**Figure 1 : Distribution factor $F_{QSW}$**

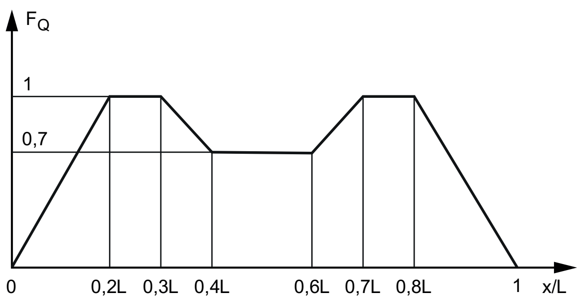



**Figure 2 : Vessel weight distribution - Hull girder load case 1**

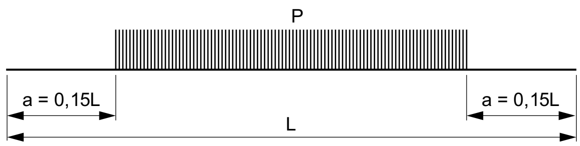



**Figure 3 : Vessel weight distribution - Hull girder load case 2**

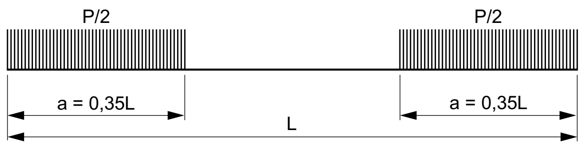


**Figure 4 : Ballast weight distribution (controllable ballast) - Hull girder load case 1**

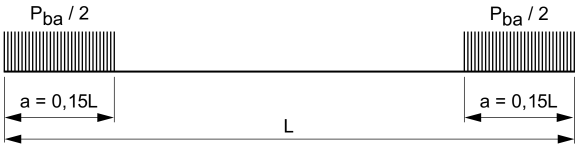
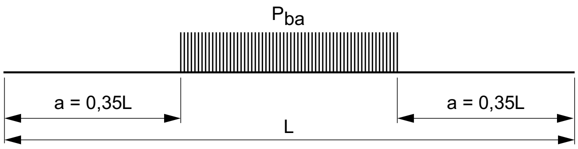



**Figure 5 : Ballast weight distribution (controllable ballast) - Hull girder load case 2**




## 4.5 Transverse loads

### 4.5.1 Definitions

a) Floating dock portion

A floating dock portion is a section of the dock extending longitudinally between two transverse bulkheads.

b) Maximum keel block load, $P_1$

The maximum keel block load is obtained by distributing the floating dock lifting capacity on the keel blocks, considering the shortest vessel intended to be docked.

### 4.5.2 Transverse loads calculation

The transverse loads (transverse bending moment, $M_T$ and transverse shear force, $Q_{TT}$) acting on different floating dock portions are to be provided by the Designer, considering all loading conditions foreseen in the operating manual. All calculation details are to be submitted to the Society for information.

If no specific data are available, at least the transverse load cases specified in Tab 7 are to be considered.

**Table 7 : Transverse load cases**

| Transverse load cases | Value of load on blocks - $P_B$ | | |
|---|---|---|---|
| | Amidships - 0,7L | At ends | At ends - beyond blocks |
| Maximum positive bending moment<br>• 100% of the vessel weight on the keel blocks<br>• buoyancy on the pontoon and submerged section of the wings | • P≤40000 t<br>keel block - $P_B$ = 1,4$P_1$<br>side blocks - $P_B$ = 0<br>• P>40000 t<br>keel block - $P_B$ = 1,6$P_1$<br>side blocks - $P_B$ = 0 | • keel block - $P_B$ = 1,4$P_1$<br>side blocks - $P_B$ = 0 | $P_B$ = 0 |
| 50% keel block - 50% side block<br>• 50% of the vessel weight acting on the keel blocks<br>• 25% of the vessel weight acting on the side blocks<br>• buoyancy on the pontoon and submerged section of the wings | • P≤40000 t<br>keel block - $P_B$ = 0,7$P_1$<br>side blocks - $P_B$ = 0,35$P_1$<br>• P>40000 t<br>keel block - $P_B$ = 0,8$P_1$<br>side blocks - $P_B$ = 0,4$P_1$ | • keel block - $P_B$ = 0,7$P_1$<br>side blocks - $P_B$ = 0,35$P_1$ | $P_B$ = 0 |
| Reverse bending<br>• no vessel weight<br>• buoyancy corresponding to draught of floating dock with docked vessel (vessel weight considered equal to the lifting capacity) | $P_B$ = 0 | | |

# 5 Hull girder strength

## 5.1 Calculation of the hull girder section modulus

**5.1.1** Calculation of the hull girder section modulus is to be carried out according to Pt B, Ch 3, Sec 1, considering all continuous longitudinal members.

In the case of a self docking or modular floating dock, some members of the transverse pontoons may also be taken into account, either partly or fully, according to the type and scantlings of the assembly (bolted, riveted or welded assembly).

The section moduli at bottom and at upper deck are obtained, in $m^3$, from the following formulae:

- at bottom:

$$Z_{AB} = \frac{I_Y}{N}$$

- at upper deck:

$$Z_{AD} = \frac{I_Y}{z_D - N}$$

where:

$I_Y$ : Net moment of inertia, in $m^4$, of the dock transverse section about its horizontal neutral axis

N : Vertical distance, in m, from the base line to the centre of gravity of the dock transverse section

$z_D$ : Vertical distance, in m, from the base line to the upper deck.

## 5.2 Hull girder stresses

### 5.2.1 Normal stresses induced by vertical bending moments

The normal stresses induced by vertical bending moments are obtained, in $N/mm^2$, from the following formulae:

- at any point of the hull transverse section:

$$\sigma_1 = \frac{M_{SW} + M_{WV}}{Z_A} 10^{-3}$$

- at bottom:

$$\sigma_1 = \frac{M_{SW} + M_{WV}}{Z_{AB}} 10^{-3}$$

- at deck:

$$\sigma_1 = \frac{M_{SW} + M_{WV}}{Z_{AD}} 10^{-3}$$

where

$M_{SW}$ : Maximum still water bending moment, in kNm

$M_{SW} = MAX (M_S, M_H)$

### 5.2.2 Shear stresses induced by vertical shear forces

The hull girder shear stresses $\tau_1$ to be considered for the strength check are obtained, in $N/mm^2$, from the following formula:

$$\tau_1 = \tau_{S1} + \gamma_{W1} \tau_{W1}$$

where:

$\tau_{S1}$ : Absolute value of the hull girder shear stresses, in $N/mm^2$, induced by the maximum still water hull girder vertical shear force in the section considered

$\tau_{W1}$ : Absolute value of the hull girder shear stresses, in $N/mm^2$, induced by the maximum wave hull girder vertical shear force in the section considered.

The shear stresses induced by shear forces are obtained through direct calculation analyses.

### 5.3 Checking criteria

**5.3.1** It is to be checked that the hull girder normal stresses and shear stresses, in N/mm², at any point of the net hull girder transverse section, calculated according to [5.2] are in compliance with the conditions given in Tab 8.

**Table 8 : Checking criteria**

| Floating dock capacity | Normal stresses | Shear stresses |
|---|---|---|
| P ≤ 40000 t | $\sigma_1 \le \frac{190}{k}$ | $\tau_1 \le \frac{110}{k}$ |
| P > 40000 t | $\sigma_1 \le \frac{165}{k}$ | $\tau_1 \le \frac{95}{k}$ |

#### 5.3.2 Net hull girder section modulus within 0,4L amidships

The net section moduli $Z_{AB}$ and $Z_{AD}$ within 0,4L amidships are to be not less than the value obtained, in m³, from the following formulae:

$Z_{R,MIN} = 0{,}9\ n_1\ C\ L^2\ B\ (C_B + 0{,}7)\ k\ 10^{-6}$

where

$n_1$ : Operation area coefficient

$n_1 = 0{,}06$

The k material factors are to be defined with respect to the materials used for the bottom and deck members contributing to the longitudinal strength according to [5.1]. When material factors for higher strength steels are used, the requirement [5.3.3] apply.

#### 5.3.3 Extent of higher strength steel

When a material factor for higher strength steel is used in calculating the required section modulus at bottom or deck according to [5.3.2], the relevant higher strength steel is to be adopted for all members contributing to the longitudinal strength (see Pt B, Ch 3, Sec 1, [2]), at least up to a vertical distance, in m, obtained from the following formulae:

- above the baseline (for section modulus at bottom):

$$V_{HB} = \frac{\sigma_{1B} - k\sigma_{1,ALL}}{\sigma_{1B} + \sigma_{1D}} z_D$$

- below a horizontal line located at a distance $V_D$ (see Pt B, Ch 3, Sec 1, [2.3.1]) above the neutral axis of the hull transverse section (for section modulus at deck):

$$V_{HD} = \frac{\sigma_{1D} - k\sigma_{1,ALL}}{\sigma_{1B} + \sigma_{1D}} (N + V_D)$$

where:

$\sigma_{1B}$, $\sigma_{1D}$ : Normal stresses, in N/mm², at bottom and deck, respectively, calculated according to [5.1.1]

$\sigma_{1ALL}$ : Allowable normal stresse, in N/mm², defined in [5.3.1]

$z_D$ : Z co-ordinate, in m, of the strength deck, defined in [5.1.1], with respect to the reference co-ordinate system defined in Pt B, Ch 3, Sec 1, [2]

N : Z co-ordinate, in m, of the centre of gravity of the hull transverse section defined in Pt B, Ch 3, Sec 1, [2.3.1] , with respect to the reference co-ordinate system defined in Pt B, Ch 3, Sec 1, [2]

$V_D$ : Vertical distance, in m, defined in Pt B, Ch 3, Sec 1, [2.3.1].

The higher strength steel is to extend in length at least throughout 0,4 L amidships where it is required for strength purposes according to the provisions of Part B.

## 6 Transverse strength

### 6.1 Calculation of transverse stresses

#### 6.1.1 Normal stress

The normal stress, $\sigma_2$, in N/mm² is obtained from the following formula

$$\sigma_2 = \frac{M_T}{Z_T} 10^3$$

where:

$M_T$ : Transverse bending moment in kN·m, for a dock portion, calculated as specified in [4.5]

$Z_T$ : Transverse section modulus, in cm³, of the dock portion

#### 6.1.2 Shear stress

The shear stress, $\tau_2$, in N/mm² is obtained from the following formula

$$\tau_2 = \frac{Q_{TT}}{\sum t(d-d')} 10^3$$

the summation being extended to all structural members contributing to the transverse strength of the dock portion,

where:

$Q_{TT}$ : Transverse shear force, in kN, for a dock portion, calculated as specified in [4.5]

t : Structural member net thickness, in mm

d : Structural member depth, in mm

d' : Depth of lightening hole in the structural member, in mm.

### 6.2 Strength criteria

#### 6.2.1 Von Mises combined stress

The Von Mises combined stress, $\sigma_{VM}$, in N/mm², is to comply with the following condition:

$$\sigma_{VM} = \sqrt{\sigma_2^{\ 2} + 3\tau_2^{\ 2}} \le \frac{190}{k}$$

#### 6.2.2 Normal stress

The normal stress, $\sigma_2$, in N/mm² is to comply with the following condition:

$$\sigma_2 \le \frac{170}{k}$$

#### 6.2.3 Shear stress

The shear stress, $\tau_2$, in N/mm² is to comply with the following condition:

$$\tau_2 \le \frac{115}{k}$$

## 7 Hull scantlings

### 7.1 General

**7.1.1** The scantlings of the hull structure are to be determined in compliance with Part B, Chapter 4, taking into account the load model defined in Pt B, Ch 4, Sec 1, [5].

**7.1.2** For plating scantling,

- in-plane hull girder shear stresses determined according to [5.2.2] are to be considered
- coefficients $\lambda_T$ and $\lambda_L$ are to be determined according to the following formulae:

$$\lambda_T = \sqrt{1 - 3\left(\gamma_m \frac{\tau_1}{R_y}\right)^2} - 0{,}89\gamma_m \frac{\sigma_{x1}}{R_y}$$

$$\lambda_L = \sqrt{1 - 3\left(\gamma_m \frac{\tau_1}{R_y}\right)^2 - 0{,}95\left(\gamma_m \frac{\sigma_{x1}}{R_y}\right)^2} - 0{,}225\gamma_m \frac{\sigma_{x1}}{R_y}$$

where,

$\sigma_{x1}$ : Hull girder normal stress, in N/mm², to be determined according to Pt B, Ch 4, Sec 1, [5.3].

**7.1.3** The scantling of the midship section are to be maintained throughout the region extending over 0,4 L amidship. Outside such region, the scantlings may decrease gradually, to reach their minimum values at 0,1 L from the fore and aft perpendiculars.

### 7.2 Structural members under keel and side blocks

**7.2.1** The strength check of structural members located under the keel and side blocks is to be carried out by direct calculation according to NR217, Pt B, Ch2, Sec 8.

# 8 Intact stability

## 8.1 General

**8.1.1** This Article provides the requirements allowing to ascertain that the floating dock has adequate intact stability under specified operating conditions.

Evidence of approval by the Administration concerned may be accepted for the purpose of classification.

**8.1.2** Transverse stability as well as longitudinal stability are to be considered.

**8.1.3** All calculations are to be carried out free from trim and sinkage.

**8.1.4** The operating manual of the floating dock is to include data giving a range of vessel weights and the associated vessel centers of gravity complying with [8.3].

**8.1.5** Stability calculations are to be determined taking into account the most severe conditions, including the effect of the free surfaces for spaces in the floating dock.

The relevant requirements of NR217, Pt B, Ch 2, Sec 2 apply.

### 8.1.6 Wind force

The force of the wind $F_{WD}$, in kN, on floating dock is to be calculated as follows:

$F_{WD} = p_{WD} A_W$

where:

$p_{WD}$ : Wind pressure to be taken equal to 0,25 kN/m$^2$, in general

$A_W$ : Lateral area, in m$^2$, above water plane, including floating dock equipment and docked vessel portion above the floating dock upper deck.

## 8.2 Loading conditions

**8.2.1** At least, the following loading conditions are to be considered:

a) Floating dock with supported vessel, with the top of the keel blocks at water level

b) Floating dock with supported vessel, with the top of the pontoon at water level

c) Floating dock with supported vessel, with the water level below the pontoon deck.

d) Floating dock fully submerged to minimum freeboard to the upper deck.

## 8.3 Design criteria

**8.3.1** In any loading condition according to [8.2], the initial metacentric height $GM_0$ is not to be less than 1 m.

**8.3.2** Moreover, the residual freeboard is to comply with the following:

- in loading condition [8.2] c), the value of the residual freeboard to the pontoon deck is to be at least 0,075 m
- in loading condition [8.2] d), the value of the residual freeboard to the upper deck is to be at least 0,5 m.

# 9 Freeboard

## 9.1 General

**9.1.1** The requirements of this Subarticle apply to floating docks operated in smooth stretches of water (see Pt A, Ch 1, Sec 1, [1.2.11] for definition).

### 9.1.2 Freeboard to the upper deck

As a rule, the freeboard to the upper deck (at any point of the upper deck), is to be not less than 1 m.

In any case, integrity of the wing walls above the safety deck is to be assured.

### 9.1.3 Freeboard to the pontoon deck

As a rule, the freeboard to the pontoon deck (at any point of the pontoon deck) is to be not less than 0,30 m.

# Section 3 Machinery Systems and Electricity

## 1 General

### 1.1 Documents to be submitted

**1.1.1** In addition to the documents required in the relevant Sections of NR217, Part C, the following information is to be submitted to the Society:

- lifting system arrangement
- deflection indicating system
- tank water level indicating system
- draft and trim indicating system
- operating manual.

## 2 Auxiliary machinery and relevant equipment

### 2.1 Water ballast lifting system

**2.1.1** The ballast system is to be so arranged that each tank can be ballasted by at least two pumps or free flow remote actuated valves.

**2.1.2** The de-ballasting system is to be so arranged that each tank can be de-watered by at least two pumps.

## 3 Electrical installations and automation equipment

### 3.1 General

**3.1.1** As a rule, floating dock complying with the standards of industrial equipment may be accepted insofar as their satisfactory operation can be established under specified temperature, moisture and corrosion conditions.

**3.1.2** The degree of protection of the electrical equipment on the deck is to be at least IP22 in enclosed areas and IP55 in wet areas and on exposed deck, in compliance with EN 60529.

### 3.2 Lighting

**3.2.1** No lights disrupting or impeding navigation by dazzling or reflective effects likely to be confused with navigational signals or hinder their effects is to be fitted on the floating dock.

## 4 Automation

### 4.1 Instrumentation

#### 4.1.1 Measuring devices

The floating dock is to be fitted with redundant devices allowing measuring the following parameters:

a) Deflections

b) Ballast tank level

c) Bilge level

d) Draft

e) Trim and heel.

#### 4.1.2 Control and monitoring

Indicators showing measured parameters according to [4.1.1] are to be provided in the control station.

As a rule, deflection indicators are to be fitted with visual and audible alarms.

Part D
Additional Requirements for Notations

# CHAPTER 2
# FLOATING LANDING DOCK

# Section 1 General

## 1 General

### 1.1 Application

**1.1.1** Harbour equipment complying with the requirements of this Chapter are eligible for the assignment of the service notation **Floating landing dock,** as defined in Pt A, Ch 1, Sec 3, [3].

**1.1.2** Harbour equipment assigned the service notation **Floating landing dock,** is to comply, as applicable, with Part A of the Rules and with the requirements indicated in Tab 1.

**1.1.3** The handling of dangerous goods will be considered by the Society on a case-by-case basis.

**1.1.4** Examination of the towing conditions is not covered by this Rule Note.

### 1.2 General requirements

**1.2.1** A floating landing dock consists of floating pontoon, means of access and anchorage system.

The floating landing dock construction is to be adapted to its service.

**1.2.2** The freeboard of floating landing dock is to be chosen in a way that the height difference between the deck of the vessel intended to be docked and the deck of the floating landing dock is the minimum.

## 2 Mooring system

### 2.1 General

**2.1.1** Floating landing docks are to be fitted with an efficient mooring system preventing them from turning or being pushed away by the docked vessels, wind, current, wave, or by changing of the water level and draught or the wake of passing vessels.

### 2.2 Design of dock mooring system

**2.2.1** The dock mooring force, $F_D$ , to be used for the mooring system design is defined in Ch 2, Sec 2, [3.5.6].

In particular, the mooring cables are to be selected using the tension $T_{DM}$ in each mooring cable, calculated from the following formula:

$$T_{DM} = \frac{F_D}{N} + P$$

where:

$T_{DM}$ : Tension in dock mooring cables, in kN

N : Number of mooring cables

P : Mooring cables pretension, in kN.

### 2.3 Vessel mooring system

**2.3.1** Floating landing dock are to be equipped with at least two bollards.

**2.3.2** The bollards are to be designed to withstand the docked vessel mooring force, $F_{MV}$, to be determined according to Ch 2, Sec 2, [3.5.5].

**2.3.3** The bollards are to be led through the deck and below be attached to a horizontal plate spaced at least one bollard diameter from the deck. Said plate being of the same thickness as the bollard wall has to be connected to the side wall and adjacent beam knees. Should this be impossible, the bollards are to be constrained in a bollard seat on deck.

## 3 Fenders

### 3.1 General

**3.1.1** Floating landing docks are to be fitted with fenders of appropriate energy absorption capacity to soften the berthing impact.

**3.1.2** The main characteristics of the fenders are to be determined on the basis of the berthing impact force $F_B$, defined in Ch 2, Sec 2, [3.5.3].

**Table 1 : Applicable requirements**

| Item | Reference |
|---|---|
| Unit arrangement | Part B<br>[1.2], [2], [3] |
| Hull | Part B<br>Ch 2, Sec 2 |
| Stability | Ch 2, Sec 2, [7] |
| Machinery and systems | Pt C, Ch 1, Sec 1<br>NR217, Pt C, Chap 1 |
| Electrical installations | Pt C, Ch 1, Sec 1<br>NR217, Pt C, Chap 2<br>Ch 2, Sec 3 |
| Automation | Pt C, Ch 1, Sec 1<br>NR217, Pt C, Chap 3<br>Ch 2, Sec 3 |
| Fire protection, detection and extinction | Pt C, Ch 1, Sec 1<br>NR217, Pt C, Chap 4 |

# Section 2 Hull and Stability

## Symbols

Δ : Displacement, in t, at draught T

B : Breadth, in m, defined in Pt B, Ch 1, Sec 2, [3.3]

$d_{AP}$ : Distance from the top of the air pipe of the top of the tank, in m (see Pt B, Ch 1, Sec 2, Fig 1)

g : Gravity acceleration, in m/s²

$g = 9,81$ m/s²

L : Rule length, in m, defined in Pt B, Ch 1, Sec 2, [3.1]

$L_{WL}$ : Length of waterline, in m, defined in Pt B, Ch 1, Sec 2, [3.7]

$p_{PV}$ : Setting pressure, in kN/m², of safety valves, if any

$r_L$ : Density, in t/m³, of the liquid carried

T : Draught, in m, defined in Pt B, Ch 1, Sec 2, [3.5]

$T_1$ : Draught associated with each loading condition, in m, defined in [3.1.2]

z : Z co-ordinate of the calculation point of a structural element

$z_{TOP}$ : Z co-ordinate of the highest point of the tank or compartment, in m (see Pt B, Ch 1, Sec 2, Fig 1)

## 1 General

### 1.1 Application

**1.1.1** The requirements of this Section apply for the assignment of the service notation **Floating landing dock** to harbour equipment up to a rule length L=135 m.

**1.1.2** Floating landing docks with rule length L exceeding 135 m will be specially considered by the Society.

**1.1.3** Floating landing docks made of non metallic hulls is to comply with the strength criteria defined in Pt B, Ch 2, Sec 5.

### 1.2 Documents to be submitted

**1.2.1** The plans and documents to be submitted to the Society for review are listed in Tab 1.

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.

**1.2.2** If direct calculation analyses are carried out, calculation notes are to be submitted to the Society for review.

**1.2.3** In addition to those in [1.2.1], the following plans and documents are to be submitted to the Society for information:

- justificative calculation of forces induced by mooring equipment
- general arrangement plan.

**1.2.4** The Society may require any other necessary guidance for the safe operation of the floating landing dock.

## 2 Structure design principles

### 2.1 Hull structure

#### 2.1.1 Framing

In general, the hull structure is to be longitudinally framed. Longitudinal stiffening members are to be supported by transverses arranged to form ring systems.

#### 2.1.2 Truss arrangement supporting deck loads

Where truss arrangement may be used as supports of the deck loads, including top and bottom girders in association with pillars and diagonal bracing, the diagonal members are generally to have angles of inclination with respect to the horizontal of about 45° and cross sectional area of about 50% that of the adjacent pillars.

**Table 1 : Plans and documents to be submitted for review**

| Plan or document | Containing also information on |
|---|---|
| Transverse sections<br>Shell expansion<br>Decks and profiles<br>Bulkheads<br>Machinery space, if any | Main dimensions and maximum draft<br>Frame spacing<br>Design loads on decks<br>Material specifications (steel grades, aluminium alloys, etc...)<br>Openings in decks and shell and relevant compensations<br>Details of structural reinforcement and/or discontinuities<br>Setting pressure of safety relief valves, if any<br>Corrosion protection<br>Details related to welding<br>Calculations and data for longitudinal and transverse strength analysis |
| Plan of tank testing | Testing procedures for the various compartments<br>Height of pipes for testing |
| Windows and side scuttles, arrangements and details | |
| Mooring equipment | Forces and moments induced by mooring equipment<br>Connections of mooring equipment to the dock structures |
| Compartment arrangements | Use of space with Indication of compartments not intended for filling<br>Location and height of air vent outlets |
| Stability documentation | See NR217, Pt B, Ch 2, Sec 2, [2.1] |
| Calculations relevant to intact stability and, where required, damage stability | |

# 3 Loads and loading conditions

## 3.1 General

### 3.1.1 Loading conditions

The following loading conditions are to be taken in consideration:

a) Loaded dock, no vessel

b) Loaded dock, vessel during docking

c) Light dock, no vessel

d) Light dock with docked vessel

e) Loaded dock with docked vessel.

### 3.1.2 Draught $T_1$ associated with each loading condition

Local loads are to be calculated on the basis of the floating landing dock's draught $T_1$ corresponding to each loading condition according to [3.1.1].

## 3.2 Lateral load in service conditions

**3.2.1** The lateral load in service conditions is to be determined in compliance with [3.2.2] to [3.2.5].

### 3.2.2 External pressure on the shell structure

a) External design pressure

- for $z \leq T_1$: $p_E = \rho g (T_1 - z + 0{,}3)$
- for $z > T_1$: $p_E = 0{,}3 \rho g$

b) External counter pressure

- for $z \leq T_1$: $p_{Em} = \rho g (T_1 - z - 0{,}3)$
- for $z > T_1$: $p_{Em} = 0$

### 3.2.3 Internal pressure

For capacities containing liquids, the internal design pressure $p_{In}$ at any point of the hull, in kN/m², is given by the following formulae, as applicable:

$p_{In} = \rho_L \, g \, (z_{TOP} - z) + d_{AP}$

$p_{In} = \rho_L \, g \, (z_{TOP} - z) + 1{,}15 p_{PV}$

#### 3.2.4 Loads on deck

The pressure $p_D$ on decks and platforms structures is to be defined by the Designer.

The pressure $p_D$ is not to be taken less than 5 kN/m².

#### 3.2.5 Wheeled loads

Wheeled loads on the deck structure are to be determined according to NR 217, Pat B, Ch3, Sec 4, [3.5]. Inertial forces may be neglected.

### 3.3 Dry uniform loads

**3.3.1** The pressure $p_C$, in kN/m², induced by dry uniform loads is to be defined by the Designer.

### 3.4 Dry unit loads

**3.4.1** The force F induced by dry unit loads and transmitted to the hull structure is to be determined on the basis of the force obtained, in kN, from the following formula:

$F = 9,81\ m_C$

where $m_C$ is the mass, in t, of the dry unit load.

Account is to be taken of the elastic characteristics of the lashing arrangement and/or the structure which supports the load.

### 3.5 Loads induced by docked vessel

#### 3.5.1 General

The loads induced by docked vessel are to be provided by the Designer for all intended operating conditions. All calculation details are to be submitted to the Society.

Where the values of the loads induced by docked vessel are not available, they may be determined according to the requirements of this Sub-article.

#### 3.5.2 Symbols and definitions

$L_V$ : Rule length, in m, of the docked vessel

$B_V$ : Breadth, in m, of the docked vessel

$T_V$ : Draught, in m, of the docked vessel

$\Delta_V$ : Displacement, in ton, of the docked vessel

h : Minimum water depth, in m, in way of the floating landing dock.

#### 3.5.3 Berthing impact

The berthing impact $F_B$, in kN, induced by the docked vessel on the floating landing dock is to be calculated taking in consideration the displacement of the biggest vessel intended to be docked and the elastic characteristics of the berthing system (see Fig 1), according to the following formula:

$$F_B = 0,077\left(\frac{m \cdot V_V^2}{f}\right)$$

where:

m : Total mass, in ton, equal to:

$m = \Delta_V + m_H$

with:

$m_H$ : Hydrodynamic mass, in ton, equal to:

$m_H = \Delta_V\ k_1\ k_2$

$k_1$ : Coefficient defined in Tab 2

$k_2$ : Coefficient defined in Tab 3

$V_V$ : Vessel berthing speed, in km/h.

Where the vessel berthing speed is not known, $V_V$ may be determined according to Tab 4

f : Displacement, in m, of the berthing system (see Fig 2)

In absence of an element with manifest elastic behavior or structural elastic system, f is not to be taken greater than 0,05 m.

**Table 2 : C6ient $k_1$, in function $B_V/T_V$**

| $B_V/T_V$ | 14 | 12 | 10 | 8 | 6 | 4 | 2 |
|---|---|---|---|---|---|---|---|
| $k_1$ | 0,22 | 0,26 | 0,30 | 0,38 | 0,48 | 0,66 | 1,20 |

**Table 3 : Coefficient $k_2$, in function $T_V/h$**

| $T_V/h$ | 0,1 | 0,2 | 0,3 | 0,5 | 0,6 | 0,7 | 0,8 | 0,85 |
|---|---|---|---|---|---|---|---|---|
| $k_2$ | 1,05 | 1,1 | 1,2 | 1,5 | 1,8 | 2,3 | 3,2 | 4,0 |

**Table 4 : Vessel berthing speed $V_V$, in function $\Delta_V$**

| $\Delta_V$ (t) | 100 | 200 | 500 | 1000 | 1500 | 2000 | 3000 | 4000 | ≥ 5000 |
|---|---|---|---|---|---|---|---|---|---|
| $V_V$ (km/h) | 1,04 | 1,01 | 0,94 | 0,83 | 0,76 | 0,68 | 0,58 | 0,50 | 0,47 |

**Figure 1 : Loads induced by docked vessel on floating landing dock**

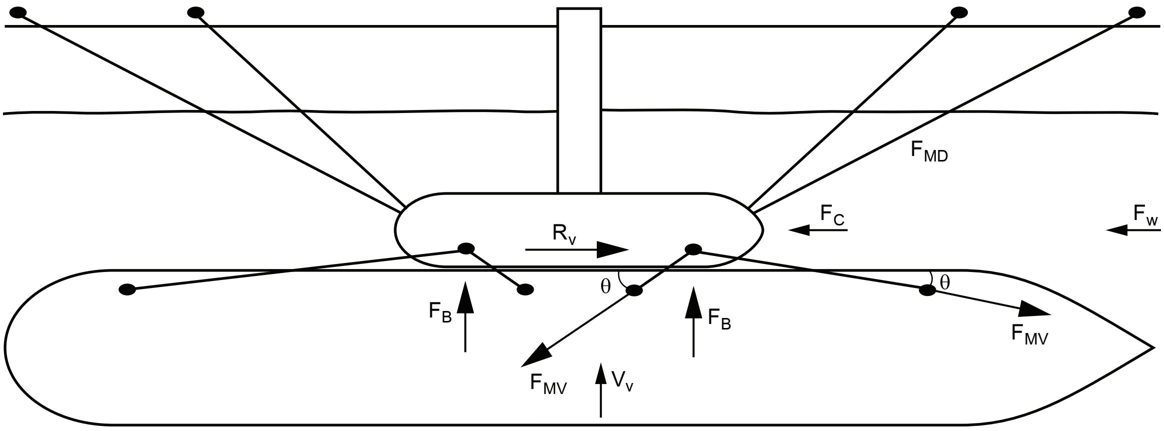
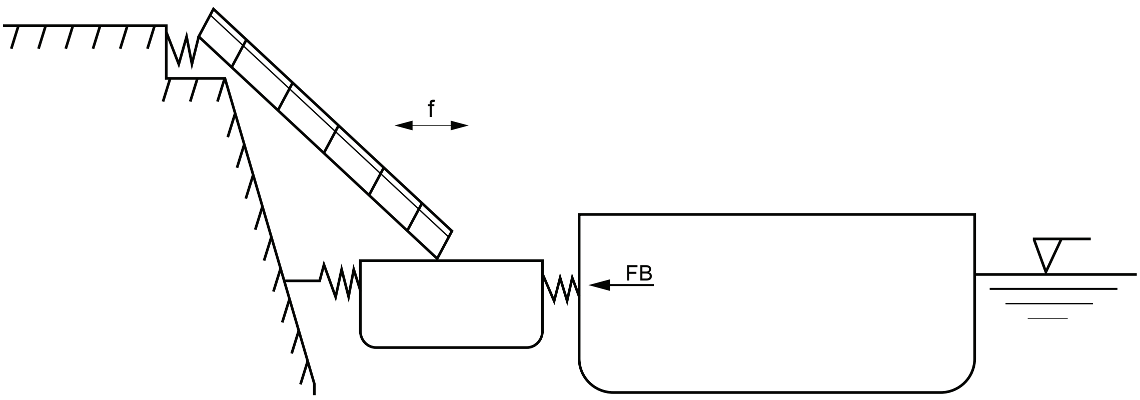



**Figure 2 : Elastic system**




### 3.5.4 Friction force

The friction force $R_V$, in kN, induced by the vessel along the docking side of the floating landing dock is to be calculated using the following formula:

$R_V = \mu F_B$

where:

$\mu$ : Friction coefficient between the vessel and docking side:

- $\mu$ = 0,15 between steel and steel
- $\mu$ = 0,50 between steel and wood or wood and wood.

#### 3.5.5 Mooring force of docked vessel

The mooring force of the docked vessel $F_{MV}$, in kN, is to be calculated using the formulae given in Tab 5, where:

C : Force coefficient, equal to:

$$C = Cc\sqrt{\frac{L_V}{8B_V}}B_VT_V$$

with:

Cc : Coefficient as defined in Tab 6.

**Table 5 : Mooring force**

| Force coefficient C | F, in kN |
|---|---|
| $C \le 500$ | F = 0,35 C |
| $500 < C \le 2000$ | $F = \left(0,35 - \frac{C - 500}{15000}\right)C$ |
| $2000 < C$ | F = 0,25 C |

**Table 6 : Coefficient Cc**

| Displacement, in ton | Cc |
|---|---|
| $\Delta_V \le 400$ | 45 |
| $400 < \Delta_V \le 650$ | 55 |
| $650 < \Delta_V \le 1000$ | 65 |
| $1000 < \Delta_V$ | 70 |

#### 3.5.6 Mooring force of floating landing dock

The mooring force of the floating landing dock, $F_D$, is to be defined by the Designer.

Where the mooring force of the floating landing dock, $F_D$, is not known, it may be determined, in kN, according to the following formula:

$F_D = F_{MD} + \text{Max}(F_B ; F_{MV})$

where:

$F_{MD}$ : Mooring force of the floating landing dock, without docked vessel, in kN, to be calculated using the formulae given in Tab 5, with:

C : Mooring force coefficient, equal to:

$$C = Cc\sqrt{\frac{L}{8B}}BT$$

Cc : Coefficient as defined in Tab 6, substituting $\Delta$ for $\Delta_V$

$F_B$ : Vessel berthing impact defined in [3.5.3]

$F_{MV}$ : Vessel mooring force, defined in [3.5.5].

### 3.6 Lateral pressure in testing conditions

**3.6.1** The lateral pressure $p_{ST}$ to be considered as acting on platings and structural members subject to tank testing are specified in Tab 7.

**Table 7 : Lateral pressure in testing conditions**

| Compartment or structure to be tested | Water pressure, in kN/m² |
|---|---|
| Ballast compartment | The greater of the following:<br>$P_{ST} = g\,[(z_{TOP} - z) + d_{AP}]$<br>$P_{ST} = g\,[(z_{TOP} - z) + 1]$<br>$P_{ST} = g\,[(z_{TOP} - z) + 1{,}3p_{PV}]$ |
| Watertight compartment not used as tank | $P_{ST} = g\,(z_{AP} - z)$ |
| Other tank | $P_{ST} = g\,[(z_{TOP} - z) + d_{AP}]$ |

### 3.7 Hull girder loads

#### 3.7.1 Still water hull girder loads

The values of design still water hull girder loads are to be provided by the Designer.

#### 3.7.2 Vertical wave hull girder loads

The vertical wave hull girder loads at any hull transverse section are to be determined according to Pt B, Ch 4, Sec 1, [4.2].

## 4 Hull girder strength

### 4.1 General

**4.1.1** Calculation of the hull girder section modulus is to be carried out according to Pt B, Ch 3, Sec 1, considering all continuous longitudinal members.

**4.1.2** The hull girder strength check is to be in compliance with Pt B, Ch 3, Sec 1, [4].

## 5 Transverse strength

### 5.1 General

**5.1.1** The transverse strength check is to comply with Pt B, Ch 3, Sec 2.

## 6 Hull scantlings

### 6.1 General

**6.1.1** The scantlings of the hull structure are to be determined in compliance with Part B, Chapter 4, taking into account the load model defined in Pt B, Ch 4, Sec 1, [5].

### 6.2 Reinforcements

**6.2.1** Reinforcements are to be provided at places where the hull is heavily stressed, as the area of coupling systems for the modular floating landing dock and area of mooring equipment.

### 6.3 Wood sheathing

**6.3.1** Wood sheathing is recommended for caterpillar trucks and unusual vehicles.

It is recommended that a piece of wood of suitable thickness should be provided under each crutch in order to distribute the mass over the plate and nearest stiffeners.

## 7 Stability

### 7.1 General

**7.1.1** This Article provides the requirements allowing to ascertain that the floating landing dock has adequate stability under all operating conditions.

Evidence of approval by the Administration concerned may be accepted for the purpose of classification.

**7.1.2** All calculations are to be carried out free from trim and sinkage.

**7.1.3** Stability calculations are to be determined taking into account the most severe conditions, including the effect of the free surfaces of liquids in tanks.

The following requirements of NR217, Pt B, Ch 2, Sec 2 apply:

- definitions
- examination procedure
- inclining test and lightweight check.

### 7.2 Heeling moments

**7.2.1** The values of the heeling moments to be considered are to be defined by the Designer.

**7.2.2** The following heeling moments are to be considered.

a) Load induced moment

b) Asymmetric structure induced moment

c) Moment due to wind pressure

The moment caused by the wind pressure, in kN·m, is to be calculated in accordance with the following formula:

$$M_W = F_{WD}\left(\ell_W + \frac{T}{2}\right)$$

where:

$\ell_W$ : Distance, in m, of the centre of gravity of area $A_W$, from waterline.

$F_{WD}$ : Wind force, in kN

$F_{WD} = p_{WD} A_W$

$p_{WD}$ : Wind pressure to be taken equal to 0,25 kN/m², in general

$A_W$ : Lateral area, in m², above water plane, including cargo and equipment windage area.

d) Cross current induced moment

The moment resulting from the cross current is only to be taken into account for floating landing dock which is anchored or moored across the current while operating.

e) Ballast and supplies induced moment

The least favourable extent of tank filling from the point of view of stability is to be determined and the corresponding moment introduced into the calculation.

f) Moment induced by docked vessel

The moment resulting from docked vessel is to be taken into account if the movements of the vessel are likely to affect the floating landing dock stability.

g) Moment due to inertia forces

The moment resulting from inertia forces is to be taken into account if the movements of the load are likely to affect its stability.

h) Moment due to crowding of persons

Where the floating landing dock is intended for passengers, the moment due to crowding of persons is to be taken into account.

The heeling moment $M_P$, in kN.m, due to one-sided accumulation of persons is to be calculated according to the following formula:

$$M_P = 9,81\,Py = 9,81\sum P_i y_i$$

where:

$P$ : Total weight of persons on board, in t, calculated by taking into account the maximum permitted number of persons, $n_{max}$, personnel and crew included, under normal operating conditions, assuming an average weight per person of 0,075 t

$y$ : Lateral distance, in m, of center of gravity of total weight of persons P from center line

$y_i$ : Lateral distance, in m, of geometrical center of area $A_i$ from center line

$P_i$ : Weight of persons accumulated on area $A_i$, in t:

$P_i = 0,075\ n_i\ A_i$

$A_i$ : Area, in m², occupied by persons

$n_i$ : Number of persons per square meter

$n_i = 3,75$

The calculation is to be carried out for an accumulation of persons both to starboard and to port.

The distribution of persons is to correspond to the most unfavorable one from the point of view of stability.

For calculation of the loading cases, the centre of gravity of a person is to be taken as 1 m above the lowest point of the deck at 1/2 $L_{WL}$, ignoring any deck curvature and assuming a weight of 0,075 t per person.

A detailed calculation of deck areas which are occupied by persons may be dispensed with if the following values are used:

- $y = B/2$
- $P = 1,1 \cdot n_{max} \cdot 0,075$

  where:

  $n_{max}$ : Maximum permitted number of persons.

## 7.3 Intact stability

**7.3.1** It is to be confirmed that, when account has been taken of the combined action of heeling moments defined in [7.2]:

- the residual safety clearance is not less than:
  - 0,30 m for weathertight apertures
  - 0,40 m for unprotected openings
- the residual freeboard value is at least 0,30 m

  the residual freeboard may be reduced if it is proven that the requirements of [7.4] or [7.5], as the case may be, have been met.

The angle of list is not to exceed 10° and the base of the hull shall not emerge.

## 7.4 Intact stability in case of reduced residual freeboard - Harbour equipment not intended for passengers

**7.4.1** If a reduced residual freeboard is taken into account, it is be checked, for all operating conditions, that:

a) After correction for the free surfaces of liquids, the metacentric height GM is not less than 0,15 m

b) For list angles between 0° and 30°, there is a righting lever, in m, of at least:

   $h = 0,30 - 0,28\ \varphi_n$

c) The list angle does not exceed 10°

d) The residual safety clearance value is, at least:

   - 0,30 m for weathertight openings
   - 0,40 m for unprotected openings

e) The residual freeboard is at least 0,05 m

f) For list angles between 0° and 30°, the residual righting lever arm, in m, is at least:

   $h = 0,20 - 0,23\ \varphi_n$

   Residual righting lever arm means the maximum difference existing between 0° and 30° list between the righting lever and the heeling lever curves. If an opening towards the inside of the floating equipment is immersed at a list angle less than the one corresponding to the maximum difference between the lever arm curves, the lever arm corresponding to that list angle is to be taken into account.

where:

$\varphi_n$ : List angle, in radian, from which the righting lever arm curve displays negative values; this is not to be inserted into the formula for more than 30° or 0,52 rad.

## 7.5 Intact stability in case of reduced residual freeboard - Harbour equipment intended for passengers

**7.5.1** If a reduced residual freeboard is taken into account, it is not be checked, for all operating conditions, that:

a) After correction for the free surfaces of liquids, the metacentric height GM is not less than 0,15 m

b) The maximum righting lever arm $h_{max}$ is to occur at a list angle of $\varphi_{max} \geq (\varphi_{mom} + 3°)$ and is not to be less than 0,20 m. However, in case $\varphi_f < \varphi_{max}$ the righting lever arm at the downflooding angle $\varphi_f$ is not to be less than 0,20 m.

c) The list angle does not exceed 10°

d) The residual safety clearance value is, at least:

   - 0,30 m for weathertight openings
   - 0,40 m for unprotected openings

e) The residual freeboard is at least 0,05 m

f) The area A under the curve of the righting lever arm is to reach 0,05 m.rad up to the angle $\varphi_f$.

where:

$\varphi_f$ : List angle, at which openings in the hull which cannot be closed so as to be weathertight, submerge

$\varphi_f \leq 15°$

$\varphi_{max}$ : List angle at which the maximum righting lever arm occurs

$\varphi_{mom}$ : List angle due to the combined action of heeling moments defined in [7.2].

## 7.6 Damage stability

**7.6.1** Where the floating landing dock is intended for passengers, proof of appropriate damage stability is to be furnished according to [7.6.5] and [7.6.6].

**7.6.2** Floating landing dock is to comply with the one-compartment status, taking into account the assumptions concerning the extent of damage given in Tab 8 and assuming the compartment permeability to be 95%.

**7.6.3** The bulkheads can be assumed to be intact if the distance between two adjacent bulkheads is greater than the damage length. Longitudinal bulkheads at a distance of less than B/3 measured rectangular to centre line from the shell plating at the maximum draught plane is not to be taken into account for calculation purposes.

**7.6.4** If damage of a smaller dimension than specified in [7.6.2] produces more detrimental effects with respect to heeling or loss of metacentric height, such damage is to be taken into account for calculation purposes.

**7.6.5** Under the combined action of heeling moments defined in [7.2], the residual freeboard and the residual safety clearance are not less than 0,10 m.

**7.6.6** For safety reasons, greater values of the residual safety clearance or residual freeboard may be required by the Society.

**Table 8 : Extent of damage, in m**

| Damage location | Dimension of the damage | |
|---|---|---|
| Wall | Longitudinal $\ell$ | $0,1\ L_{WL} \geq 4$ (1) |
| | Transverse b | B/5 |
| | Vertical h | From unit bottom to top without delimitation |
| Bottom (3) | Longitudinal $\ell$ | $0,1\ L_{WL} \geq 4$ **(1)** |
| | Transverse b | B/5 |
| | Vertical h | 0,59; pipework is to be deemed intact (2) |

**(1)** For units with $L_{WL} \leq 25$, smaller values of the damage extent may be accepted by the Society on a case-by-case basis.
**(2)** Where a pipework system has no open outlet in a compartment, the pipework shall be regarded as intact in the event of this compartment being damaged, if it runs within the safe area and is more than 0,50 m off the bottom of the unit.
**(3)** May be disregarded if the water stretch level is relatively constant (e.g., no season or tide effect).

# SECTION 3 MACHINERY SYSTEMS AND ELECTRICITY

## 1 Electrical installations and automation equipment

### 1.1 General

**1.1.1** As a rule, floating landing dock complying with the standards of industrial equipment may be accepted insofar as their satisfactory operation can be established under specified temperature, moisture and corrosion conditions.

**1.1.2** The degree of protection of the electrical equipment on the deck is to be at least IP22 in enclosed areas and IP55 in wet areas and on exposed deck, in compliance with EN 60529.

### 1.2 Lighting

**1.2.1** No lights disrupting or impeding navigation by dazzling or reflective effects likely to be confused with navigational signals or hinder their effects is to be fitted on the floating landing dock.

Part D
Additional Requirements for Notations

# CHAPTER 3
# FLOATING DOOR

# Section 1 General

## 1 General

### 1.1 Application

**1.1.1** Harbour equipment complying with the requirements of this Chapter are eligible for the assignment of the service notation **Floating door**, as defined in Pt A, Ch 1, Sec 3, [4].

**1.1.2** Harbour equipment assigned the service notation **Floating door** are to comply, as applicable, with Part A of the Rules and with the requirements indicated in Tab 1.

**1.1.3** Examination of the towing conditions is not covered by this Rule Note.

**Table 1 : Applicable requirements**

| Item | Reference |
| --- | --- |
| Unit arrangement | Part B |
| Hull | Part B<br>Ch 3, Sec 2 |
| Stability | Ch 3, Sec 2, [6] |
| Machinery and systems | Pt C, Ch 1, Sec 1<br>NR217, Pt C, Chap 1 |
| Electrical installations | Pt C, Ch 1, Sec 1<br>NR217, Pt C, Chap 2<br>Ch 3, Sec 3 |
| Automation | Pt C, Ch 1, Sec 1<br>NR217, Pt C, Chap 3<br>Ch 3, Sec 3 |
| Fire protection, detection and extinction | Pt C, Ch 1, Sec 1<br>NR217, Pt C, Chap 4 |

# Section 2 Hull and Stability

## Symbols

$d_{AP}$ : Distance from the top of the air pipe of the top of the tank, in m (see Pt B, Ch 1, Sec 2, Fig 1)

$g$ : Gravity acceleration, in m/s²

$g = 9{,}81$ m/s²

$h_T$ : Tide height, in m

$p_{PV}$ : Setting pressure, in kN/m², of safety valves, if any

$r_L$ : Density, in t/m³, of the liquid carried

$T_1$ : Draught associated with each loading condition, in m, defined in [3.1.2]

$z_{TOP}$ : Z co-ordinate of the highest point of the tank or compartment, in m (see Pt B, Ch 1, Sec 2, Fig 1)

$z$ : Z co-ordinate of the calculation point of a structural element

## 1 General

### 1.1 Documents to be submitted

**1.1.1** The plans and documents to be submitted to the Society for review are listed in Tab 1.

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.

**1.1.2** If direct calculation analyses are carried out, calculation notes are to be submitted to the Society for review.

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

- justificative calculation of forces induced by towing, mooring and operation of the floating door
- general arrangement plan.

**Table 1 : Plans and documents to be submitted for review**

| Plan or document | Containing also information on |
|---|---|
| Transverse sections<br>Shell expansion<br>Decks and profiles<br>Bulkheads<br>Machinery space, if any | Main dimensions and maximum draft<br>Frame spacing<br>Design loads on decks<br>Material specifications (steel grades, aluminium alloys, etc ...)<br>Openings in decks and shell and relevant compensations<br>Details of structural reinforcement and/or discontinuities<br>Setting pressure of safety relief valves, if any<br>Corrosion protection<br>Details related to welding<br>Calculations and data for longitudinal and transverse strength analysis |
| Plan of tank testing | Testing procedures for the various compartments<br>Height of pipes for testing |
| Compartment arrangements | Use of space with Indication of compartments not intended for filling<br>Location and height of air vent outlets |
| Stability documentation | See NR217, Pt B, Ch 2, Sec 2, [2.1] |
| Calculations relevant to intact stability | |

# 2 Structural design principles

## 2.1 Hull structure

### 2.1.1 Framing

In general, the hull structure is to be transversely framed.

### 2.1.2 Supports for door fixation edges

Adequate supports are to be fitted on the longitudinal centreline in order to carry loads acting on the structure when the floating door is in dry dock.

Adequate supports and reinforcement of the floating door edge structure are to be fitted along the quoins of fixation.

# 3 Loads and loading conditions

## 3.1 General

### 3.1.1 Loading conditions

The following loading conditions are generally to be considered:

a) Light floating door, no ballast, navigation

b) 50%, and 75% ballast conditions

c) 100% ballast condition, floating door in sealing position.

### 3.1.2 Draught $T_1$ associated with each loading condition

Local loads are to be calculated on the basis of the floating door's draught $T_1$ corresponding to each loading condition according to [3.1.1].

In the case of fully ballasted floating door in sealing position (see [3.1.1], item c)), the draught $T_1$ is the maximum still water depth, tide height excluded.

## 3.2 Lateral load in service conditions

**3.2.1** The lateral load in service conditions is to be determined in compliance with [3.2.2] to [3.2.4].

### 3.2.2 External pressure on the shell structure

a) External design pressure

- for $z \le T_1$: $p_E = \rho g (T_1 - z + 0,3 + z_1)$
- for $z > T_1$: $p_E = \rho g (0,3 + z_1)$

b) External counter pressure

- for $z \le T_1$: $p_{Em} = \rho g (T_1 - z - 0,3)$
- for $z > T_1$: $p_{Em} = 0$

where

$z_1$ : Parameter taken as follows:

- $z_1 = h_T$, for fully ballasted floating door in sealing position (see [3.1.1], item c))
- $z_1 = 0$ for other loading conditions

### 3.2.3 Internal pressure

For capacities intended to contain liquids (ballast or supplies), the internal design pressure $p_{In}$ induced at any point of the hull, in kN/m², is given by the following formulae, as applicable:

$$p_{In} = \rho_L \, g \, (z_{TOP} - z) + d_{AP}$$

$$p_{In} = \rho_L \, g \, (z_{TOP} - z) + 1,15 p_{PV}$$

### 3.2.4 Loads on deck

The pressure $p_D$ on decks and platforms structures is to be defined by the Designer.

The pressure $p_D$ is not to be taken less than 5 kN/m².

### 3.3 Lateral pressure in testing conditions

**3.3.1** The lateral pressure $p_{ST}$ to be considered as acting on the structural members of compartments subject to tank testing are specified in Tab 2.

**Table 2 : Testing pressure**

| Compartment or structure to be tested | Water pressure, in kN/m$^2$ |
|---|---|
| Ballast tanks | The greater of the following:<br>$P_{ST} = 9{,}81\ [(z_{TOP} - z) + d_{AP}]$<br>$P_{ST} = 9{,}81\ [(z_{TOP} - z) + 1]$ |
| Watertight compartments not used as tank | $P_{ST} = 9{,}81\ (z_{AP} - z)$ |
| Other tanks | $P_{ST} = 9{,}81\ [(z_{TOP} - z) + d_{AP}]$ |

### 3.4 Hull girder loads

#### 3.4.1 Vertical hull girder loads

The still water vertical hull girder loads are to be provided by the Designer.

The wave vertical hull girder loads at any hull transverse section are to be determined according to Pt B, Ch 4, Sec 1, [4.2].

#### 3.4.2 Horizontal hull girder loads

The horizontal hull girder loads are to be determined taking into account the following conditions:

- One side of the floating door subjected to a head of water h, in m, taken as:
  $h = T_1 + h_1 + h_T$
- No counter pressure on the other side
- Fore and aft ends assumed to be simply supported

where,

$h_1$ : Floating door relative motion in upright conditions, in m

- $h_1 = 0{,}3$ m, for operation in smooth stretches of water
- $h_1$ to be determined according to Ch 8, Sec 4, [2.3.2], for floating doors assigned notation $\mathbf{H_S{\le}x}$

## 4 Hull girder strength

### 4.1 Longitudinal strength

**4.1.1** Calculation of the hull girder section modulus is to be carried out according to Pt B, Ch 3, Sec 1, considering all continuous longitudinal members.

**4.1.2** The hull girder strength check is to be in compliance with Pt B, Ch 3, Sec 1, [4].

### 4.2 Transverse strength

**4.2.1** The hull girder transverse loads are to be determined according to [3.4.2].

#### 4.2.2 Strength criteria

The transverse strength check is to be performed according to Pt B, Ch 3, Sec 1, [4], considering the transverse hull girder section modulus.

## 5 Hull scantlings

### 5.1 General

**5.1.1** The scantlings of the hull structure are to be determined in compliance with Part B, Chapter 4, taking into account the load model defined in Pt B, Ch 4, Sec 1, [5].

**5.1.2** For fully ballasted floating door in sealing position, the hull girder normal stresses induced by the horizontal hull girder bending moment is to be substituted for those induced by the vertical bending, when applying the requirements in Part B, Chapter 4.

### 5.2 Reinforcements

**5.2.1** Reinforcements are to be provided at places where the hull is heavily stressed, as the securing points of the fixation at the door edges.
Replaceable, strong layer of wood for the protection of the door edge may be used.

# 6 Stability

## 6.1 General

**6.1.1** This Article provides the requirements allowing to ascertain that the floating door has adequate intact stability under specified operating conditions.

Evidence of approval by the Administration concerned may be accepted for the purpose of classification.

**6.1.2** Stability calculations are to be determined taking into account the most severe conditions, including the effect of the free surfaces of liquids in tanks.

The following requirements of NR217, Pt B, Ch 2, Sec 2 apply:

- definitions
- examination procedure
- inclining test and lightweight check.

### 6.1.3 Wind force

The force of wind $F_{WD}$ , in kN, on floating door is to be calculated as follows:

$F_{WD} = p_{WD} A_W$

where:

$p_{WD}$ : Wind pressure to be taken equal to 0,25 kN/m$^2$, in general

$A_W$ : Lateral area above water plane, in m$^2$, including equipment windage area.

## 6.2 Loading conditions

**6.2.1** Stability is to be examined in different situations including:

- floating door without ballast
- floating door with different amount of ballast taking in consideration the different distribution of ballast tanks.

## 6.3 Intact stability design criteria

### 6.3.1 General

Proof of appropriate intact stability of the floating door is to be provided. All calculations are to be carried out free from trim and sinkage.

### 6.3.2 Metacentric height GM

The metacentric height GM is to remain positive in all loading conditions.

# Section 3 Machinery Systems and Electricity

## 1 Electrical installations and automation equipment

### 1.1 General

**1.1.1** As a rule, floating doors complying with the standards of industrial equipment may be accepted insofar as their satisfactory operation can be established under specified temperature, moisture and corrosion conditions.

**1.1.2** The degree of protection of the electrical equipment on the deck is to be at least IP22 in enclosed areas and IP55 in wet areas and on exposed deck, in compliance with EN 60529.

### 1.2 Lighting

**1.2.1** No lights disrupting or impeding navigation dazzling effects or reflective likely to be confused with navigational signals or hinder their effects is to be fitted on the floating door.

Part D
Additional Requirements for Notations

# CHAPTER 4
# FLOATING BRIDGE

# Section 1 General

## 1 General

### 1.1 Application

**1.1.1** Harbour equipment complying with the requirements of this Chapter are eligible for the assignment of the service notation **Floating bridge**, as defined in Pt A, Ch 1, Sec 3, [5].

**1.1.2** Harbour equipment assigned the service notation **Floating bridge** are to comply, as applicable, with Part A of the Rules and with the requirements indicated in Tab 1.

**1.1.3** Examination of the towing conditions is not covered by this Rule Note.

### 1.2 Arrangement

**1.2.1** A floating bridge consists of an entrance, a mooring system and floating foundations which can be pontoons or small boats to support the bridge roadway. Supporting pontoons can be one continuous unit or modular ones.

**Table 1 : Applicable requirements**

| Item | Reference |
|---|---|
| Unit arrangement | Part B<br>[1.2] |
| Hull | Part B<br>Ch 4, Sec 2 |
| Stability | Ch 4, Sec 2, [7] |
| Machinery and systems | Pt C, Ch 1, Sec 1<br>NR217, Pt C, Chap 1 |
| Electrical installations | Pt C, Ch 1, Sec 1<br>NR217, Pt C, Chap 2<br>Ch 4, Sec 3 |
| Automation | Pt C, Ch 1, Sec 1<br>NR217, Pt C, Chap 3<br>Ch 4, Sec 3 |
| Fire protection, detection and extinction | Pt C, Ch 1, Sec 1<br>NR217, Pt C, Chap 4 |

# Section 2 Hull and Stability

## Symbols

Δ : Displacement, in t, at draught T
B : Breadth, in m, defined in Pt B, Ch 1, Sec 2, [3.3]
$d_{AP}$ : Distance from the top of the air pipe of the top of the tank, in m (see Pt B, Ch 1, Sec 2, Fig 1)
g : Gravity acceleration, in m/s$^2$
g = 9,81 m/s$^2$
L : Rule length, in m, defined in Pt B, Ch 1, Sec 2, [3.1]
$L_{WL}$ : Length of waterline, in m, defined in Pt B, Ch 1, Sec 2, [3.7]
$p_{PV}$ : Setting pressure, in kN/m$^2$, of safety valves, if any
$r_L$ : Density, in t/m$^3$, of the liquid carried
T : Draught, in m, defined in Pt B, Ch 1, Sec 2, [3.5]
$T_1$ : Draught associated with each loading condition, in m, defined in [3.1.2]
z : Z co-ordinate of the calculation point of a structural element
$z_{TOP}$ : Z co-ordinate of the highest point of the tank or compartment, in m (see Pt B, Ch 1, Sec 2, Fig 1)

## 1 General

### 1.1 Application

**1.1.1** The requirements of this Section apply for the assignment of the service notation **Floating bridge** to harbour equipment up to a rule length L=135 m.

**1.1.2** Floating bridge with rule length L exceeding 135 m will be specially considered by the Society.

**1.1.3** Floating bridge made of non metallic hulls is to comply with the strength criteria defined in Pt B, Ch 2, Sec 5.

### 1.2 Documents to be submitted

**1.2.1** The plans and documents to be submitted to the Society for review are listed in Tab 1.

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.

**1.2.2** If direct calculation analyses are carried out, calculation notes are to be submitted to the Society for review.

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

- justificative calculation of forces induced by towing and mooring equipment
- general arrangement plan.

## 2 Structure design principles

### 2.1 Hull structure

#### 2.1.1 Framing

In general, the hull structure is to be longitudinally framed. Longitudinal stiffening members are to be supported by transverses arranged to form ring systems.

#### 2.1.2 Supports for docking

Adequate supports are to be fitted on the longitudinal centreline in order to carry loads acting on the structure when the floating bridge is in dry dock.

#### 2.1.3 Truss arrangement supporting deck loads

Where truss arrangement may be used as supports of the deck loads, including top and bottom girders in association with pillars and diagonal bracing, the diagonal members are generally to have angles of inclination with respect to the horizontal of about 45° and cross sectional area of about 50% that of the adjacent pillars.

**Table 1 : Plans and documents to be submitted for review**

| Plan or document | Containing also information on |
|---|---|
| Transverse sections<br>Shell expansion<br>Decks and profiles<br>Bulkheads<br>Machinery space, if any | Main dimensions and maximum draft<br>Frame spacing<br>Design loads on decks<br>Material specifications (steel grades, aluminium alloys, etc ...)<br>Openings in decks and shell and relevant compensations<br>Details of structural reinforcement and/or discontinuities<br>Setting pressure of safety relief valves, if any<br>Corrosion protection<br>Details related to welding |
| Plan of tank testing | Testing procedures for the various compartments<br>Height of pipes for testing |
| Mooring equipment | Forces and moments induced by mooring equipment<br>Connections of mooring equipment to the bridge structures |
| Compartment arrangements | Use of space with Indication of compartments not intended for filling<br>Location and height of air vent outlets |
| Stability documentation | See NR217, Pt B, Ch 2, Sec 2, [2.1] |
| Calculations relevant to intact stability and, where required, damage stability | |

# 3 Loads and loading conditions

## 3.1 General

### 3.1.1 Loading conditions

The following loading conditions are to be taken in consideration:

a) Fully loaded at the relevant draft

b) Light unit with residual supplies and 50% ballast, at the relevant draft.

### 3.1.2 Draught $T_1$ associated with each loading condition

Local loads are to be calculated on the basis of the floating bridge's draught $T_1$ corresponding to each loading condition according to [3.1.1].

## 3.2 Lateral load in service conditions

**3.2.1** The lateral load in service conditions is to be determined in compliance with [3.2.2] to [3.2.5].

### 3.2.2 External pressure on the shell structure

a) External design pressure

- for $z \leq T_1$: $p_E = \rho g (T_1 - z + 0,3)$
- for $z > T_1$: $p_E = 0,3\rho g$

b) External counter pressure

- for $z \leq T_1$: $p_{Em} = \rho g (T_1 - z - 0,3)$
- for $z > T_1$: $p_{Em} = 0$

### 3.2.3 Internal pressure

For capacities containing liquids, the internal design pressure $p_{In}$ at any point of the hull, in kN/m$^2$, is given by the following formulae, as applicable:

$p_{In} = \rho_L g (z_{TOP} - z) + d_{AP}$

$p_{In} = \rho_L g (z_{TOP} - z) + 1,15 p_{PV}$

### 3.2.4 Loads on deck

The pressure $p_D$ on decks and platforms structures is to be defined by the Designer.

The pressure $p_D$ is not to be taken less than 5 kN/m$^2$.

### 3.2.5 Wheeled loads

Wheeled loads on the deck structure are to be determined according to NR 217, Pat B, Ch3, Sec 4, [3.5]. Inertial forces may be neglected.

## 3.3 Dry uniform loads

**3.3.1** The pressure $p_C$, in kN/m², induced by dry uniform loads is to be defined by the Designer.

## 3.4 Lateral pressure in testing conditions

**3.4.1** The lateral pressure $p_{ST}$ to be considered as acting on platings and structural members subject to tank testing are specified in Tab 2.

**Table 2 : Lateral pressure in testing conditions**

| Compartment or structure to be tested | Water pressure, in kN/m² |
|---|---|
| Ballast tanks | The greater of the following:<br>$P_{ST} = g\ [(z_{TOP} - z) + d_{AP}]$<br>$P_{ST} = g\ [(z_{TOP} - z) + 1]$<br>$P_{ST} = g\ [(z_{TOP} - z) + 1{,}3p_{PV}]$ |
| Watertight compartments not used as tank | $P_{ST} = g\ (z_{AP} - z)$ |
| Other tanks | $P_{ST} = g\ [(z_{TOP} - z) + d_{AP}]$ |

## 3.5 Mooring force

**3.5.1** The mooring force F to be considered in the design of the mooring system and hull structural reinforcement is to be provided by the Designer for all intended operating conditions. Where the value of the mooring force is not available, it may be calculated using the formulae given in Tab 3, where:

C : Force coefficient, equal to:

$$C = Cc\sqrt{\frac{L}{8B}}BT$$

Cc : Coefficient, as defined in Tab 4.

**Table 3 : Mooring force**

| Force coefficient C | F, in kN |
|---|---|
| $C \le 500$ | F = 0,35 C |
| $500 < C \le 2000$ | $F = \left(0,35 - \frac{C - 500}{15000}\right)C$ |
| $2000 < C$ | F = 0,25 C |

**Table 4 : Coefficient Cc**

| Displacement, in ton | Cc |
|---|---|
| $\Delta \le 400$ | 45 |
| $400 < \Delta \le 650$ | 55 |
| $650 < \Delta \le 1000$ | 65 |
| $1000 < \Delta$ | 70 |

## 3.6 Hull girder loads

### 3.6.1 Still water hull girder loads

The values of design still water hull girder loads are to be provided by the Designer.

### 3.6.2 Vertical wave hull girder loads

The vertical wave hull girder loads at any hull transverse section are to be determined according to Pt B, Ch 4, Sec 1, [4.2].

# 4 Hull girder strength

## 4.1 General

**4.1.1** Calculation of the hull girder section modulus is to be carried out according to Pt B, Ch 3, Sec 1, considering all continuous longitudinal members.

**4.1.2** The hull girder strength check is to be in compliance with Pt B, Ch 3, Sec 1, [4].

# 5 Transverse strength

## 5.1 General

**5.1.1** The transverse strength check is to comply with Pt B, Ch 3, Sec 2.

# 6 Hull scantlings

## 6.1 General

**6.1.1** The scantlings of the hull structure are to be determined in compliance with Part B, Chapter 4, taking into account the load model defined in Pt B, Ch 4, Sec 1, [5].

## 6.2 Reinforcements

**6.2.1** Reinforcements are to be provided at places where the hull is heavily stressed, as the area of coupling systems for the modular floating bridge and area of mooring equipment.

## 6.3 Wood sheathing

**6.3.1** Wood sheathing is recommended for caterpillar trucks and unusual vehicles.

It is recommended that a piece of wood of suitable thickness be provided under each crutch in order to distribute the mass over the plate and nearest stiffeners.

# 7 Stability

## 7.1 General

**7.1.1** This Article provides the requirements allowing to ascertain that the floating bridge has adequate intact stability under all operating conditions.

Evidence of approval by the Administration concerned may be accepted for the purpose of classification.

**7.1.2** All calculations are to be carried out free from trim and sinkage.

**7.1.3** Stability calculations are to be determined taking into account the most severe conditions, including the effect of the free surfaces of liquids in tanks.

The following requirements of NR217, Pt B, Ch 2, Sec 2 apply:

- definitions
- examination procedure
- inclining test and lightweight check.

## 7.2 Heeling moments

**7.2.1** The values of the heeling moments to be considered are to be defined by the Designer.

**7.2.2** The following heeling moments are to be considered.

a) Load induced moment

b) Asymmetric structure induced moment

c) Moment due to wind pressure

   The moment caused by the wind pressure, in kN·m, is to be calculated in accordance with the following formula:

$$M_W = F_{WD}\left(\ell_W + \frac{T}{2}\right)$$

   where:

$\ell_W$ : Distance, in m, of the centre of gravity of area $A_W$, from waterline.

$F_{WD}$ : Wind force, in kN

$F_{WD} = p_{WD} A_W$

$p_{WD}$ : Wind pressure to be taken equal to 0,25 kN/m², in general

$A_W$ : Lateral area, in m², above water plane, including equipment windage area.

d) Cross current induced moment

The moment resulting from the cross current is only to be taken into account for floating landing dock which is anchored or moored across the current while operating.

e) Ballast and supplies induced moment

The least favourable extent of tank filling from the point of view of stability is to be determined and the corresponding moment introduced into the calculation.

f) Moment due to inertia forces

The moment resulting from inertia forces is to be taken into account if the movements of the load are likely to affect its stability.

g) Moment due to crowding of persons

Where the floating bridge is intended for passengers, the moment due to crowding of persons is to be taken into account.

The heeling moment $M_P$, in kN.m, due to one-sided accumulation of persons is to be calculated according to the following formula:

$$M_P = 9,81 P y = 9,81 \sum P_i y_i$$

where:

P : Total weight of persons on board, in t, calculated by taking into account the maximum permitted number of persons, $n_{max}$, personnel and crew included, under normal operating conditions, assuming an average weight per person of 0,075 t

y : Lateral distance, in m, of center of gravity of total weight of persons P from center line

$y_i$ : Lateral distance, in m, of geometrical center of area $A_i$ from center line

$P_i$ : Weight of persons accumulated on area $A_i$, in t:

$P_i = 0,075\ n_i\ A_i$

A : Area, in m², occupied by persons

$n_i$ : Number of persons per square meter

$n_i = 3,75$

The calculation is to be carried out for an accumulation of persons both to starboard and to port.

The distribution of persons is to correspond to the most unfavorable one from the point of view of stability.

For calculation of the loading cases, the centre of gravity of a person should be taken as 1 m above the lowest point of the deck at 1/2 $L_{WL}$, ignoring any deck curvature and assuming a weight of 0,075 t per person.

A detailed calculation of deck areas which are occupied by persons may be dispensed with if the following values are used:

- $y = B/2$
- $P = 1,1 \cdot n_{max} \cdot 0,075$

  where:

  $n_{max}$ : Maximum permitted number of persons.

## 7.3 Intact stability

**7.3.1** It is to be confirmed that, when account has been taken of the combined action of heeling moments defined in [7.2]:

- the residual safety clearance is not less than:

  - 0,30 m for weathertight apertures

  - 0,40 m for unprotected openings

- the residual freeboard value is at least 0,30 m.

  the residual freeboard may be reduced if it is proven that the requirements of [7.4] or [7.5], as the case may be, have been met.

The angle of list is not to exceed 10° and the base of the hull is not to emerge.

### 7.4 Intact stability in case of reduced residual freeboard - Harbour equipment not intended for passengers

**7.4.1** If a reduced residual freeboard is taken into account, it is to be checked, for all operating conditions, that:

a) After correction for the free surfaces of liquids, the metacentric height GM is not less than 0,15 m

b) For list angles between 0° and 30°, there is a righting lever, in m, of at least:

$h = 0{,}30 - 0{,}28\ \varphi_n$

c) The list angle does not exceed 10°

d) The residual safety clearance value is, at least:

- 0,30 m for weathertight openings
- 0,40 m for unprotected openings

e) The residual freeboard is at least 0,05 m

f) For list angles between 0° and 30°, the residual righting lever arm, in m, is at least:

$h = 0{,}20 - 0{,}23\ \varphi_n$

Residual righting lever arm means the maximum difference existing between 0° and 30° list between the righting lever and the heeling lever curves. If an opening towards the inside of the floating equipment is immersed at a list angle less than the one corresponding to the maximum difference between the lever arm curves, the lever arm corresponding to that list angle is to be taken into account.

where:

$\varphi_n$ : List angle, in radian, from which the righting lever arm curve displays negative values; this is not to be inserted into the formula for more than 30° or 0,52 rad.

### 7.5 Intact stability in case of reduced residual freeboard - Harbour equipment intended for passengers

**7.5.1** If a reduced residual freeboard is taken into account, it is to be checked, for all operating conditions, that:

a) After correction for the free surfaces of liquids, the metacentric height GM is not less than 0,15 m

b) The maximum righting lever arm $h_{max}$ is to occur at a list angle of $\varphi_{max} \geq (\varphi_{mom} + 3°)$ and must not be less than 0,20 m. However, in case $\varphi_f < \varphi_{max}$ the righting lever arm at the downflooding angle $\varphi_f$ is not to be less than 0,20 m.

c) The list angle does not exceed 10°

d) The residual safety clearance value is, at least:

- 0,30 m for weathertight openings
- 0,40 m for unprotected openings

e) The residual freeboard is at least 0,05 m

f) The area A under the curve of the righting lever arm is to reach 0,05 m.rad up to the angle $\varphi_f$.

where:

$\varphi_f$ : List angle, at which openings in the hull which cannot be closed so as to be weathertight, submerge

$\varphi_f \leq 15°$

$\varphi_{max}$ : List angle at which the maximum righting lever arm occurs

$\varphi_{mom}$ : List angle due to the combined action of heeling moments defined in [7.2].

### 7.6 Damage stability

**7.6.1** Where the floating bridge is intended for passengers, proof of appropriate damage stability is to be furnished according to [7.6.5] and [7.6.6].

**7.6.2** The bulkheads can be assumed to be intact if the distance between two adjacent bulkheads is greater than the damage length. Longitudinal bulkheads at a distance of less than B/3 measured rectangular to centre line from the shell plating at the maximum draught plane is not to be taken into account for calculation purposes.

**7.6.3** Floating bridge is to comply with the one-compartment status, taking into account the assumptions concerning the extent of damage given in Tab 5 and assuming the compartment permeability to be 95%.

**7.6.4** If damage of a smaller dimension than specified in [7.6.3] produces more detrimental effects with respect to heeling or loss of metacentric height, such damage is to be taken into account for calculation purposes.

**7.6.5** Under the combined action of heeling moments defined in [7.2], the residual freeboard and the residual safety clearance are not less than 0,10 m.

**7.6.6** For safety reasons, greater values of the residual safety clearance or residual freeboard may be required by the Society.

**Table 5 : Extent of damage, in m**

| Damage location | Dimension of the damage | |
|---|---|---|
| Wall | Longitudinal $\ell$ | 0,1 $L_{WL} \geq 4$ **(1)** |
| | Transverse b | B/5 |
| | Vertical h | From unit bottom to top without delimitation |
| Bottom **(3)** | Longitudinal $\ell$ | 0,1 $L_{WL} \geq 4$ **(1)** |
| | Transverse b | B/5 |
| | Vertical h | 0,59; pipework is to be deemed intact **(2)** |

**(1)** For units with $L_{WL} \leq 25$, smaller values of the damage extent may be accepted by the Society on a case-by-case basis.
**(2)** Where a pipework system has no open outlet in a compartment, the pipework shall be regarded as intact in the event of this compartment being damaged, if it runs within the safe area and is more than 0,50 m off the bottom of the unit.
**(3)** May be disregarded if the water stretch level is relatively constant (e.g., no season or tide effect).

# Section 3 Machinery Systems and Electricity

## 1 Electrical installations and automation equipment

### 1.1 General

**1.1.1** As a rule, floating bridge complying with the standards of industrial equipment may be accepted insofar as their satisfactory operation can be established under specified temperature, moisture and corrosion conditions.

**1.1.2** The degree of protection of the electrical equipment on the deck is to be at least IP22 in enclosed areas and IP55 in wet areas and on exposed deck, in compliance with EN 60529.

### 1.2 Lighting

**1.2.1** No lights disrupting or impeding navigation dazzling effects or reflective likely to be confused with navigational signals or hinder their effects is to be fitted on the floating bridge.

Part D
Additional Requirements for Notations

# CHAPTER 5
# WORKSITE UNIT

# Section 1 General

## 1 General

### 1.1 Application

**1.1.1** Harbour equipment complying with the requirements of this Chapter are eligible for the assignment of the service notation **Worksite unit,** as defined in Pt A, Ch 1, Sec 3, [6].

**1.1.2** Harbour equipment assigned the service notation **Worksite unit** are to comply, as applicable, with Part A of the Rules and with the requirements indicated in Tab 1.

**1.1.3** Examination of the towing conditions is not covered by this Rule Note.

**Table 1 : Applicable requirements**

| Item | Reference |
|---|---|
| Unit arrangement | Part B |
| Hull | Part B<br>Ch 5, Sec 2 |
| Stability | Ch 5, Sec 2, [7] |
| Machinery and systems | Pt C, Ch 1, Sec 1<br>NR217, Pt C, Chap 1 |
| Electrical installations | Pt C, Ch 1, Sec 1<br>NR217, Pt C, Chap 2<br>Ch 5, Sec 3 |
| Automation | Pt C, Ch 1, Sec 1<br>NR217, Pt C, Chap 3<br>Ch 5, Sec 3 |
| Fire protection, detection and extinction | Pt C, Ch 1, Sec 1<br>NR217, Pt C, Chap 4 |

# Section 2 Hull and Stability

## Symbols

| | | |
|---|---|---|
| $\Delta$ | : | Displacement, in t, at draught T |
| B | : | Breadth, in m, defined in Pt B, Ch 1, Sec 2, [3.3] |
| $d_{AP}$ | : | Distance from the top of the air pipe of the top of the tank, in m (see Pt B, Ch 1, Sec 2, Fig 1) |
| g | : | Gravity acceleration, in m/s$^2$<br>g = 9,81 m/s$^2$ |
| L | : | Rule length, in m, defined in Pt B, Ch 1, Sec 2, [3.1] |
| $p_{PV}$ | : | Setting pressure, in kN/m$^2$, of safety valves, if any |
| $r_L$ | : | Density, in t/m$^3$, of the liquid carried |
| T | : | Draught, in m, defined in Pt B, Ch 1, Sec 2, [3.5] |
| $T_1$ | : | Draught associated with each loading condition, in m, defined in [3.1.2] |
| z | : | Z co-ordinate of the calculation point of a structural element |
| $z_{TOP}$ | : | Z co-ordinate of the highest point of the tank or compartment, in m (see Pt B, Ch 1, Sec 2, Fig 1) |

## 1 General

### 1.1 Application

**1.1.1** The requirements of this Section apply for the assignment of the service notation **Worksite unit** to harbour equipment up to a rule length L=135 m.

**1.1.2** Worksite units with rule length L exceeding 135 m will be specially considered by the Society.

**1.1.3** Worksite units made of non metallic hulls are to comply with the strength criteria defined in Pt B, Ch 2, Sec 5.

### 1.2 Documents to be submitted

**1.2.1** The plans and documents to be submitted to the Society for review are listed in Tab 1.

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.

**1.2.2** If direct calculation analyses are carried out, calculation notes are to be submitted to the Society for review.

**1.2.3** In addition to those in [1.2.1], the following plans and documents are to be submitted to the Society for information:

- justificative calculation of forces induced by towing and mooring equipment
- general arrangement plan.

**1.2.4** The Society may require any other necessary guidance for the safe operation of the worksite unit.

## 2 Structure design principles

### 2.1 Hull structure

#### 2.1.1 Framing

In general, the hull structure is to be longitudinally framed. Longitudinal stiffening members are to be supported by transverses arranged to form ring systems.

#### 2.1.2 Supports for docking

Adequate supports are to be fitted on the longitudinal centreline in order to carry loads acting on the structure when the worksite unit is in dry dock.

**Table 1 : Plans and documents to be submitted for review**

| Plan or document | Containing also information on |
|---|---|
| Transverse sections<br>Shell expansion<br>Decks and profiles<br>Bulkheads<br>Machinery space, if any | Main dimensions and maximum draft<br>Frame spacing<br>Design loads on decks<br>Material specifications (steel grades, aluminium alloys, etc...)<br>Openings in decks and shell and relevant compensations<br>Details of structural reinforcement and/or discontinuities<br>Setting pressure of safety relief valves, if any<br>Corrosion protection<br>Details related to welding<br>Calculations and data for longitudinal and transverse strength analysis |
| Plan of tank testing | Testing procedures for the various compartments<br>Height of pipes for testing |
| Mooring equipment | Forces and moments induced by mooring equipment<br>Connections of mooring equipment to the dock structures |
| Compartment arrangements | Use of space with Indication of compartments not intended for filling<br>Location and height of air vent outlets |
| Stability documentation | See NR217, Pt B, Ch 2, Sec 2, [2.1] |
| Calculations relevant to intact stability | |

#### 2.1.3 Truss arrangement supporting deck loads

Where truss arrangements may be used as supports of the deck loads, including top and bottom girders in association with pillars and diagonal bracing, the diagonal members are generally to have angles of inclination with respect to the horizontal of about 45° and cross-sectional area of about 50% that of the adjacent pillars.

## 3 Loads and loading conditions

### 3.1 General

#### 3.1.1 Loading conditions

The following loading conditions are to be taken in consideration:

a) Fully loaded at the relevant draft

b) Light unit with residual supplies and 50% ballast, at the relevant draft.

#### 3.1.2 Draught $T_1$ associated with each loading condition

Local loads are to be calculated on the basis of the worksite unit’s draught $T_1$ corresponding to each loading condition according to [3.1.1].

### 3.2 Lateral load in service conditions

**3.2.1** The lateral load in service conditions is to be determined in compliance with [3.2.2] to [3.2.5].

#### 3.2.2 External pressure on the shell structure

a) External design pressure

- for $z \leq T_1$: $p_E = \rho g (T_1 - z + 0,3)$
- for $z > T_1$: $p_E = 0,3 \rho g$

b) External counter pressure

- for $z \leq T_1$: $p_{Em} = \rho g (T_1 - z - 0,3)$
- for $z > T_1$: $p_{Em} = 0$

#### 3.2.3 Internal pressure

For capacities containing liquids, the internal design pressure $p_{In}$ at any point of the hull, in kN/m², is given by the following formulae, as applicable:

$$p_{In} = \rho_L \, g \, (z_{TOP} - z) + d_{AP}$$

$$p_{In} = \rho_L \, g \, (z_{TOP} - z) + 1,15 p_{PV}$$

#### 3.2.4 Loads on deck

The pressure $p_D$ on decks and platforms structures is to be defined by the Designer.

The pressure $p_D$ is not to be taken less than 5 kN/m².

#### 3.2.5 Wheeled loads

Wheeled loads on the deck structure are to be determined according to NR 217, Pat B, Ch3, Sec 4, [3.5]. Inertial forces may be neglected.

### 3.3 Dry uniform loads

**3.3.1** The pressure $p_C$, in kN/m², induced by dry uniform loads is to be defined by the Designer.

### 3.4 Dry unit loads

**3.4.1** The force F induced by dry unit loads and transmitted to the hull structure is to be determined on the basis of the force obtained, in kN, from the following formula:

$F = 9{,}81\ m_C$

where $m_C$ is the mass, in t, of the dry unit load.

Account is to be taken of the elastic characteristics of the lashing arrangement and/or the structure which supports the load.

### 3.5 Lateral pressure in testing conditions

**3.5.1** The lateral pressure $p_{ST}$ to be considered as acting on platings and structural members subject to tank testing are specified in Tab 2.

**Table 2 : Lateral pressure in testing conditions**

| Compartment or structure to be tested | Water pressure, in kN/m² |
|---|---|
| Ballast tanks | The greater of the following:<br>$P_{ST} = g\ [(z_{TOP} - z) + d_{AP}]$<br>$P_{ST} = g\ [(z_{TOP} - z) + 1]$<br>$P_{ST} = g\ [(z_{TOP} - z) + 1{,}3p_{PV}]$ |
| Watertight compartments not used as tank | $P_{ST} = g\ (z_{AP} - z)$ |
| Other tanks | $P_{ST} = g\ [(z_{TOP} - z) + d_{AP}]$ |

### 3.6 Mooring force

**3.6.1** The mooring force F to be considered in the design of the mooring system and hull structural reinforcement is to be provided by the Designer for all intended operating conditions. Where the value of the mooring force is not available, it may be calculated using the formulae given in Tab 3, where:

C : Force coefficient, equal to:

$$C = Cc\sqrt{\frac{L}{8B}}BT$$

Cc : Coefficient, as defined in Tab 4.

**Table 3 : Mooring force**

| Force coefficient C | F, in kN |
|---|---|
| $C \leq 500$ | $F = 0{,}35\ C$ |
| $500 < C \leq 2000$ | $F = \left(0,35 - \frac{C - 500}{15000}\right)C$ |
| $2000 < C$ | $F = 0{,}25\ C$ |

**Table 4 : Coefficient Cc**

| Displacement, in ton | Cc |
|---|---|
| $\Delta \leq 400$ | 45 |
| $400 < \Delta \leq 650$ | 55 |
| $650 < \Delta \leq 1000$ | 65 |
| $1000 < \Delta$ | 70 |

### 3.7 Hull girder loads

#### 3.7.1 Still water hull girder loads

The values of design still water hull girder loads are to be provided by the Designer.

#### 3.7.2 Vertical wave hull girder loads

The vertical wave hull girder loads at any hull transverse section are to be determined according to Pt B, Ch 4, Sec 1, [4.2].

## 4 Hull girder strength

### 4.1 General

**4.1.1** Calculation of the hull girder section modulus is to be carried out according to Pt B, Ch 3, Sec 1, considering all continuous longitudinal members.

**4.1.2** The hull girder strength check is to be in compliance with Pt B, Ch 3, Sec 1, [4].

## 5 Transverse strength

### 5.1 General

**5.1.1** The transverse strength check is to comply with Pt B, Ch 3, Sec 2.

## 6 Hull scantlings

### 6.1 General

**6.1.1** The scantlings of the hull structure are to be determined in compliance with Part B, Chapter 4, taking into account the load model defined in Pt B, Ch 4, Sec 1, [5].

### 6.2 Reinforcements

**6.2.1** Reinforcements are to be provided at places where the hull is heavily stressed, as the area of coupling systems for the modular worksite unit and area of mooring equipment.

### 6.3 Wood sheathing

**6.3.1** Wood sheathing is recommended for caterpillar trucks and unusual vehicles.

It is recommended that a piece of wood of suitable thickness be provided under each crutch in order to distribute the mass over the plate and nearest stiffeners.

## 7 Stability

### 7.1 General

**7.1.1** This Article provides the requirements allowing to ascertain that the worksite unit has adequate intact stability under all operating conditions.

Evidence of approval by the Administration concerned may be accepted for the purpose of classification.

**7.1.2** All calculations are to be carried out free from trim and sinkage.

**7.1.3** Stability calculations are to be determined taking into account the most severe conditions, including the effect of the free surfaces of liquids in tanks.

The following requirements of NR217, Pt B, Ch 2, Sec 2 apply:

- definitions
- examination procedure
- inclining test and lightweight check.

### 7.2 Heeling moments

**7.2.1** The values of heeling moments to be considered are to be defined by the Designer.

**7.2.2** The following heeling moments are to be considered.

a) Load induced moment

b) Asymmetric structure induced moment

c) Moment due to wind pressure

The moment caused by the wind pressure, in kN·m, shall be calculated in accordance with the following formula:

$$M_W = F_{WD}\left(\ell_W + \frac{T}{2}\right)$$

where:

$\ell_W$ : Distance, in m, of the centre of gravity of area $A_W$, from waterline.

$F_{WD}$ : Wind force, in kN

$F_{WD} = p_{WD} A_W$

$p_{WD}$ : Wind pressure to be taken equal to 0,25 kN/m$^2$, in general

$A_W$ : Lateral area, in m$^2$, above water plane, including equipment windage area.

d) Cross current induced moment

The moment resulting from the cross current must only be taken into account for worksite unit which is anchored or moored across the current while operating.

e) Ballast and supplies induced moment

The least favourable extent of tank filling from the point of view of stability is to be determined and the corresponding moment introduced into the calculation.

f) Moment due to inertia forces

The moment resulting from inertia forces is to be taken into account if the movements of the load are likely to affect its stability.

## 7.3 Intact stability

**7.3.1** It shall be confirmed that, when account has been taken of the loads applied during the use and operation, the residual freeboard and the residual safety clearance are adequate, i.e.:

- the residual safety clearance is not less than:
  - 0,30 m for weathertight apertures
  - 0,40 m for unprotected openings.
- the residual freeboard value is at least 0,30 m

  the residual freeboard may be reduced if it is proven that the requirements of [7.4] have been met.

For this purpose, the angle of list is not to exceed 10° and the base of the hull is not to emerge.

## 7.4 Intact stability in case of reduced residual freeboard

**7.4.1** If a reduced residual freeboard is taken into account, it shall be checked, for all operating conditions, that:

a) After correction for the free surfaces of liquids, the metacentric height GM is not less than 0,15 m

b) For list angles between 0° and 30°, there is a righting lever, in m, of at least:

$h = 0{,}30 - 0{,}28\ \varphi_n$

c) The list angle does not exceed 10°

d) The residual safety clearance value is, at least:

- 0,30 m for weathertight openings
- 0,40 m for unprotected openings

e) The residual freeboard is at least 0,05 m

f) For list angles between 0° and 30°, the residual righting lever arm, in m, is at least:

$h = 0{,}20 - 0{,}23\ \varphi_n$

Residual righting lever arm means the maximum difference existing between 0° and 30° list between the righting lever and the heeling lever curves. If an opening towards the inside of the floating equipment is immersed at a list angle less than the one corresponding to the maximum difference between the lever arm curves, the lever arm corresponding to that list angle is to be taken into account.

where:

$\varphi_n$ : List angle, in radian, from which the righting lever arm curve displays negative values; this is not to be inserted into the formula for more than 30° or 0,52 rad.

# Section 3 Machinery Systems and Electricity

## 1 Electrical installations and automation equipment

### 1.1 General

**1.1.1** As a rule, worksite unit complying with the standards of industrial equipment may be accepted insofar as their satisfactory operation can be established under specified temperature, moisture and corrosion conditions.

**1.1.2** The degree of protection of the electrical equipment on the deck is to be at least IP22 in enclosed areas and IP55 in wet areas and on exposed deck, in compliance with EN 60529.

### 1.2 Lighting

**1.2.1** No lights disrupting or impeding navigation dazzling effects or reflective likely to be confused with navigational signals or hinder their effects is to be fitted on the worksite unit.

Part D
Additional Requirements for Notations

# CHAPTER 6
# FLOATING STORAGE

# Section 1 General

## 1 General

### 1.1 Application

**1.1.1** Harbour equipment complying with the requirements of this Chapter are eligible for the assignment of the service notation **Floating storage,** as defined in Pt A, Ch 1, Sec 3, [7].

**1.1.2** Harbour equipment assigned the service notation **Floating storage** are to comply, as applicable, with Part A of the Rules and with the requirements indicated in Tab 1.

**1.1.3** Examination of the towing conditions is not covered by this Rule Note.

**Table 1 : Applicable requirements**

| Item | Reference |
| --- | --- |
| Unit arrangement | Part B |
| Hull | Part B<br>Ch 6, Sec 2 |
| Stability | Ch 6, Sec 2, [7] |
| Machinery and systems | Pt C, Ch 1, Sec 1<br>NR217, Pt C, Chap 1 |
| Electrical installations | Pt C, Ch 1, Sec 1<br>NR217, Pt C, Chap 2<br>Ch 6, Sec 3 |
| Automation | Pt C, Ch 1, Sec 1<br>NR217, Pt C, Chap 3<br>Ch 6, Sec 3 |
| Fire protection, detection and extinction | Pt C, Ch 1, Sec 1<br>NR217, Pt C, Chap 4 |

# Section 2 Hull and Stability

## Symbols

| | | |
|---|---|---|
| $\Delta$ | : | Displacement, in t, at draught T |
| B | : | Breadth, in m, defined in Pt B, Ch 1, Sec 2, [3.3] |
| $d_{AP}$ | : | Distance from the top of the air pipe of the top of the tank, in m (see Pt B, Ch 1, Sec 2, Fig 1 |
| g | : | Gravity acceleration, in m/s$^2$ <br> g = 9,81 m/s$^2$ |
| L | : | Rule length, in m, defined in Pt B, Ch 1, Sec 2, [3.1] |
| $p_{PV}$ | : | Setting pressure, in kN/m$^2$, of safety valves, if any |
| $r_L$ | : | Density, in t/m$^3$, of the liquid carried |
| T | : | Draught, in m, defined in Pt B, Ch 1, Sec 2, [3.5] |
| $T_1$ | : | Draught associated with each loading condition, in m, defined in [3.1.2] |
| z | : | Z co-ordinate of the calculation point of a structural element |
| $z_{TOP}$ | : | Z co-ordinate of the highest point of the tank or compartment, in m (see Pt B, Ch 1, Sec 2, Fig 1) |

## 1 General

### 1.1 Application

**1.1.1** The requirements of this Section apply for the assignment of the type and service notation **Floating storage** to harbour equipment up to a rule length L=135 m.

**1.1.2** Harbour equipment with rule length L exceeding 135 m will be specially considered by the Society.

### 1.2 Documents to be submitted

**1.2.1** The plans and documents to be submitted to the Society for review are listed in Tab 1.

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.

**1.2.2** If direct calculation analyses are carried out, calculation notes are to be submitted to the Society for review.

**1.2.3** In addition to those in [1.2.1], the following plans and documents are to be submitted to the Society for information:

- justificative calculation of forces induced by towing and mooring equipment
- general arrangement plan.

**1.2.4** The Society may require any other necessary guidance for the safe operation of the floating storage unit.

## 2 Structure design principles

### 2.1 Hull structure

#### 2.1.1 Framing

In general, the hull structure is to be longitudinally framed. Longitudinal stiffening members are to be supported by transverses arranged to form ring systems.

#### 2.1.2 Supports for docking

Adequate supports are to be fitted on the longitudinal centreline in order to carry loads acting on the structure when the floating storage is in dry dock.

#### 2.1.3 Truss arrangement supporting deck loads

Where truss arrangements may be used as supports of the deck loads, including top and bottom girders in association with pillars and diagonal bracing, the diagonal members are generally to have angles of inclination with respect to the horizontal of about 45° and cross-sectional area of about 50% that of the adjacent pillars.

**Table 1 : Plans and documents to be submitted for review**

| Plan or document | Containing also information on |
|---|---|
| Transverse sections<br>Shell expansion<br>Decks and profiles<br>Bulkheads<br>Machinery space, if any | Main dimensions and maximum draft<br>Frame spacing<br>Design loads on decks<br>Material specifications (steel grades, aluminium alloys, etc ...)<br>Openings in decks and shell and relevant compensations<br>Details of structural reinforcement and/or discontinuities<br>Setting pressure of safety relief valves, if any<br>Corrosion protection<br>Details related to welding<br>Calculations and data for longitudinal and transverse strength analysis |
| Plan of tank testing | Testing procedures for the various compartments<br>Height of pipes for testing |
| Mooring equipment | Forces and moments induced by mooring equipment<br>Connections of mooring equipment to the dock structures |
| Compartment arrangements | Use of space with Indication of compartments not intended for filling<br>Location and height of air vent outlets |
| Stability documentation | See NR217, Pt B, Ch 2, Sec 2, [2.1] |
| Calculations relevant to intact stability and, where required, damage stability | |

# 3 Loads and loading conditions

## 3.1 General

### 3.1.1 Loading conditions

The following loading conditions are to be taken in consideration:

a) Fully loaded at the relevant draft

b) Light unit with residual supplies and 50% ballast, at the relevant draft.

### 3.1.2 Draught $T_1$ associated with each loading condition

Local loads are to be calculated on the basis of the floating storage's draught $T_1$ corresponding to each loading condition according to [3.1.1].

## 3.2 Lateral load in service conditions

**3.2.1** The lateral load in service conditions is to be determined in compliance with [3.2.2] to [3.2.5].

### 3.2.2 External pressure on the shell structure

a) External design pressure

- for $z \leq T_1$: $p_E = \rho g (T_1 - z + 0{,}3)$
- for $z > T_1$: $p_E = 0{,}3 \rho g$

b) External counter pressure

- for $z \leq T_1$: $p_{Em} = \rho g (T_1 - z - 0{,}3)$
- for $z > T_1$: $p_{Em} = 0$

### 3.2.3 Internal pressure

For capacities containing liquids, the internal design pressure $p_{In}$ at any point of the hull, in kN/m², is given by the following formulae, as applicable:

$p_{In} = \rho_L \, g \, (z_{TOP} - z) + d_{AP}$

$p_{In} = \rho_L \, g \, (z_{TOP} - z) + 1{,}15 p_{PV}$

### 3.2.4 Loads on deck

The pressure $p_D$ on decks and platforms structures is to be defined by the Designer.

The pressure $p_D$ is not to be taken less than 5 kN/m².

#### 3.2.5 Wheeled loads

Wheeled loads on the deck structure are to be determined according to NR 217, Pat B, Ch3, Sec 4, [3.5]. Inertial forces may be neglected.

### 3.3 Dry uniform loads

**3.3.1** The pressure $p_C$, in kN/m², induced by dry uniform loads is to be defined by the Designer.

### 3.4 Dry unit loads

**3.4.1** The force F induced by dry unit loads and transmitted to the hull structure is to be determined on the basis of the force obtained, in kN, from the following formula:

$F = 9{,}81\ m_C$

where $m_C$ is the mass, in t, of the dry unit load.

Account is to be taken of the elastic characteristics of the lashing arrangement and/or the structure which supports the load.

### 3.5 Lateral pressure in testing conditions

**3.5.1** The lateral pressure $p_{ST}$ to be considered as acting on platings and structural members subject to tank testing are specified in Tab 2.

**Table 2 : Lateral pressure in testing conditions**

| Compartment or structure to be tested | Water pressure, in kN/m² |
|---|---|
| Ballast tanks<br>Storage tanks | The greater of the following:<br>$P_{ST} = g\ [(z_{TOP} - z) + d_{AP}]$<br>$P_{ST} = g\ [(z_{TOP} - z) + 1]$<br>$P_{ST} = g\ [(z_{TOP} - z) + 1{,}3p_{PV}]$ |
| Watertight compartments not used as tank | $P_{ST} = g\ (z_{AP} - z)$ |
| Other tanks | $P_{ST} = g\ [(z_{TOP} - z) + d_{AP}]$ |

### 3.6 Mooring force

**3.6.1** The mooring force F to be considered in the design of the mooring system and hull structural reinforcement is to be provided by the Designer for all intended operating conditions. Where the value of the mooring force is not available, it may be calculated using the formulae given in Tab 3, where:

C : Force coefficient, equal to:

$$C = Cc\sqrt{\frac{L}{8B}}BT$$

Cc : Coefficient, as defined in Tab 4.

**Table 3 : Mooring force**

| Force coefficient C | F, in kN |
|---|---|
| $C \le 500$ | $F = 0{,}35\ C$ |
| $500 < C \le 2000$ | $F = \left(0{,}35 - \frac{C - 500}{15000}\right)C$ |
| $2000 < C$ | $F = 0{,}25\ C$ |

**Table 4 : Coefficient Cc**

| Displacement, in ton | Cc |
|---|---|
| $\Delta \le 400$ | 45 |
| $400 < \Delta \le 650$ | 55 |
| $650 < \Delta \le 1000$ | 65 |
| $1000 < \Delta$ | 70 |

### 3.7 Hull girder loads

#### 3.7.1 Still water hull girder loads

The values of design still water hull girder loads are to be provided by the Designer.

#### 3.7.2 Vertical wave hull girder loads

The vertical wave hull girder loads at any hull transverse section are to be determined according to Pt B, Ch 4, Sec 1, [4.2].

## 4 Hull girder strength

### 4.1 General

**4.1.1** Calculation of the hull girder section modulus is to be carried out according to Pt B, Ch 3, Sec 1, considering all continuous longitudinal members.

**4.1.2** The hull girder strength check is to be in compliance with Pt B, Ch 3, Sec 1, [4].

## 5 Transverse strength

### 5.1 General

**5.1.1** The transverse strength check is to comply with Pt B, Ch 3, Sec 2.

## 6 Hull scantlings

### 6.1 General

**6.1.1** The scantlings of the hull structure are to be determined in compliance with Part B, Chapter 4, taking into account the load model defined in Pt B, Ch 4, Sec 1, [5].

### 6.2 Reinforcements

**6.2.1** Reinforcements are to be provided at places where the hull is heavily stressed, as the area of coupling systems for the modular floating storage and area of mooring equipment.

## 7 Stability

### 7.1 General

**7.1.1** This Article provides the requirements allowing to ascertain that the floating storage has adequate intact stability under all operating conditions.

Evidence of approval by the Administration concerned may be accepted for the purpose of classification.

**7.1.2** All calculations are to be carried out free from trim and sinkage.

**7.1.3** Stability calculations are to be determined taking into account the most severe conditions, including the effect of the free surfaces of liquids in tanks.

The following requirements of NR217, Pt B, Ch 2, Sec 2 apply:

- definitions
- examination procedure
- inclining test and lightweight check.

### 7.2 Heeling moments

**7.2.1** The values of heeling moments to be considered are to be defined by the Designer.

**7.2.2** The following heeling moments are to be considered.

a) Load induced moment

b) Asymmetric structure induced moment

c) Moment due to wind pressure

The moment caused by the wind pressure, in kN·m, shall be calculated in accordance with the following formula:

$$M_W = F_{WD}\left(\ell_W + \frac{T}{2}\right)$$

where:

$\ell_W$ : Distance, in m, of the centre of gravity of area $A_W$, from waterline.

$F_{WD}$ : Wind force, in kN

$F_{WD} = p_{WD} A_W$

$p_{WD}$ : Wind pressure to be taken equal to 0,25 kN/m², in general

$A_W$ : Lateral area, in m², above water plane, including equipment windage area.

d) Cross current induced moment

The moment resulting from the cross current must only be taken into account for floating storage which is anchored or moored across the current while operating.

e) Ballast and supplies induced moment

The least favourable extent of tank filling from the point of view of stability is to be determined and the corresponding moment introduced into the calculation.

f) Moment due to inertia forces

The moment resulting from inertia forces is to be taken into account if the movements of the load are likely to affect its stability.

## 7.3 Intact stability

**7.3.1** It shall be confirmed that, when account has been taken of the loads applied during the use and operation, the residual freeboard and the residual safety clearance are adequate, i.e.:

- the residual safety clearance is not less than:
  - 0,30 m for weathertight apertures
  - 0,40 m for unprotected openings
- the residual freeboard value is at least 0,30 m.

  the residual freeboard may be reduced if it is proven that the requirements of [7.4] have been met.

For this purpose, the angle of list is not to exceed 10° and the base of the hull shall not emerge.

## 7.4 Intact stability in case of reduced residual freeboard

**7.4.1** If a reduced residual freeboard is taken into account, it is to be checked, for all operating conditions, that:

a) After correction for the free surfaces of liquids, the metacentric height GM is not less than 0,15 m

b) For list angles between 0° and 30°, there is a righting lever, in m, of at least:

$h = 0,30 - 0,28\ \varphi_n$

c) The list angle does not exceed 10°

d) The residual safety clearance value is, at least:

- 0,30 m for weathertight openings
- 0,40 m for unprotected openings

e) The residual freeboard is at least 0,05 m

f) For list angles between 0° and 30°, the residual righting lever arm, in m, is at least:

$h = 0,20 - 0,23\ \varphi_n$

Residual righting lever arm means the maximum difference existing between 0° and 30° list between the righting lever and the heeling lever curves. If an opening towards the inside of the floating equipment is immersed at a list angle less than the one corresponding to the maximum difference between the lever arm curves, the lever arm corresponding to that list angle is to be taken into account.

where:

$\varphi_n$ : List angle, in radian, from which the righting lever arm curve displays negative values; this is not to be inserted into the formula for more than 30° or 0,52 rad.

# Section 3 Machinery Systems and Electricity

## 1 Electrical installations and automation equipment

### 1.1 General

**1.1.1** As a rule, floating storage complying with the standards of industrial equipment may be accepted insofar as their satisfactory operation can be established under specified temperature, moisture and corrosion conditions.

**1.1.2** The degree of protection of the electrical equipment on the deck is to be at least IP22 in enclosed areas and IP55 in wet areas and on exposed deck, in compliance with EN 60529.

### 1.2 Lighting

**1.2.1** No lights disrupting or impeding navigation dazzling effects or reflective likely to be confused with navigational signals or hinder their effects is to be fitted on the floating storage.

Part D
Additional Requirements for Notations

# CHAPTER 7
# FLOATING PLANT

# Section 1 General

## 1 General

### 1.1 Application

**1.1.1** Harbour equipment complying with the requirements of this Chapter are eligible for the assignment of the service notation **Floating plant,** as defined in Pt A, Ch 1, Sec 3, [8].

**1.1.2** Harbour equipment assigned the service notation **Floating plant** are to comply, as applicable, with Part A of the Rules and with the requirements indicated in Tab 1.

**1.1.3** Examination of the towing conditions is not covered by this Rule Note.

**Table 1 : Applicable requirements**

| Item | Reference |
| --- | --- |
| Unit arrangement | Part B |
| Hull | Part B<br>Ch 7, Sec 2 |
| Stability | Ch 7, Sec 2, [7] |
| Machinery and systems | Pt C, Ch 1, Sec 1<br>NR217, Pt C, Chap 1<br>Ch 7, Sec 3 |
| Electrical installations | Pt C, Ch 1, Sec 1<br>NR217, Pt C, Chap 2<br>Ch 7, Sec 3 |
| Automation | Pt C, Ch 1, Sec 1<br>NR217, Pt C, Chap 3<br>Ch 7, Sec 3 |
| Fire protection, detection and extinction | Pt C, Ch 1, Sec 1<br>NR217, Pt C, Chap 4<br>Ch 7, Sec 3 |

# Section 2 Hull and Stability

## Symbols

| | | |
|---|---|---|
| Δ | : | Displacement, in t, at draught T |
| B | : | Breadth, in m, defined in Pt B, Ch 1, Sec 2, [3.3] |
| $d_{AP}$ | : | Distance from the top of the air pipe of the top of the tank, in m (see Pt B, Ch 1, Sec 2, Fig 1 |
| g | : | Gravity acceleration, in m/s$^2$<br>g = 9,81 m/s$^2$ |
| L | : | Rule length, in m, defined in Pt B, Ch 1, Sec 2, [3.1] |
| $p_{PV}$ | : | Setting pressure, in kN/m$^2$, of safety valves, if any |
| $r_L$ | : | Density, in t/m$^3$, of the liquid carried |
| T | : | Draught, in m, defined in Pt B, Ch 1, Sec 2, [3.5] |
| $T_1$ | : | Draught associated with each loading condition, in m, defined in [3.1.2] |
| z | : | Z co-ordinate of the calculation point of a structural element |
| $z_{TOP}$ | : | Z co-ordinate of the highest point of the tank or compartment, in m (see Pt B, Ch 1, Sec 2, Fig 1) |

## 1 General

### 1.1 Application

**1.1.1** The requirements of this Section apply for the assignment of the service notation **Floating plant** to harbour equipment up to a rule length L=135 m.

**1.1.2** Harbour equipment with rule length L exceeding 135 m will be specially considered by the Society.

### 1.2 Documents to be submitted

**1.2.1** The plans and documents to be submitted to the Society for review are listed in Tab 1.

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.

**1.2.2** If direct calculation analyses are carried out, calculation notes are to be submitted to the Society for review.

**1.2.3** In addition to those in [1.2.1], the following plans and documents are to be submitted to the Society for information:

- justificative calculation of forces induced by towing and mooring equipment
- general arrangement plan
- general arrangement plan of the plant unit.

**1.2.4** The Society may require any other necessary guidance for the safe operation of the floating plant.

## 2 Structure design principles

### 2.1 Hull structure

#### 2.1.1 Framing

In general, the hull structure is to be longitudinally framed. Longitudinal stiffening members are to be supported by transverses arranged to form ring systems.

#### 2.1.2 Supports for docking

Adequate supports are to be fitted on the longitudinal centreline in order to carry loads acting on the structure when the floating plant is in dry dock.

#### 2.1.3 Truss arrangement supporting deck loads

Where truss arrangements may be used as supports of the deck loads, including top and bottom girders in association with pillars and diagonal bracing, the diagonal members are generally to have angles of inclination with respect to the horizontal of about 45° and cross-sectional area of about 50% that of the adjacent pillars.

**Table 1 : Plans and documents to be submitted for review**

| Plan or document | Containing also information on |
|---|---|
| Transverse sections<br>Shell expansion<br>Decks and profiles<br>Bulkheads<br>Machinery space, if any | Main dimensions and maximum draft<br>Frame spacing<br>Design loads on decks<br>Material specifications (steel grades, aluminium alloys, et...)<br>Openings in decks and shell and relevant compensations<br>Details of structural reinforcement and/or discontinuities<br>Setting pressure of safety relief valves, if any<br>Corrosion protection<br>Details related to welding<br>Calculations and data for longitudinal and transverse strength analysis |
| Plan of tank testing | Testing procedures for the various compartments<br>Height of pipes for testing |
| Mooring equipment | Forces and moments induced by mooring equipment<br>Connections of mooring equipment to the dock structures |
| Compartment arrangements | Use of space with Indication of compartments not intended for filling<br>Location and height of air vent outlets |
| Stability documentation | See NR217, Pt B, Ch 2, Sec 2, [2.1] |
| Calculations relevant to intact stability | |

# 3 Loads and loading conditions

## 3.1 General

### 3.1.1 Loading conditions

The following loading conditions are to be taken in consideration:

a) Fully loaded at the relevant draft

b) Light unit with residual supplies and 50% ballast, at the relevant draft.

### 3.1.2 Draught $T_1$ associated with each loading condition

Local loads are to be calculated on the basis of the floating plant draught $T_1$ corresponding to each loading condition according to [3.1.1].

## 3.2 Lateral load in service conditions

**3.2.1** The lateral load in service conditions is to be determined in compliance with [3.2.2] to [3.2.5].

### 3.2.2 External pressure on the shell structure

a) External design pressure

- for $z \le T_1$: $p_E = \rho g (T_1 - z + 0{,}3)$
- for $z > T_1$: $p_E = 0{,}3\rho g$

b) External counter pressure

- for $z \le T_1$: $p_{Em} = \rho g (T_1 - z - 0{,}3)$
- for $z > T_1$: $p_{Em} = 0$

### 3.2.3 Internal pressure

For capacities containing liquids, the internal design pressure $p_{In}$ at any point of the hull, in kN/m², is given by the following formulae, as applicable:

$$p_{In} = \rho_L \, g \, (z_{TOP} - z) + d_{AP}$$

$$p_{In} = \rho_L \, g \, (z_{TOP} - z) + 1{,}15 p_{PV}$$

### 3.2.4 Loads on deck

The pressure $p_D$ on decks and platforms structures is to be defined by the Designer.

The pressure $p_D$ is not to be taken less than 5 kN/m².

### 3.2.5 Wheeled loads

Wheeled loads on the deck structure are to be determined according to NR 217, Part B, Ch 3, Sec 4, [3.5]. Inertial forces may be neglected.

## 3.3 Dry uniform loads

**3.3.1** The pressure $p_C$, in kN/m², induced by dry uniform loads is to be defined by the Designer.

## 3.4 Dry unit loads

**3.4.1** The force F induced by dry unit loads and transmitted to the hull structure is to be determined on the basis of the force obtained, in kN, from the following formula:

$F = 9{,}81\ m_C$

where $m_C$ is the mass, in t, of the dry unit load.

Account is to be taken of the elastic characteristics of the lashing arrangement and/or the structure which supports the load.

## 3.5 Lateral pressure in testing conditions

**3.5.1** The lateral pressure $p_{ST}$ to be considered as acting on platings and structural members subject to tank testing are specified in Tab 2.

**Table 2 : Lateral pressure in testing conditions**

| Compartment or structure to be tested | Water pressure, in kN/m² |
|---|---|
| Ballast tanks | The greater of the following:<br>$P_{ST} = g\ [(z_{TOP} - z) + d_{AP}]$<br>$P_{ST} = g\ [(z_{TOP} - z) + 1]$<br>$P_{ST} = g\ [(z_{TOP} - z) + 1{,}3p_{PV}]$ |
| Watertight compartments not used as tank | $P_{ST} = g\ (z_{AP} - z)$ |
| Other tanks | $P_{ST} = g\ [(z_{TOP} - z) + d_{AP}]$ |

## 3.6 Mooring force

**3.6.1** The mooring force F to be considered in the design of the mooring system and hull structural reinforcement is to be provided by the Designer for all intended operating conditions. Where the value of the mooring force is not available, it may be calculated using the formulae given in Tab 3, where:

C : Force coefficient, equal to:

$$C = Cc\sqrt{\frac{L}{8B}}BT$$

Cc : Coefficient, as defined in Tab 4.

**Table 3 : Mooring force**

| Force coefficient C | F, in kN |
|---|---|
| $C \leq 500$ | $F = 0{,}35\ C$ |
| $500 < C \leq 2000$ | $F = \left(0,35 - \frac{C-500}{15000}\right)C$ |
| $2000 < C$ | $F = 0{,}25\ C$ |

**Table 4 : Coefficient Cc**

| Δισπλαχεμεντ, ιν τον | Cc |
|---|---|
| $\Delta \leq 400$ | 45 |
| $400 < \Delta \leq 650$ | 55 |
| $650 < \Delta \leq 1000$ | 65 |
| $1000 < \Delta$ | 70 |

## 3.7 Hull girder loads

### 3.7.1 Still water hull girder loads

The values of design still water hull girder loads are to be provided by the Designer.

### 3.7.2 Vertical wave hull girder loads

The vertical wave hull girder loads at any hull transverse section are to be determined according to Pt B, Ch 4, Sec 1, [4.2].

# 4 Hull girder strength

## 4.1 General

**4.1.1** Calculation of the hull girder section modulus is to be carried out according to Pt B, Ch 3, Sec 1, considering all continuous longitudinal members.

**4.1.2** The hull girder strength check is to be in compliance with Pt B, Ch 3, Sec 1, [4].

# 5 Transverse strength

## 5.1 General

**5.1.1** The transverse strength check is to comply with Pt B, Ch 3, Sec 2.

# 6 Hull scantlings

## 6.1 General

**6.1.1** The scantlings of the hull structure are to be determined in compliance with Part B, Chapter 4, taking into account the load model defined in Pt B, Ch 4, Sec 1, [5].

## 6.2 Reinforcements

**6.2.1** Reinforcements are to be provided at places where the hull is heavily stressed, as the area of coupling systems for the modular floating storage and area of mooring equipment.

# 7 Stability

## 7.1 General

**7.1.1** This Article provides the requirements allowing to ascertain that the floating plant has adequate intact stability under all operating conditions.

Evidence of approval by the Administration concerned may be accepted for the purpose of classification.

**7.1.2** All calculations are to be carried out free from trim and sinkage.

**7.1.3** Stability calculations are to be determined taking into account the most severe conditions, including the effect of the free surfaces of liquids in tanks.

The following requirements of NR217, Pt B, Ch 2, Sec 2 apply:

- definitions
- examination procedure
- inclining test and lightweight check.

## 7.2 Heeling moments

**7.2.1** The values of heeling moments to be considered are to be defined by the Designer.

**7.2.2** The following heeling moments are to be considered.

a) Load induced moment

b) Asymmetric structure induced moment

c) Moment due to wind pressure

The moment caused by the wind pressure, in kN·m, is to be calculated in accordance with the following formula:

$$M_W = F_{WD}\left(\ell_W + \frac{T}{2}\right)$$

where:

$\ell_W$ : Distance, in m, of the centre of gravity of area $A_W$, from waterline.

$F_{WD}$ : Wind force, in kN

$F_{WD} = p_{WD}\, A_W$

$p_{WD}$ : Wind pressure to be taken equal to 0,25 kN/m², in general

$A_W$ : Lateral area, in m², above water plane, including equipment windage area.

d) Cross current induced moment

The moment resulting from the cross current is only to be taken into account for floating plant which is anchored or moored across the current while operating.

e) Ballast and supplies induced moment

The least favourable extent of tank filling from the point of view of stability is to be determined and the corresponding moment introduced into the calculation.

f) Moment due to inertia forces

The moment resulting from inertia forces is to be taken into account if the movements of the load are likely to affect its stability.

## 7.3 Intact stability

**7.3.1** It is to be confirmed that, when account has been taken of the loads applied during the use and operation, the residual freeboard and the residual safety clearance are adequate, i.e.:

- the residual safety clearance is not less than:
  - 0,30 m for weathertight apertures
  - 0,40 m for unprotected openings
- the residual freeboard value is at least 0,30 m.

  the residual freeboard may be reduced if it is proven that the requirements of [7.4] have been met.

For this purpose, the angle of list is not to exceed 10° and the base of the hull shall not emerge.

## 7.4 Intact stability in case of reduced residual freeboard

**7.4.1** If a reduced residual freeboard is taken into account, it is to be checked, for all operating conditions, that:

a) After correction for the free surfaces of liquids, the metacentric height GM is not less than 0,15 m

b) For list angles between 0° and 30°, there is a righting lever, in m, of at least:

$h = 0,30 - 0,28\ \varphi_n$

c) The list angle does not exceed 10°

d) The residual safety clearance value is, at least:
  - 0,30 m for weathertight openings
  - 0,40 m for unprotected openings

e) The residual freeboard is at least 0,05 m

f) For list angles between 0° and 30°, the residual righting lever arm, in m, is at least:

$h = 0,20 - 0,23\ \varphi_n$

Residual righting lever arm means the maximum difference existing between 0° and 30° list between the righting lever and the heeling lever curves. If an opening towards the inside of the floating equipment is immersed at a list angle less than the one corresponding to the maximum difference between the lever arm curves, the lever arm corresponding to that list angle is to be taken into account.

where:

$\varphi_n$ : List angle, in radian, from which the righting lever arm curve displays negative values; this is not to be inserted into the formula for more than 30° or 0,52 rad.

# Section 3 Machinery Systems and Electricity

## 1 General

### 1.1 Definitions

#### 1.1.1 Dangerous products

Dangerous products mean substances and articles the carriage of which is prohibited by ADN (see Note 1) or equivalent standards, or authorized only under the conditions prescribed therein.

Note 1: ADN means European agreement concerning the international carriage of dangerous goods by inland waterways.

#### 1.1.2 Hazardous areas

Hazardous areas are areas in which an explosive gas atmosphere is or may be expected to be present in quantities such as to require special precautions for the construction, installation and use of electrical apparatus.

Hazardous areas are classified in zones according to Ch 8, Sec 1, [1.2.4].

### 1.2 Documentation to be submitted

**1.2.1** Documents to be submitted to the Society are listed in Tab 1.

## 2 Electrical installations and automation equipment

### 2.1 General

**2.1.1** As a rule, floating plant complying with the standards of industrial equipment may be accepted insofar as their satisfactory operation can be established under specified temperature, moisture and corrosion conditions.

**2.1.2** The degree of protection of the electrical equipment on the deck is to be at least IP22 in enclosed areas and IP55 in wet areas and on exposed deck, in compliance with EN 60529.

**2.1.3** No lights disrupting or impeding navigation dazzling effects or reflective likely to be confused with navigational signals or hinder their effects are to be fitted on the floating plant.

## 3 Plant systems

### 3.1 General

**3.1.1** Enclosed plant installations are to be considered as “Machinery spaces of category A”, as defined in NR217, Pt C, Ch 1, Sec 1, [1.4].

#### 3.1.2 Technical references

Plant systems are to be certified in accordance with:

- applicable Society’s Rules
- recognised standards.

### 3.2 Handling and processing dangerous products

**3.2.1** Where dangerous products are involved in the production process, their handling, processing and storage are to be carried out according to the applicable requirements of NR217, Pt D, Chap 3.

### 3.3 Power production plant

**3.3.1** Floating plants assigned the additional service feature **POWERGEN** are to comply with the applicable requirements of NR656 Power production units.

**Table 1 : Documents to be submitted**

| No. | I/A **(1)** | Documents to be submitted |
|---|---|---|
| 1 | I | Process flow diagram (PFD) |
| 2 | A | Piping and instrument diagrams (PID) |
| 3 | I | Production operational philosophy (includes process and safety) |
| 4 | I | Operational and maintenance manual |
| 5 | A | Hazardous area plans |
| 6 | A | Fire and gas detection and alarm systems |
| 7 | A | Passive and active fire protection systems |
| 8 | A | Escape route and evacuation plan |
| 9 | A | Detailed diagrams of the electrical installations of unit |
| 10 | A | Architecture diagram of the automation systems |
| 11 | I | Standards and/or codes used as design and construction basis |

**(1)** A : To be submitted for review
I : To be submitted for information.

Part D
Additional Requirements for Notations

# CHAPTER 8
# ADDITIONAL SERVICE FEATURES AND ADDITIONAL CLASS NOTATIONS

# Section 1 DG-S/Bunker Station and DG-S/Wastes

## Symbols

B : Breadth, in m, defined in Pt B, Ch 1, Sec 2, [3.3]
$B_2$ : Breadth of the side tank, in m
D : Depth, in m, defined in Pt B, Ch 1, Sec 2, [3.4]
$D_2$ : Height of the double bottom, in m.
L : Rule length, in m, defined in Pt B, Ch 1, Sec 2, [3.1]
$L_{OA}$ : Length overall, in m, defined in Pt B, Ch 1, Sec 2, [3.6]
T : Draught, in m, defined in Pt B, Ch 1, Sec 2, [3.5]

## 1 General

### 1.1 Application

**1.1.1** Harbour equipment complying with the requirements of this Section are eligible for the assignment of the following notations:

- **DG-S/Bunker station** or
- **DG-S/Wastes**.

as defined in Pt A, Ch 1, Sec 3, [7.2.5] or Pt A, Ch 1, Sec 3, [7.2.6].

**1.1.2** Harbour equipment not covered by Pt A, Ch 1, Sec 3, [7.2.5] or Pt A, Ch 1, Sec 3, [7.2.6] are to comply with the applicable requirements of NR 217, Part D, Chap 3.

**1.1.3** Harbour equipment dealt with in this Section are to comply with the requirements stated under Part A, Part B Part C and Part D, Chap 6, as applicable.

**1.1.4** Additional measures and Regulations containing the provisions dealing with:

- loading, storage, unloading and handling of products
- harbour equipment personnel, equipment, operation and documentation
- harbour equipment construction,

are also to be complied with.

**1.1.5** The list of products accepted for storage in the harbour equipment will be indicated in a list issued by the Society.

**1.1.6** Alternative arrangements and/or constructions will be specially considered by the Society on a case-by-case basis, taking into account the level of encountered risks in handling of dangerous substances intended to be stored together with anticipated counter measures.

### 1.2 Definitions

**1.2.1** Other general or specific definitions used for the purposes of this Section are given in NR217, Pt D, Ch 3, App 1.

#### 1.2.2 Storage area

Storage area means the whole of the spaces defined here below (see Fig 1):

a) Storage area part above deck means the space which is bounded:
   - at the sides, by the shell plating extending upwards from the decks sides
   - fore and aft, by planes inclined at 45° towards the storage area, starting at the boundary of the storage area part below deck
   - vertically, by a horizontal plane at a height H, in m, to be determined as follows:
     - harbour equipment with superstructure (see Pt B, Ch 1, Sec 2, [3.8] for definition):

       $H = \text{Min}(z_S - z_D ; 3)$

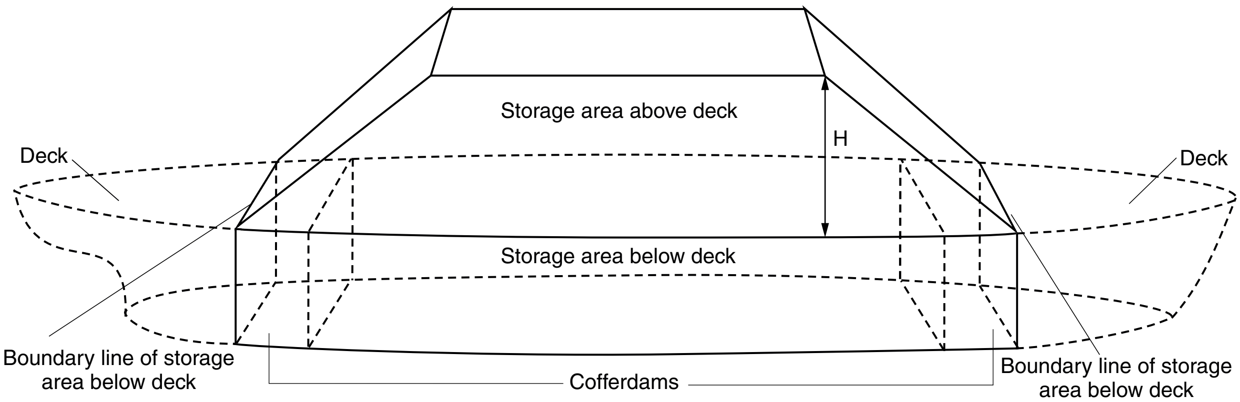
       where:

       $z_S$ : Z-coordinate of the superstructure deck, in m

       $z_D$ : Z-coordinate of the main deck in way of the midship section, in m
     - harbour equipment without superstructure:

       $H = 0$

**Figure 1 : Storage area**




b) Storage area part below deck means the space between two vertical planes perpendicular to the centre-line plane of the harbour equipment, which comprises storage tanks, hold spaces, cofferdams, double-hull spaces and double bottoms; these planes normally coincide with the outer cofferdam bulkheads or hold end bulkheads. Their intersection line with the deck is referred to as the boundary of the storage area part below deck.

#### 1.2.3 Dangerous products

Dangerous products mean substances and articles the carriage of which is prohibited by ADN (see Note 1) or equivalent standards, or authorized only under the conditions prescribed therein.

Note 1: ADN means European agreement concerning the international carriage of dangerous goods by inland waterways.

#### 1.2.4 Hazardous areas

Hazardous areas are areas in which an explosive gas atmosphere (see Note 1) is or may be expected to be present in quantities such as to require special precautions for the construction, installation and use of electrical apparatus.

Hazardous areas are classified in the following zones based upon the frequency and the duration of the occurrence of explosive atmosphere:

- Zone 0: areas in which dangerous explosive atmospheres of gases, vapours or sprays exist permanently or during long periods
- Zone 1: areas in which dangerous explosive atmospheres of gases, vapours or sprays are likely to occur occasionally
- Zone 2: areas in which dangerous explosive atmospheres of gases, vapours or sprays are likely to occur rarely and, if so, for short periods only.

The different spaces of a harbour equipment intended for the storage of substances for which anti-explosion protection is prescribed in column (17) of NR217, Pt D, Ch 3, App 3, Tab 2 are to be classified according to Tab 1.

Note 1: An explosive gas atmosphere is a mixture with air, under atmospheric conditions, of flammable substances in the form of gas, vapour or mist, in which, after ignition, combustion spreads throughout the unconsumed mixture.

#### 1.2.5 Service space

Service space means a space which is accessible during the operation of the harbour equipment and which is neither part of the accommodation nor of the storage tanks, with the exception of the peaks, provided no machinery has been installed in these latter spaces.

### 1.3 Documents to be submitted

**1.3.1** Tab 2 lists the plans and documents to be submitted in addition to the documents required in the other Parts of the Rule note for the parts of the harbour equipment not affected by the product, as applicable.

**Table 1 : Space descriptions and hazardous area zones**

| No. | Description of spaces | Hazardous area zone |
| --- | --- | --- |
| 1 | The interior of storage tanks, slop tanks, any pipework of pressure-relief or other venting systems for storage tanks, pipes and equipment containing the substance or developing flammable gases and vapours | Zone 0 |
| 2 | Void space adjacent to, above or below integral storage tanks | Zone 1 |
| 3 | Hold spaces | Zone 1 |
| 4 | Cofferdams and permanent (for example, segregated) ballast tanks adjacent to storage tanks | Zone 1 |
| 5 | Pump rooms | Zone 1 |
| 6 | Spaces, other than cofferdam, adjacent to and below the top of a storage tank (for example, trunks, passageways and hold) | Zone 1 |
| 7 | Spaces on open deck located in the storage area | Zone 1 |

| No. | Description of spaces | Hazardous area zone |
|---|---|---|
| 8 | Areas on open deck, or semi-enclosed spaces on open deck, within 2 m of any storage tank outlet, gas or vapour outlet, valves, pipe flange, pump-room ventilation outlets, and storage tank openings for pressure release provided to permit the flow of gas or vapour mixtures caused by thermal variation | Zone 1 |
| 9 | Areas on open deck, or semi-enclosed spaces on open deck, within 1 m of pump room entrances, pump room ventilation inlet, openings into cofferdams, service spaces located in the storage area below deck, or other zone 1 spaces | Zone 1 |
| 10 | Compartments for hoses | Zone 1 |
| 11 | Enclosed or semi-enclosed spaces in which pipes containing substances are located | Zone 1 |
| 12 | Spaces above deck, surrounding open or semi-enclosed spaces of zone 1 | Zone 2 |
| 13 | Spaces outside storage area, below the level of the main deck, and having an opening on to the main deck or at a level less than 0,5 m above the main deck, unless:<br>• the spaces are mechanically ventilated, or<br>• the wall of the superstructure facing the storage area extends from one side to the other and has doors the sills of which have a height of not less than 0,50 m | Zone 2 |

**Table 2 : Documents to be submitted**

| No. | A/I | Document |
|---|---|---|
| 1 | I | List of substances intended to be stored with their UN number (see NR217, Pt D, Ch 3, App 3, Tab 2), including all design characteristics of substances and other important design conditions |
| 2 | I | General arrangement plan, showing location of storage tanks and fuel oil, ballast and other tanks, void spaces |
| 3 | A | Hazardous areas plan and location of the electrical equipment installed in these areas |
| 4 | A | Ventilation duct arrangement in gas-dangerous spaces and adjacent zones |
| 5 | A | Details of hull structure in way of storage tanks, including support arrangement for tanks, saddles, anti-floating and anti-lifting devices, deck sealing arrangements, independent storage tanks, etc. |
| 6 | A | Intact and damage stability calculations |
| 7 | A | Scantlings, material and arrangement of the storage tank system |
| 8 | A | Details of product handling system, including arrangements and details of piping and fittings |
| 9 | A | Details of product pumps and compressors |
| 10 | A | Bilge and ballast system in storage area |
| 11 | A | Gas freeing system in storage tanks |
| 12 | A | Ventilation system in storage area |
| 13 | A | List of the electrical equipment installed in hazardous areas comparable to zone 0 and 1, including the following equipment particulars: location, type of protection, type of protection against explosion, testing body and approval number |
| 14 | A | Schematic electrical wiring diagram |
| 15 | A | Pressure drop calculation note |
| 16 | A | Gas detection system |
| 17 | A | Storage tank instrumentation |
| 18 | A | Details of fire-extinguishing appliances and systems in storage area |
| 19 | A | Arrangement drawing of the various fire bulkheads and decks with standard fire test reports for the various arrangements, surface coverings, paints and similar |
| 20 | I | Loading and unloading operation description, including storage tank filling limits, where applicable |
| 21 | A | Gas return system |
| 22 | A | List of equipment installed in hazardous areas comparable to zone 2 which may be used during loading, unloading and gas-freeing and red equipment |

**Note 1:**
A = to be submitted for review
I = to be submitted for information.

# 2 Materials of construction

## 2.1 General

**2.1.1** The harbour equipment's hull and the storage tanks must be constructed of hull structural steel conforming to the applicable requirements of NR216 Materials and Welding (see also Pt B, Ch 2, Sec 2) or other at least equivalent metal.

## 2.2 Specific requirements

**2.2.1** Every part of the harbour equipment including any installation and equipment which may come into contact with the product is to consist of materials which can neither be dangerously affected by the product nor cause decomposition of the product or react with it so as to form harmful or hazardous products.

**2.2.2** Venting pipes and gas discharge pipes is to be protected against corrosion.

**2.2.3** The use of wood, aluminium alloys or synthetic materials within the storage area is only permitted for:

- gangways and external ladders
- movable items of equipment (aluminium gauging rods are, however permitted, provided that they are fitted with brass feet or protected in another way to avoid sparking)
- chocking of storage tanks which are independent of the harbour equipment's hull and chocking of installations and equipment
- masts and similar round timber
- engine parts
- parts of the electrical installation
- loading and unloading appliances
- lids of boxes which are placed on the deck.

**2.2.4** The use of wood or plastic materials within the storage area is only permitted for supports and stops of any kind.

**2.2.5** The use of plastic materials or rubber within the storage area is only permitted for:

- coating of storage tanks and of pipes for loading and unloading
- all kinds of gaskets (e.g. for dome or hatch covers)
- electric cables
- hoses for loading and unloading
- insulation of storage tanks and of hoses for loading and unloading.

**2.2.6** All permanently fitted materials in the accommodation, with the exception of furniture, are not to readily ignite. They are not to evolve fumes or toxic gases in dangerous quantities, if involved in a fire.

**2.2.7** The paint used in the storage area is not to be liable to produce sparks in case of impact.

# 3 Harbour equipment arrangement

## 3.1 General

**3.1.1** The harbour equipment’s hull structural configuration as well as the storage tank type and design are to be determined in compliance with NR217, Pt D, Ch 3, App 3, Tab 2, depending on the products intended to be stored.

## 3.2 Machinery spaces

**3.2.1** Internal combustion engines are to be located outside the storage area. Entrances and other openings of machinery spaces are to be at a distance of not less than 2,00 m from any hazardous area comparable to zone 0 or 1.

**3.2.2** The machinery spaces are to be accessible from the deck; the entrances are not to face the storage area.

## 3.3 Accommodation and service spaces

**3.3.1** Accommodation spaces are to be located outside the storage area forward of the fore vertical plane or abaft the aft vertical plane bounding the part of storage area below deck.

**3.3.2** Entrances to spaces and openings of superstructures are not to face the storage area.

**3.3.3** Entrances from the deck and openings of spaces facing the weather are to be capable of being closed.

#### 3.3.4 Integrity and space segregation

The following is to be complied with to assure segregation between different spaces:

a) Driving shafts of the bilge or ballast pumps in the storage area may penetrate through the bulkhead between the service space and the machinery space, provided the arrangement of the service space is in compliance with [3.4.5].

b) The penetration of the shaft through the bulkhead is to be gastight and approved by the Society.

c) Penetrations through the bulkhead between the machinery space and the service space in the storage area, and the bulkhead between the machinery space and the hold spaces may be provided for electrical cables, hydraulic and piping for measuring, control and alarm systems, provided that the penetrations have been approved by the Society. The penetrations are to be gastight. Penetrations through a bulkhead with an "A-60" fire protection insulation are to have an equivalent fire protection.

d) Pipes may penetrate the bulkhead between the machinery space and the service space in the storage area provided that these are pipes between the mechanical equipment in the machinery space and the service space which do not have any openings within the service space and which are provided with shut-off devices at the bulkhead in the machinery space.

e) Notwithstanding [3.4.4], pipes from the machinery space may penetrate the service space in the storage area or a cofferdam or a hold space or a double-hull space to the outside provided that within the service space or cofferdam or hold space or double-hull space they are of the thick-walled type and have no flanges or openings.

### 3.4 Storage spaces

**3.4.1** The storage tanks are to be separated by cofferdams of at least 0,60 m in width from the accommodation, machinery space and service spaces outside the storage area below deck or, if there are no such accommodation, machinery space and service spaces, from the harbour equipment's ends. Where the storage tanks are installed in a hold space, a space of not less than 0,50 m is to be provided between such tanks and the end bulkheads of the hold space. In this case an end bulkhead meeting at least the definition for Class "A-60", is to be deemed equivalent to a cofferdam.

**3.4.2** Storage spaces, cofferdams and storage tanks are to be capable of being inspected.

**3.4.3** All spaces in the storage area are to be capable of being ventilated. Means for checking their gas-free condition is to be provided.

**3.4.4** The bulkheads bounding the storage tanks, cofferdams and hold spaces are to be watertight. The storage tanks and the bulkheads bounding the storage area are to have no openings or penetrations below deck.

The bulkhead between the machinery space and the cofferdam or service space in the storage area or between the machinery space and a hold space may be fitted with penetrations provided that they conform to the provisions of [3.3.4].

The bulkheads between the storage tanks may be fitted with penetrations provided that the loading and unloading pipes are fitted with shut-off devices in the storage tank from which they come. The shut-off devices are to be operable from the deck.

These pipes are to be at least 0,60 m above the bottom.

**3.4.5** The arrangement of the service space is to comply with the following:

- A cofferdam, the centre part of a cofferdam or another space below deck in the storage area may be arranged as a service space, provided the bulkheads bounding the service space extend vertically to the bottom. This service space is only to be accessible from the deck.
- The service space is to be watertight with the exception of its access hatches and ventilation inlets.

**3.4.6** Cofferdams, double-hull spaces, double bottoms, storage tanks, hold spaces and other accessible spaces within the storage area are to be arranged so that they may be completely inspected and cleaned in an appropriate manner. The dimensions of openings, except for those of double hull spaces and double bottoms which do not have a wall adjoining the storage tanks, are to be in compliance with Pt B, Ch 2, Sec 1, [3.2.2].

### 3.5 Ventilation

**3.5.1** Each hold space is to have two openings the dimensions and location of which are to be such as to permit effective ventilation of any part of the hold space.

**3.5.2** Double-hull spaces and double bottoms within the storage area which are not arranged for being filled with ballast water, hold spaces and cofferdams, are to be provided with ventilation systems.

**3.5.3** Any service spaces located in the storage area below deck are to be provided with a suitable ventilation installation.

**3.5.4** Ventilation of accommodation and service spaces is to be possible.

### 3.6 Engines

**3.6.1** Where the list of products accepted for storage in the harbour equipment includes those for which anti-explosion protection is prescribed in column (17) of NR217, Ch 3, App 3, Tab 2, sparking is not to be possible within any hazardous area comparable to zone 0 or 1.

### 3.7 Exhaust pipes

**3.7.1** Exhausts are to be evacuated from the harbour equipment into the open air either upwards through an exhaust pipe or through the shell plating. The exhaust pipes of engines are to be arranged so that the exhausts are led away from the harbour equipment. The exhaust pipes are not to be located within any hazardous area comparable to zone 0 or 1.

**3.7.2** Exhaust pipes are to be provided with a device preventing the escape of sparks, e.g. spark arresters.

### 3.8 Bilge pumping and ballasting arrangements

**3.8.1** Bilge and ballast pumps for spaces within the storage area are to be installed within such area.

This provision does not apply to:

- double-hull spaces and double bottoms which do not have a common boundary wall with the storage tanks
- cofferdams, double hull spaces, double bottoms and hold spaces where ballasting is carried out using the piping of the fire-fighting system in the storage area and bilge-pumping is performed using eductors.

**3.8.2** Where the double bottom is used as oil fuel tank, it is not to be connected to the bilge piping system.

**3.8.3** Where the ballast pump is installed in the storage area, the standpipe and its outboard connection for suction of ballast water shall be located within the storage area but outside the storage tanks.

**3.8.4** A product pump-room below deck is to be capable of being drained in an emergency by an installation located in the storage area and independent from any other installation. This installation is to be provided outside the product pump-room.

### 3.9 Ventilation of pump room

**3.9.1** Product pump rooms must be provided with extraction type ventilation systems, independent of other harbour equipment's spaces, providing at least 30 cycles of air change per hour. Warning notices are to be placed requiring that the ventilation is in operation for at least 15 minutes prior to entering these spaces.

**3.9.2** Portable means is to be provided for gas-freeing of storage tanks and other spaces not equipped with fixed ventilation.

### 3.10 Arrangements of cofferdams

**3.10.1** Cofferdams or cofferdam compartments remaining once a service space has been arranged in accordance with [3.4.5] are to be accessible through an access hatch. If, however, the cofferdam is connected to a double hull space, it is sufficient for it to be accessible from that space.

**3.10.2** No fixed pipe is to permit connection between a cofferdam and other piping of the harbour equipment outside the storage area.

## 4 Storage tank

### 4.1 General

**4.1.1** The scantlings and structural arrangements are to be in compliance with applicable requirements of Ch 6, Sec 2, [2] to Ch 6, Sec 2, [6].

### 4.2 Storage area hull design

**4.2.1** Where independent storage tanks are used, or for double-hull construction where the storage tanks are integrated in harbour equipment’s structure, the space between the wall of the harbour equipment and wall of the storage tanks is to be not less than 0,60 m.

The space between the bottom of the harbour equipment and the bottom of the storage tanks is to be not less than 0,50 m. The space may be reduced to 0,40 m under the pump sumps. The vertical space between the suction well of a storage tank and the bottom structures is to be not less than 0,10 m.

When a hull is constructed in the storage area as a double hull with independent storage tanks located in hold spaces, the above values are applicable to the double hull. If in this case the minimum values for inspections of independent tanks referred to in [3.4.6] are not feasible, it is to be possible to remove the storage tanks easily for inspection.

**4.2.2** Where service spaces are located in the storage area under deck, they are to be arranged so as to be easily accessible and to permit persons wearing protective clothing and breathing apparatus to safely operate the service equipment contained therein. They are to be designed so as to allow injured or unconscious personnel to be removed from such spaces without difficulties, if necessary by means of fixed equipment.

### 4.3 Storage tank arrangements

**4.3.1** The storage tank is to comply with the following:

- for harbour equipment with a length not more than 50,00 m, the length of a storage tank is not to exceed 10,00 m
- for harbour equipment with a length of more than 50,00 m, the length of a storage tank is not to exceed 0,20 L, where L is the harbour equipment rule length. This provision does not apply to harbour equipment with independent built-in cylindrical tanks having a length to diameter ratio ≤ 7.

**4.3.2** The capacity of a suction well is to be limited to not more than 0,10 $m^3$.

### 4.4 Integrated storage tank scantlings

**4.4.1** The scantlings of the integrated storage tank structure are to be determined in compliance with Ch 6, Sec 2, [6].

### 4.5 Independent storage tank scantlings

#### 4.5.1 Storage tank scantlings

The scantlings of independent storage tanks are to be determined in compliance with Ch 6, Sec 2, [6].

#### 4.5.2 Supports and fastenings

The scantlings of the tank supports and fastenings are to be in compliance with NR217, Pt D, Ch 1 Sec 3, [8].

### 4.6 Storage tank openings

#### 4.6.1

a) Storage tank openings are to be located on deck in the storage area.

b) Storage tank openings with a cross-section of more than 0,10 $m^2$ and openings of safety devices for preventing overpressures are to be located not less than 0,50 m above deck.

#### 4.6.2 Safety devices

On harbour equipment fitted with open venting storage tanks, each storage tank or group of storage tanks connected to a common venting pipe is to be fitted with safety devices designed to prevent any accumulation of water and its penetration into the storage tanks.

## 5 Product piping system

### 5.1 Arrangement for product pumps

**5.1.1** Product pumps are to be capable of being shut down from an area between the fore vertical plane and the aft vertical plane bounding the part of the storage area below deck and from a position outside this area.

### 5.2 Arrangement of product piping

**5.2.1** Pipes for loading and unloading are to be independent of any other piping of the harbour equipment.

**5.2.2** The pipes for loading and unloading are to be arranged so that, after loading or unloading operations, the liquid remaining in these pipes may be safely removed and may flow either into the harbour equipment’s tanks or the tanks ashore.

**5.2.3** Piping for loading and unloading is to be clearly distinguishable from other piping, e.g. by means of colour marking.

**5.2.4** The shore connections are to be located not less than 6 m from the entrances to or openings of, the accommodation and service spaces outside the storage area.

**5.2.5** Each connection of the venting pipe and connections of the pipes for loading and unloading, through which the loading or unloading operation is carried out, is to be fitted with a shut-off device.

### 5.3 Control and monitoring

**5.3.1** The stop valves or other shut-off devices of the pipes for loading and unloading are to indicate whether they are open or shut.

### 5.4 Permissible loading and unloading flows

**5.4.1** The permissible loading and unloading flows are to be calculated. The loading and unloading flows depend on the total cross section of the exhaust ducts.

# 6 Product temperature control

## 6.1 Storage tank heating

**6.1.1** Storage tank heating system is to be installed as a separate system, equipped with a heat exchanger located in the storage area. Where special heat transfer media are used this requirement may be dispensed with upon approval by the Society.

**6.1.2** Boilers which are used for heating the product are to be fuelled with a liquid fuel having a flash point of more than 55°C. They are to be placed either in the machinery space or in another separate space below deck and outside the storage area, which is accessible from the deck or from the machinery space.

**6.1.3** The product heating system is to be designed so that the product cannot penetrate into the boiler in the case of a leak in the heating coils. A product heating system with artificial draught is to be ignited electrically.

**6.1.4** The ventilation system of the machinery space is to be designed taking into account the air required for the boiler.

# 7 Receptacles for residual products and receptacles for slops

## 7.1 General

**7.1.1** If harbour equipment is provided with a tank for residual products, it is to comply with the provisions of [7.1.3] and [7.1.6]. Receptacles for residual products and receptacles for slops are to be located only in the storage area.

**7.1.2** Receptacles for slops are to be fire resistant and capable of being closed with lids. The receptacles for slops are to be marked and easy to handle.

**7.1.3** The maximum capacity of a tank for residual products is 30 $m^3$.

**7.1.4** The tank for residual products is to be equipped with:
- an ullage opening
- a device for ensuring pressure equilibrium
- connections, with stop valves, for pipes and hoses.

**7.1.5** Receptacles for residual products are to be equipped with:
- a possibility of indicating the degree of filling
- connections with stop valves, for pipes and hoses.
- a connection enabling gases released during filling to be evacuated safely

**7.1.6** Receptacles for residual products placed on the deck are to be located at a minimum distance from the hull equal to one quarter of the harbour equipment’s breadth.

# 8 Electrical installations

## 8.1 Type and location of electrical equipment

**8.1.1** Electrical installations and equipment are to be of at least the “limited explosion risk” type.
This provision does not apply to:

a) Lighting installations in the accommodation and the wheelhouse, except for switches near to the entrances
b) Mobile phones, fixed telephone installations, stationary and portable computers and loading instruments in the accommodation or the wheelhouse
c) Electrical installations and equipment which, during a stay in the immediate vicinity of or within a shoreside assigned zone:
   1) are extinguished; or
   2) are placed in premises equipped with a ventilation system according to [3.5]
d) Radiotelephone installations and inland AIS (automatic identification systems) stations in the accommodation and the wheelhouse, if no part of an aerial for radiotelephone installations or AIS stations is situated above or within 2,00 m of the cargo area.

**8.1.2** In the cofferdams, double-hull spaces, double bottoms and hold spaces, only hermetically sealed echo sounding devices are allowed, the cables of which are led through thick-walled steel tubes with gastight connections up to the main deck.

**8.1.3** The fixed electrical installations and equipment which do not meet the requirements set out in [8.1.1] and their switches are to be marked in red. The disconnection of such equipment is to be controlled from a centralized location on board.

**8.1.4** Every insulated distribution network is to be fitted with an automatic device with a visual and audible alarm for checking the insulation level.

**8.1.5** Only distribution systems without return connection to the hull are permitted. This provision does not apply to:

- Active cathodic corrosion protection
- Certain limited sections of the installations situated outside the cargo area (e.g., connections of starters of diesel engines)
- The device for checking the insulation level referred to in [8.1.4].

**8.1.6** An electric generator which is permanently driven by an engine and which does not meet the requirements of [8.1.1], is to be fitted with a switch capable of shutting down the generator. A notice board with the operating instructions is to be displayed near the switch.

**8.1.7** Failure of the power supply for the safety and control equipment is to be immediately indicated by visual and audible signals in the wheelhouse and on the deck. The alarm is to be relayed to the accommodation automatically if it has not been switched off.

**8.1.8** Electrical switches, sockets and cables on deck are to be protected against mechanical damage.

**8.1.9** Sockets for the connection of signal lights and gangway lighting are to be solidly fitted to the vessel close to the signal mast or the gangway. The sockets used in this area are to be designed so as to prevent connection or disconnection except when they are not live.

## 8.2 Type and location of electrical and non-electrical installations and equipment intended to be used in explosion hazardous areas

**8.2.1** Electrical and non-electrical installations and equipment used in explosion hazardous areas are to meet at least the requirements for use in the area concerned.

They are to be selected on the basis of the explosion groups/subgroups and temperature classes to which the substances to be carried belong (see columns (15) and (16) of NR217, Part D, Ch 3, App 3, Tab 2).

If the list of substances on the floating storage is going to include substances for which temperature classes T4, T5 or T6 are indicated in column (15) of NR217, Part D, Ch 3, App 3, Tab 2, then the corresponding surface temperatures within the assigned zones are not to exceed 135°C (T4), 100° (T5) or 85°C (T6).

If the list of substances on the floating storage is going to include substances for which temperature classes T1 or T2 are indicated in column (15) of NR217, Part D, Ch 3, App 3, Tab 2, then the corresponding surface temperatures within the assigned zones are not to exceed 200°C.

**8.2.2** Except in the case of optical fibres, electrical cables are to be armoured or placed in a metallic sheath or in protective tubes.

Electrical cables for the active cathodic protection of the shell plating are to be led through thick-walled steel tubes with gastight connections up to the main deck.

**8.2.3** Movable electric cables are prohibited in the explosion danger area, except for electric cables for intrinsically safe electric circuits or for connecting:

- Signal lights and lighting for gangways, provided the connection point (for example, the socket) is permanently fitted to the floating storage close to the signal mast or gangway
- The power network on a floating storage to a land-based power network; provided
  - The electric cables and the power supply unit conform with a valid standard
  - The power supply unit and connectors are located outside of the explosion danger area.

Connecting and disconnecting sockets/connectors is only to be possible when they are not live.

**8.2.4** Electrical cables of intrinsically safe circuits are to be separated from other cables not intended for use in such circuits and are to be marked (they are not to be installed together in the same string of cables and be fixed by the same cable clamps).

**8.2.5** For movable electrical cables permitted under, only sheathed cables of type H07RN-F in accordance with standard IEC 60245-4:2011 or electrical cables of at least equivalent design having conductors with a cross-section of not less than 1.50 $mm^2$ is to be used.

## 8.3 Earthing

**8.3.1** The metal parts of electrical appliances in the storage area which are not live as well as protective metal tubes or metal sheaths of cables in normal service shall be earthed, unless they are so arranged that they are automatically earthed by bonding to the metal structure of the harbour equipment.

**8.3.2** The provisions of [8.3.1] apply also to equipment having service voltages of less than 50 V.

**8.3.3** Independent storage tanks, metal intermediate bulk containers and tank-containers are to be earthed.

**8.3.4** Receptacles for residual products are to be capable of being earthed.

### 8.4 Storage batteries

**8.4.1** Storage batteries are to be located outside any hazardous area comparable to zone 0 or 1.

## 9 Fire protection and fire extinguishing

### 9.1 Fire and naked light

**9.1.1** The outlets of funnels are to be located not less than 2,00 m from the storage area. Arrangements are to be provided to prevent the escape of sparks and the entry of water.

**9.1.2** Heating, cooking and refrigerating appliances are not to be fuelled with liquid fuels, liquid gas or solid fuels.

The installation in the engine room or in another separate space of heating appliances fuelled with liquid fuel having a flashpoint above 55°C is, however, permitted.

Cooking and refrigerating appliances are permitted only in the accommodation.

**9.1.3** Only electrical lighting appliances are permitted.

### 9.2 Portable fire extinguishers

**9.2.1** In addition to the fire-extinguishing appliances prescribed in NR217, Pt C, Ch 4, Sec 4, the harbour equipment is to be equipped with at least two additional portable fire-extinguishers having the same capacity in storage area.

These additional portable fire-extinguishers are to be suitable for fighting fires involving the dangerous products stored.

## 10 Safety and control installations

### 10.1 General

**10.1.1** Storage tanks are to be provided with the following equipment:

a) A mark inside the tank indicating the liquid level of 97%

b) A high level sensor for actuating the facility against overflowing at the latest when a degree of filling of 97,5% is reached.

c) An instrument for measuring the temperature of the product shall be provided, if in column (9) of NR217, Pt D, Ch 3, App 3, Tab 2, a heating installation is required, or if a possibility of heating the product is required, or if a maximum temperature is indicated in column (20).

## 11 Buoyancy and stability

### 11.1 Storage of liquid products

#### 11.1.1 General

a) Exceptions to the requirements stated in these Rules are possible where they are permitted by the statutory Regulations.

b) General requirements of NR217, Pt B, Ch 2, Sec 2, [1] to NR217, Pt B, Ch 2, Sec 2, [3] are to be complied with.

c) The longitudinal centre bulkhead may be dispensed with only if sufficient stability is guaranteed.

d) Proof of sufficient stability is to be furnished. This proof is not required for single hull harbour equipment with storage tanks the width of which is not more than 0,70 B.

e) The basic values for the stability calculation (the harbour equipment's lightweight and location of the centre of gravity) are to be determined in compliance with NR217, Pt B, Ch 2, Sec 2, [2.2].

f) Proof of sufficient intact stability is to be furnished for all stages of loading and unloading and for the final loading condition for all the relative densities of the products intended to be stored.

g) For every loading case, taking account of the actual filling and floating position of storage tanks, ballast tanks and compartments, drinking water and sewage tanks and tanks containing products for the operation of the harbour equipment, the harbour equipment is to comply with the intact and damage stability requirements.

Intermediate stages during operations are also to be taken into consideration.

#### 11.1.2 Intact stability

For harbour equipment with independent storage tanks and for double hull constructions with storage tanks integrated in the frames of the harbour equipment, the requirements for intact stability resulting from the damage stability calculation are to be fully complied with.

For harbour equipment with storage tanks of more than 0,70 B in width, the following intact stability requirements are to be complied with, bearing in mind the influence of all free surfaces in tanks for all stages of loading and unloading:

- in the positive area of the righting lever curve up to immersion of the first unprotected opening there is to be a righting lever (GZ) of not less than 0,10 m
- the surface of the positive area of the righting lever curve up to immersion of the first unprotected opening and in any event up to an angle of heel ≤ 27° is not to be less than 0,024 m.rad
- the initial metacentric height $GM_0$ is to be not less than 0,10 m.

#### 11.1.3 Damage stability

For harbour equipment with independent storage tanks and for double hull constructions with storage tanks integrated in the frames of the harbour equipment, the following assumptions are to be taken into consideration for the damaged condition:

a) Extent of side damage:
   - longitudinal extent: at least 0,10 $L_{OA}$
   - transverse extent: $B_2$ – 0,01 m
   - vertical extent: from base line upwards without limit

b) Extent of bottom damage:
   - longitudinal extent: at least 0,10 $L_{OA}$
   - transverse extent: 3,00 m
   - vertical extent: from base line to $D_2$ – 0,01 m upwards, except for pump well

c) Any bulkhead within the damaged area is to be assumed damaged, which means that the location of bulkheads is to be chosen to ensure that the harbour equipment remains afloat after the flooding of two or more adjacent compartments in the longitudinal direction.

   The following provisions are applicable:
   - for bottom damage, adjacent athwartship compartments are also to be assumed flooded
   - the lower edge of any non-watertight opening (e.g. windows, doors and access hatchways) is to, at the final stage of flooding, be not less than 0,10 m above the damage waterline.

In general, permeability is to be assumed to be 95%. Where an average permeability of less than 95% is calculated for any compartment, this calculated value obtained may be used.

However, the minimum values of permeability μ given in Tab 3 are to be used.

For the machinery space, only the one-compartment status need be taken into account, i.e. the end bulkheads of the machinery space shall be assumed as not damaged.

The damage stability is generally regarded sufficient if (see Fig 2):

- At the stage of equilibrium (in the final stage of flooding), the angle of heel is not greater than 12°.

  Non-watertight openings shall not be flooded before reaching the stage of equilibrium. If such openings are immersed before the stage of equilibrium, the corresponding spaces are to be considered flooded for the purpose of stability calculation.
- The positive range of the righting lever curve beyond the stage of equilibrium has a righting lever of ≥ 0,05 m in association with an area under the curve of ≥ 0,0065 m.rad. The minimum values of stability are to be satisfied up to immersion of the first unprotected (non-weathertight) opening and in any event up to an angle of heel ≤ 27°. If non-weathertight openings are immersed before that stage, the corresponding spaces are to be considered flooded for the purpose of stability calculation.

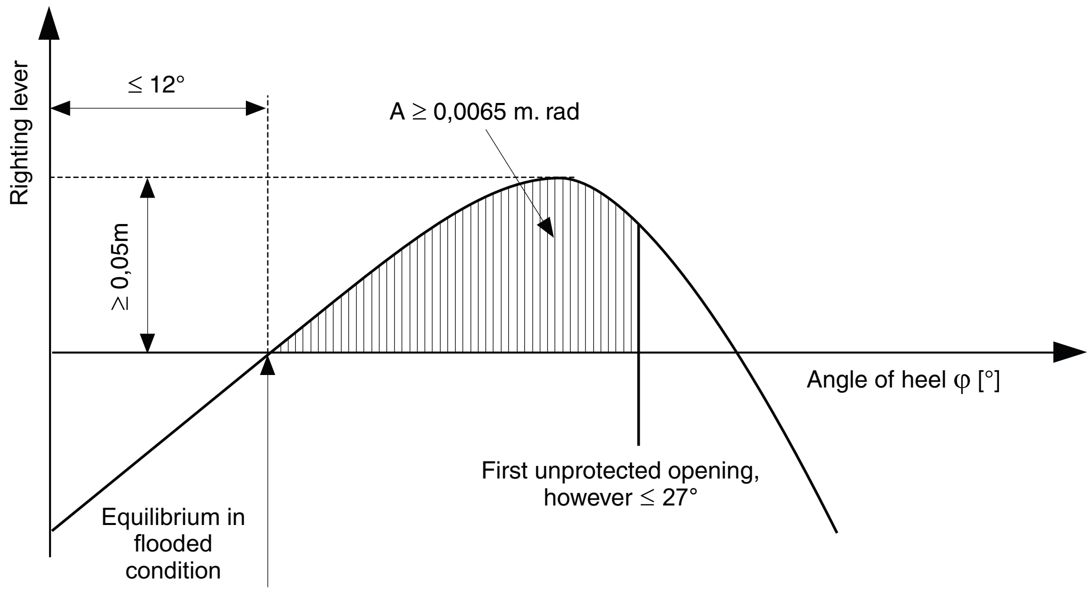
If openings through which undamaged compartments may additionally become flooded are capable of being closed watertight, the closing appliances are to be marked accordingly.

Where cross- or down-flooding openings are provided for reduction of unsymmetrical flooding, the time of equalisation is not to exceed 15 minutes, provided during the intermediate stages of flooding sufficient stability has been proved.

**Table 3 : Permeability μ - Storage of liquid products**

| Spaces | μ, in % |
|---|---|
| Machinery space | 85 |
| Accommodation spaces | 95 |
| Double bottoms, oil fuel tanks, ballast tanks, etc., depending on whether, according to their function, they have to be assumed as full or empty for the vessel floating at the maximum permissible draught | 0 or 95 |

**Figure 2 : Proof of damage stability**



# Section 2 Equipped for Wheeled Vehicles

## 1 General

### 1.1 Application

**1.1.1** The additional class notation **Equipped for wheeled vehicles** is assigned, in accordance with Pt A, Ch 1, Sec 3, [10.2], to harbour equipment intended to carry wheeled vehicles complying with the requirements of this Section.

**1.1.2** Harbour equipment dealt with in this Section are to comply with the requirements stated in Part A, Part B, Part C and relevant Chapter of these Rules, as applicable, and with the requirements of this Section, which are specific to the additional class notation **Equipped for wheeled vehicles**.

### 1.2 Documentation to be submitted

**1.2.1** In addition to the documentation required in the relevant Chapter of Part D for each specific harbour equipment, the following information is to be submitted:

a) Plans of 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.

b) Plan of arrangement of motor vehicles, railway cars and/or other types of vehicles which are intended to be carried and indicating securing and load bearing arrangements

c) 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

d) Plan of dangerous areas, in the case of harbour equipment intended for the carriage of motor vehicles with petrol in their tanks.

## 2 Hull structure

### 2.1 Framing

**2.1.1** In general, the strength deck and the bottom are to be longitudinally framed.

Where a transverse framing system is adopted for such structures, it is to be considered by the Society on a case-by-case basis.

## 3 Hull scantlings

### 3.1 General

**3.1.1** The hull scantlings and arrangements are to be in compliance with Part B, Chapter 4.

**3.1.2** In addition, scantlings of plating and structural members subjected to wheeled loads are to be in compliance with NR217, Pt D, Ch 1, Sec 5.

# Section 3 Modular

## Symbols

$\Delta$ : Displacement, in t, at draught T

B : Breadth, in m, defined in Pt B, Ch 1, Sec 2, [3.3]

L : Rule length, in m, defined in Pt B, Ch 1, Sec 2, [3.1]

T : Draught, in m, defined in Pt B, Ch 1, Sec 2, [3.5]

## 1 General

### 1.1 Application

**1.1.1** The requirements of this Section apply to harbour equipment for the assignment of the additional class notation **Modular** as defined in Pt A, Ch 1, Sec 3, [10.3].

**1.1.2** Harbour equipment to which the additional class notation **Modular** is assigned are to comply with the requirements of this Section, in addition to those developed in Part D, Chapter 1 to Part D, Chapter 7, as applicable.

### 1.2 Permanent connections

**1.2.1** Harbour equipment modules may be connected with permanent connections if the modules are not intended to be disconnected. These connections are such that no relative motion between the modules is permitted.

### 1.3 Removable connections

#### 1.3.1 General

Harbour equipment may be connected with removable connections if the modules can be disconnected afloat.

#### 1.3.2 Types of removable connections

The removable connections are classed in the two following types:

- rigid connection, if no relative motion between the modules is permitted
- flexible connection, if relative motion between the modules is permitted (e.g. a module is free to pitch with respect to another).

### 1.4 Mooring system

**1.4.1** The mooring equipment of the harbour equipment (moorings, chain cables, anchors, attachment devices, etc.) are not included in the scope of classification.

A distinct examination of the mooring system may be carried out by the Society, if requested by the designer or by the Owner.

**1.4.2** The mooring system is to be designed considering the modular harbour equipment as a single unit.

### 1.5 Documents to be submitted

**1.5.1** In addition to documents required in Part D, Chapter 1 to Part D, Chapter 7, the following plans and documents are to be submitted to the Society:

a) General plan of the harbour equipment showing connection systems' arrangements and associated equipment.

b) Force diagram for each connection system, in all operating conditions

When the forces are determined by direct calculation, the relevant calculations are to be submitted to the Society

c) Drawing of the connection systems containing information on the materials used and the scantlings of components

d) Details of the hull structural reinforcement in way of the connection system.

## 2 Harbour equipment fitted with permanent connections

### 2.1 Stability calculations

**2.1.1** Harbour equipment fitted with permanent connections is to comply with the relevant intact and, where requested, damage stability requirements in Part D, Chapter 1 to Part D, Chapter 7, considering the harbour equipment as a single unit.

### 2.2 Hull girder loads

**2.2.1** The hull girder loads and the forces transmitted through the connection are to be calculated for each loading condition considering the harbour equipment as a single unit.

### 2.3 Local loads

**2.3.1** The local loads are to be calculated according to the relevant requirements in Part D, Chapter 1 to Part D, Chapter 7 for each loading condition and draught of the modular harbour equipment. The draught of the modular harbour equipment is to be taken not less than 0,85 D, where D is the greatest of the modules' depths, and need not exceed the greatest draught of individual connected modules.

### 2.4 Hull girder strength

**2.4.1** The longitudinal strength is to comply with the relevant requirements in Part D, Chapter 1 to Part D, Chapter 7, where the hull girder loads are those defined in [2.2].

### 2.5 Hull scantlings

**2.5.1** The net scantlings of plating, ordinary stiffeners and primary supporting members are to be in accordance with the relevant requirements in Part D, Chapter 1 to Part D, Chapter 7, where the hull girder and local loads are those defined in [2.2] and [2.3].

In any case, the net scantlings of plating, ordinary stiffeners and primary supporting members of the connected modules are to be not less than those obtained according to the relevant requirements in Part D, Chapter 1 to Part D, Chapter 7 for each module alone.

## 3 Harbour equipment fitted with removable connections

### 3.1 Stability calculations

**3.1.1** Harbour equipment fitted with removable connections is to comply with the relevant intact and, where requested, damage stability requirement in Part D, Chapter 1 to Part D, Chapter 7, considering the harbour equipment as a single unit.

### 3.2 Hull girder loads

#### 3.2.1 General

The hull girder loads and the forces transmitted through the connections are to be calculated for each loading condition considering the harbour equipment as a single unit.

#### 3.2.2 Harbour equipment fitted with removable flexible connections

For harbour equipment fitted with removable flexible connections, the effect of the degrees of freedom of the connections on the hull girder loads in the combination may be taken into account (e.g. free pitch of a module with respect to another implies vertical bending moment equal to zero in the connections).

### 3.3 Local loads

**3.3.1** The local loads are to be calculated according to the relevant requirements in Part D, Chapter 1 to Part D, Chapter 7 for each loading condition and draught of the modular harbour equipment. The draught of the modular harbour equipment is to be taken not less than 0,85 D, where D is the greatest of the modules' depths, and need not exceed the greatest draught of individual connected modules.

### 3.4 Hull girder strength

**3.4.1** The longitudinal strength is to comply with the relevant requirements in Part D, Chapter 1 to Part D, Chapter 7, where the hull girder loads are those defined in [3.2].

### 3.5 Hull scantlings

#### 3.5.1 Harbour equipment fitted with removable rigid connections

The net scantlings of plating, ordinary stiffeners and primary supporting members are to be in accordance with the relevant requirements in Part D, Chapter 1 to Part D, Chapter 7, where the hull girder and local loads are those defined in [3.2] and [3.3].

In any case, the net scantlings of plating, ordinary stiffeners and primary supporting members of the connected modules are to be not less than those obtained according to the relevant requirements in Part D, Chapter 1 to Part D, Chapter 7 for each module alone.

#### 3.5.2 Harbour equipment fitted with removable flexible connections

The net scantlings of plating, ordinary stiffeners and primary supporting members of the connected modules are to be not less than those obtained according to the relevant requirements in Part D, Chapter 1 to Part D, Chapter 7 for each module alone.

## 4 Connections

### 4.1 General

**4.1.1** The hull is to be reinforced in way of the connections in order to withstand the connection forces.

The strength continuity is to be ensured in way of the structural reinforcements.

### 4.2 Connection loads

**4.2.1** The connection forces are to be provided by the designer for all intended operating conditions. All calculation details are to be submitted to the Society.

**4.2.2** Where the values of connection loads are not available, the forces and moments applied on the connection are to be taken not less than those determined according to [2.2] and [2.3] or [3.2] and [3.3], as applicable.

#### 4.2.3 Flexible connections

Where the values of connection forces are not available, they may be determined considering:

- the worst combination of forces $F_i$ induced by each single module, to be taken not less than the values obtained from Tab 1
- the elastic characteristics of the connection system
- the specificity of the harbour equipment configuration.

**Table 1 : Force induced by a single module**

| Force coefficient C | $F_i$ , in kN |
|---|---|
| $C \le 500$ | $F_i = 0{,}35\,C$ |
| $500 < C \le 2000$ | $F_i = \left(0{,}35 - \frac{C-500}{15000}\right)C$ |
| $2000 < C$ | $F_i = 0{,}25\,C$ |

**Note 1:**

C : Force coefficient, equal to:

$$C = Cc\sqrt{\frac{L_i}{8B_i}}B_iT_i$$

$L_i$ , $B_i$ , $T_i$ : Rule length, breadth and draught, respectively, of a single module i, in m

Cc : Coefficient defined in Tab 2.

**Table 2 : Coefficient Cc**

| Module displacement, in tov | Cc |
|---|---|
| $\Delta_i \le 400$ | 45 |
| $400 < \Delta_i \le 650$ | 55 |
| $650 < \Delta_i \le 1000$ | 65 |
| $1000 < \Delta_i$ | 70 |

### 4.3 Scantlings

#### 4.3.1 Calculation of stresses in the connection

The stresses in the connection are to be obtained by means of direct calculations, where the connection loads are to be obtained according to [4.2].

When calculating the stresses in the connection, pre-loading from locking devices, if any, is to be taken into account.

#### 4.3.2 Strength check

The strength check of the structural components of the connection is to be carried out, taking into account the partial safety factors $\gamma_m$ and $\gamma_R$ defined in Tab 3.

**Table 3 : Partial safety factors**

| Partial safety factors covering uncertainties regarding | Symbol | Partial safety factor value |
| --- | --- | --- |
| Material | $\gamma_m$ | 1,02 |
| Resistance | $\gamma_R$ | 1,25 |

## 5 Hinge connections

### 5.1 General

**5.1.1** Special attention is to be paid to the reinforcement of the hull structure in way of the hinges.

**5.1.2** Generally, no cut-out is to be fitted immediately near to hinges.

### 5.2 Materials used for the hinges

#### 5.2.1 Grades of hull steel plates

The construction materials are to comply with the applicable requirements of NR216 Materials and Welding.

Moreover, in low temperature service conditions, the choice of the steel grade is to be made with the Society on a case-by-case basis, according to the actual service conditions and to the design detail of the welded assembly.

In normal service conditions, the hull steel plates are to be of the grade defined in Tab 4.

**Table 4 : Material grade requirements for hinges**

| Gross thickness, in mm | Normal strength steel | Higher strength steel |
| --- | --- | --- |
| $t \leq 15$ | A | AH |
| $15 < t \leq 20$ | B | DH |
| $t > 20$ | D | DH |

#### 5.2.2 Grades of steel castings and steel forgings

The steel grade of the steel castings and steel forgings is to be defined according to the service temperature of the part and to the weld location on the part.

#### 5.2.3 Grades of steel for hinge pins

The hinge pins are generally to be made of forged steel.

#### 5.2.4 Inspections and tests of weld connections

For welds concerning the main members of the hinges, non-destructive examinations are to be carried out along the full length of the joint:

- for butt welds: 100% radiographic and ultrasonic examination
- for fillet welds with deep penetration: 100% ultrasonic examination and 100% magnetic particle inspection or penetrant fluid test
- for fillet welds with small penetration: 100% magnetic particle inspection or penetrant fluid tests.

#### 5.2.5 Other materials

Materials other than steel will be considered by the Society on a case-by-case basis.

### 5.3 Connection forces

**5.3.1** The force F to be considered for the check of the hinge scantlings is to be taken equal to:

- for a simple hinge:
  the resultant of the horizontal and vertical forces
- for a hinge with tie-rod:
  the force in the tie-rod centreline.

### 5.4 Scantling check

**5.4.1** The hinges consist generally of two side straps and a centre eye connected by a pin, as shown in Fig 1.

The two main types of hinges are generally the following:

- type I: welded assembly made of plates, as shown in Fig 2
- type II: welded assembly made of plates and of cast steel or forged steel parts, as shown in Fig 3.

The check of scantlings in [5.4.2] applies to the case of direct bearing of the pin on the side straps and the centre eye (see Fig 4) and to the case of load transfer by bearings (see Fig 5). In the second case, the designer is to demonstrate that the bearings can withstand the calculated forces.

Hinges whose manufacture is different from these two cases are to be examined by the Society on a case-by-case basis.

**5.4.2** For the pins, centre eye and side straps of the hinges, the applied forces are to comply with the formulae given in Tab 5.

## 6 Cable connections

### 6.1 General

#### 6.1.1 Materials

The construction materials are to comply with the applicable requirements of NR216 Materials and Welding.

### 6.2 Connection forces

**6.2.1** The connection forces F are to be determined according to [4.2].

**Figure 1 : Hinge arrangement**

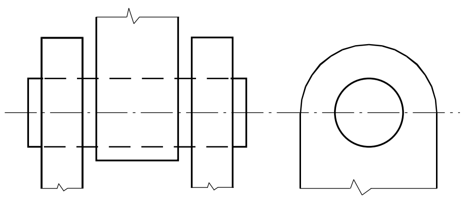


**Figure 2 : Type I hinges**

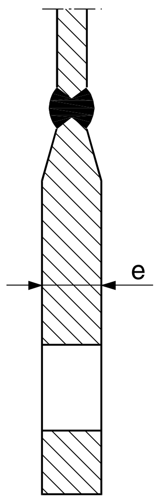


**Figure 3 : Type II hinges**

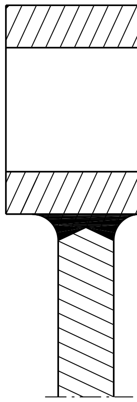


**Figure 4 : Hinges: case of direct bearing**

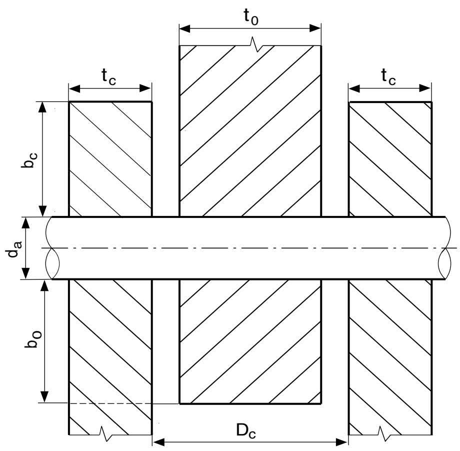



**Figure 5 : Hinges: case of load transfer by bearings**

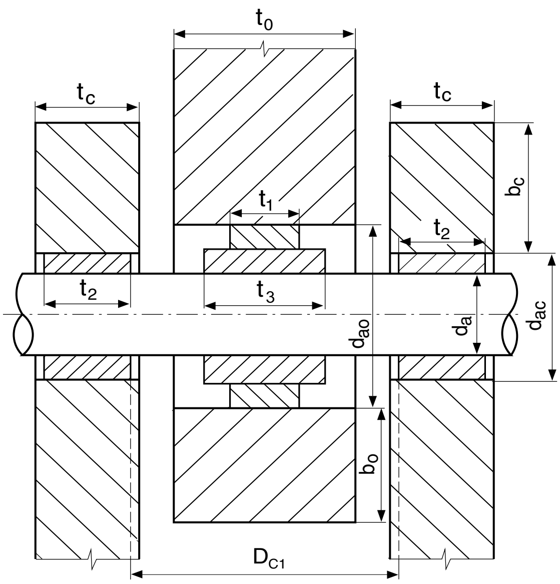


**Table 5 : Scantling check of steel hinges**

| Case | Elements to be checked | | |
|---|---|---|---|
| | Pins | Centre eye | Side straps |
| Direct bearing | $F < \frac{d_a^2 R_m}{5,76} 10^{-3}$<br>$F < \frac{2}{3} d_a t_0 R_{eH} 10^{-3}$<br>• if $t_0 < d_a$:<br>$F < \frac{d_a^3}{2D_C - t_0} \frac{R_m}{5} 10^{-3}$<br>• if $t_0 \geq d_a$:<br>$F < \frac{d_a^3}{2D_C - 2t_0 + d_a} \frac{R_m}{5} 10^{-3}$ | $F < \frac{b_0 t_0 R_{eH}}{2,27} 10^{-3}$<br>$F < d_a t_0 R_{rad} 10^{-3}$ | $F < \frac{b_C t_C R_{eH}}{1,14} 10^{-3}$<br>$F < 2 d_a t_C R_{rad} 10^{-3}$ |
| Load transfer by bearings | $F < \frac{d_a^2 R_m}{5,76} 10^{-3}$<br>$F < \frac{2}{3} d_a t_3 R_{eH} 10^{-3}$<br>• if $t_3 < d_a$:<br>$F < \frac{d_a^3}{2D_{C1} - t_3} \frac{R_m}{5} 10^{-3}$<br>• if $t_3 \geq d_a$:<br>$F < \frac{d_a^3}{2D_{C1} - 2t_3 + d_a} \frac{R_m}{5} 10^{-3}$ | $F < \frac{b_0 t_0 R_{eH}}{2,27} 10^{-3}$<br>$F < \frac{2}{3} d_{a0} t_1 R_{eH} 10^{-3}$ | $F < \frac{b_C t_C R_{eH}}{1,14} 10^{-3}$<br>$F < \frac{4}{3} d_{aC} t_2 R_{eH} 10^{-3}$ |

**Note 1:**

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

$R_m$ : Minimum ultimate tensile strength, in N/mm², of the material

$R_{rad}$ : Permissible radial pressure on the bearing, in N/mm², to be taken equal to $100/k_1$

where:

$$k_1 = \left(\frac{235}{R_{eH}}\right)^{n_2}$$

$n_2$ : Coefficient to be taken equal to:

- $n_1 = 0,75$ for $R_{eH} > 235$ N/mm²
- $n_1 = 1,00$ for $R_{eH} \leq 235$ N/mm².

## 6.3 Connection system design

**6.3.1** Steel wire ropes as well as fibre ropes from natural or synthetic fibres or ropes consisting of steel wires and fibre strands may be used for all ropes and cables.

On harbour equipment intended for the storage of dangerous products, steel wire ropes only are to be used for coupling purposes.

**6.3.2** The minimum breaking load of cables is to be determined taking into account the forces calculated according to [6.2] and the number of connections.

## 6.4 Bollards

**6.4.1** Depending on the connection system arrangement, each module of the harbour equipment is to be equipped with a sufficient number of bollards of adequate strength to withstand the connection forces.

**6.4.2** The bollards are to be led through the deck and below be attached to a horizontal plate spaced at least one bollard diameter from the deck. Said plate being of the same thickness as the bollard wall is to be connected to the side wall and adjacent beam knees. Should this be impossible, the bollards are to be constrained in a bollard seat on deck.

# 7 Bolt / pin connections

## 7.1 General

**7.1.1** All joints are to have a design resistance such that the structure is capable of satisfying all the basic design requirements of EN 1993-1-8:2005 standard or equivalent recognised applicable Standard.

### 7.1.2 Materials

The construction materials are to comply with the applicable requirements of NR216 Materials and Welding.

## 7.2 Connection loads

**7.2.1** The forces and moments applied to joints are to be determined according to [2.2] and [2.3].

## 7.3 Strength check principles

### 7.3.1 Resistance of joints

The following general principles apply:

- the resistance of a joint should be determined on the basis of the resistances of its basic components
- linear-elastic or elastic-plastic analysis may be used in the design of joints
- as a rule, where fasteners with different stiffnesses are used to carry a shear load, the fasteners with the highest stiffness are to be designed to carry the design load.

### 7.3.2 Design assumptions

The joints are to be designed on the basis of a realistic assumption of the distribution of internal forces and moments. The following assumptions are to be used to determine the distribution of forces:

- the internal forces and moments assumed in the analysis are in equilibrium with the forces and moments applied to the joints
- each element in the joint is capable of resisting the internal forces and moments
- the deformations implied by this distribution do not exceed the deformation capacity of the fasteners and the connected parts
- the assumed distribution of internal forces shall be realistic with regard to relative stiffnesses within the joint
- the deformations assumed in any design model based on elastic-plastic analysis are based on rigid body rotations and/or in-plane deformations which are physically possible.

### 7.3.3 Eccentricity at intersections

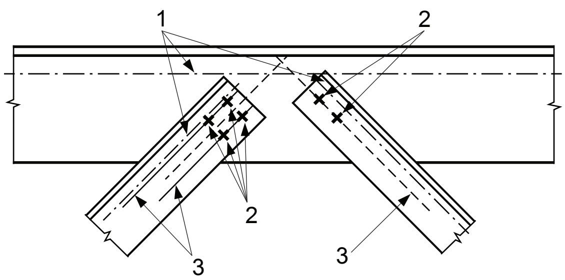
As a rule, where there is eccentricity at intersections, the joints and members are to be designed for the resulting moments and forces.

In the case of joints of angles or tees attached by either a single line of bolts or two lines of bolts any possible eccentricity are to be taken into account. In-plane and out-of-plane eccentricities are to be determined by considering the relative positions of the centroidal axis of the member and of the setting out line in the plane of the connection according to Fig 6.

### 7.3.4 Positioning of holes for fasteners

Arrangements are to be taken to comply with prescribed minimum and maximum spacing and end and edge distances for fasteners.

**Figure 6 : Setting out lines**




1 : Centroid axes

2 : Fasteners

3 : Setting out lines.

# 8 Other connections

## 8.1 General

**8.1.1** Other types of connections will be considered by the Society on a case-by-case basis.

### 8.1.2 Materials

The construction materials are to comply with the applicable requirements of NR216 Materials and Welding.

## 8.2 Connection loads

**8.2.1** The forces and moments applied to joints are to be determined according to [2.2] and [2.3] or [3.2] and [3.3].

## 8.3 Strength check principles

**8.3.1** The resistance of a joint is to be determined on the basis of the resistances of its basic components.

# Section 4 Operating Area Notation $H_S \leq x$

## Symbols

B : Breadth, in m, defined in Pt B, Ch 1, Sec 2, [3.3]

C : Wave parameter

$C = n\,(10{,}7 - 0{,}023\,L)$

$C_B$ : Total block coefficient

$$C_B = \frac{\Delta}{\rho L B T}$$

D : Depth, in m, defined in Pt B, Ch 1, Sec 2, [3.4]

$F_{MT}$ : Vertical bending moment distribution factor defined in Pt B, Ch 4, Sec 1, [4]

$F_Q$ : Vertical shear force distribution factor defined in Pt B, Ch 4, Sec 1, [4]

g : Gravity acceleration, in m/s$^2$

$g = 9{,}81$ m/s$^2$

$H_S$ : Significant wave height, in m

$h_2$ : Reference value, in m, of the relative motion in the inclined vessel condition in NR217, Pt B, Ch 3, Sec 3, [2.2.1].

L : Rule length, in m, defined in Pt B, Ch 1, Sec 2, [3.1]

$M_H$ : Design still water bending moment in hogging condition, in kN.m, defined in the relevant chapter of Part D, for each harbour equipment type

$M_S$ : Design still water vertical bending moment in sagging condition, in kN.m, defined in the relevant chapter of Part D, for each harbour equipment type

n : Operation area coefficient

$n = 0{,}165\,H_S$

$\rho$ : Water density, in t/m$^3$

- $\rho = 1{,}025$ t/m$^3$, for sea water
- $\rho = 1$ t/m$^3$, for other water areas

T : Draught, in m, defined in Pt B, Ch 1, Sec 2, [3.5]

$z_{hc}$ : Z co-ordinate, in m, of the top of sill or hatch coaming

$z_{LE}$ : Z co-ordinate, in m, of the lower edge of opening

## 1 General

### 1.1 Application

**1.1.1** Harbour equipment complying with the requirements of this Section are eligible for the assignment of the additional service feature **$H_S \leq x$** as defined in Pt A, Ch 1, Sec 1, [1.2.11].

## 2 Design loads

### 2.1 Partial safety factors covering uncertainties regarding wave loads

**2.1.1** The partial safety factors $\gamma_{W1}$ and $\gamma_{W2}$ to be considered for hull structural strength check are those specified in NR217, Pt B, Ch 5, Sec 1, [1.3].

### 2.2 Floating door - Tide height

**2.2.1** For harbour equipment with service notation **Floating door**, the tide height $h_T$ is to be properly taken into account:

- in the calculation of the external pressure on the shell structure
- in the calculation of the horizontal hull girder loads.

### 2.3 Local loads in service conditions

**2.3.1** The lateral loads in service conditions are to be determined according to NR 217, Pt B, Ch 3, Sec 4.

**2.3.2** The reference value of the relative motion in the upright condition $h_1$, in m, is to be determined according to NR 217, Pt B, Ch 3, Sec 3, [2.2] (b).

## 2.4 Vertical wave hull girder loads

**2.4.1** The absolute values of the vertical wave hull girder loads in hogging and sagging conditions are to be determined according to Tab 1.

As an alternative, the Society may accept the values of wave induced loads derived from direct calculations, when justified on the basis of the harbour equipment characteristics and intended service. The calculations are to be submitted to the Society.

**Table 1 : Vertical wave hull girder loads**

| | Vertical wave hull girder loads | Monohull unit | Multihull unit |
|---|---|---|---|
| In general | Bending moment, in kN.m | $M_{WV} = 0,11CF_{MT}L^2B(C_B+0,7)$ | $M_{WV} = 0,12CF_{MT}L^2B(C_B+0,7)$ |
| | Shear force, in kN | $Q_{WV} = 0,35CF_QLB(C_B+0,7)$ | $Q_{WV} = 0,38CF_QLB(C_B+0,7)$ |
| Additional wave hull girder loads **(1)** | Bending moment, in kN.m | NA | $M_{WVQ} = nC_{WQ}L^2BC_B$ |
| | Shear force, in kN | NA | $Q_{WVQ} = 1,6nC_{WQ}LBC_B$ |

**Note 1:** NA = Not applicable.

$F_{MT}$ : Distribution factor defined in Pt B, Ch 4, Sec 1, Tab 7 and Pt B, Ch 4, Sec 1, Fig 1

$F_Q$ : Distribution factor defined in Pt B, Ch 4, Sec 1, Tab 8 and Pt B, Ch 4, Sec 1, Fig 2

$L_{WQ}$ : Wave length, in m, defined as follows (see Fig 1):

$$L_{WQ} = \frac{2LB_E}{\sqrt{L^2+B_E^2}}$$

where:

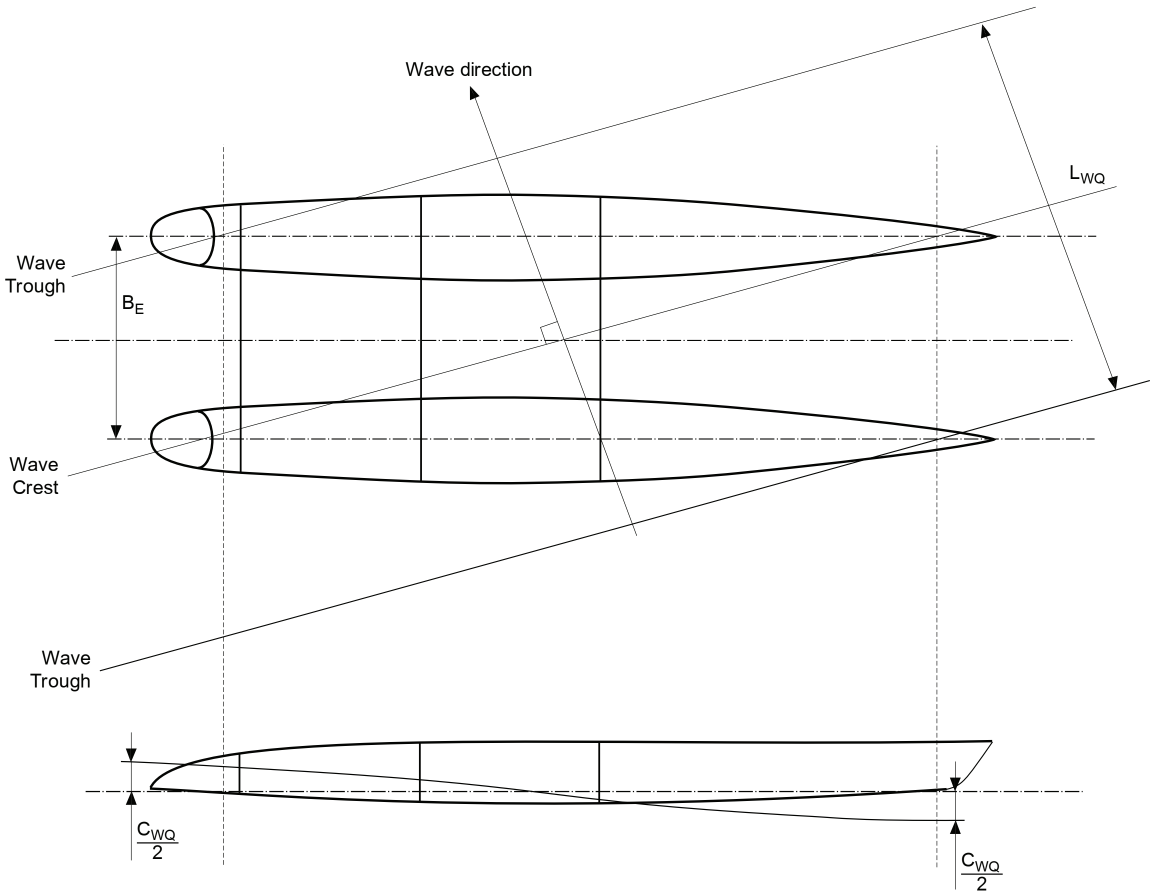
$B_E$ : Distance, in m, between the float axes (see Fig 1)

$C_{WQ}$ : Parameter (see Fig 1), in m, taken equal to:

$C_{WQ} = (118 - 0,36\, L_{WQ})\, L_{WQ} \cdot 10^{-3}$

**(1)** To be considered only for transverse strength analysis. See Pt B, Ch 3, Sec 2

**Figure 1 : Wave length $L_{WQ}$ for catamaran**



### 2.5 Coupling and mooring forces

**2.5.1** Inertial effects induced by the operating environment are to be considered for the calculation of coupling and mooring forces.

### 2.6 Other wave loads

**2.6.1** The following wave loads may be required to be taken into account if deemed necessary by the Society:

- horizontal wave bending moment
- wave torque
- dynamic local loads.

## 3 Load model

### 3.1 General

**3.1.1** The wave lateral pressures and hull girder loads are to be calculated in mutually exclusive load cases "a", "b", "c" and "d" defined in NR217, Pt B, Ch 3, Sec 1, [4].

### 3.2 Hull girder normal stresses

**3.2.1** The hull girder normal stresses to be considered for the strength check of plating, ordinary stiffeners and primary supporting members are obtained, in N/mm², from the following formulae:

- in general

  $\sigma_{X1} = \sigma_{S1} + \gamma_{W1}(C_{FV}\sigma_{WV1} + C_{FH}\sigma_{WH})$

- for structural members not contributing to the hull girder longitudinal strength:

  $\sigma_{X1} = 0$

- In flooding conditions:

  $\sigma_{X1} = 0$

where:

$\sigma_{S1}$, $\sigma_{WV}$, $\sigma_{WH}$ : Hull girder normal stresses, in N/mm², defined in:

- Tab 3, for plating subjected to lateral loads
- Tab 4, for in-plane hull girder normal stresses for buckling strength assessment
- Tab 5, for ordinary stiffeners and primary supporting members subjected to lateral pressure
- Tab 6, for ordinary stiffeners and primary supporting members subjected to wheeled loads

$C_{FV}$, $C_{FH}$ : Combination factors defined in Tab 2

**Table 2 : Combination factors $C_{FV}$ and $C_{FH}$**

| Load case | Application | $C_{FV}$ | $C_{FH}$ |
|---|---|---|---|
| "a" | - | 0 | 0 |
| "b" | - | 1,0 | 0 |
| "c" | $\mathbf{H_S \le 1,2}$ | 0 | 0 |
| | $\mathbf{1,2 < H_S \le 2}$ | 0,4 | 1,0 |
| "d" | $\mathbf{H_S \le 1,2}$ | 0 | 0 |
| | $\mathbf{1,2 < H_S \le 2}$ | 0,4 | 1,0 |
| Flooding | - | 0,6 | 0 |

**Table 3 : Hull girder normal stresses - Plating subjected to lateral loads**

| Condition | $\sigma_{S1}$, in N/mm² **(1)** | $\sigma_{WV1}$, in N/mm² | $\sigma_{WH}$, in N/mm² |
|---|---|---|---|
| $\frac{\lvert M_S + 0,625\gamma_{W1}C_{FV}M_{WV}\rvert}{M_H + 0,625\gamma_{W1}C_{FV}M_{WV}} \ge 1$ | $\left\lvert\frac{M_S}{I_Y}(z-N)\right\rvert 10^{-3}$ | $\left\lvert\frac{0,625M_{WV}}{I_Y}(z-N)\right\rvert 10^{-3}$ | $\left\lvert\frac{0,625M_{WH}}{I_Z}y\right\rvert 10^{-3}$ |
| $\frac{\lvert M_S + 0,625\gamma_{W1}C_{FV}M_{WV}\rvert}{M_H + 0,625\gamma_{W1}C_{FV}M_{WV}} < 1$ | $\left\lvert\frac{M_H}{I_Y}(z-N)\right\rvert 10^{-3}$ | | |
| **(1)** When the harbour equipment in still water is always in hogging condition, $M_S$ is to be taken equal to 0. | | | |

**Table 4 : In-plane hull girder normal stresses**

| | Condition | $\sigma_{S1}$ , in N/mm² | $\sigma_{WV1}$ , in N/mm² | $\sigma_{WH}$ , in N/mm² |
|---|---|---|---|---|
| Compressive stresses | $z \geq N$ | $\left\lvert \frac{M_S}{I_Y}(z-N) \right\rvert 10^{-3}$ | $\left\lvert \frac{M_{WV}}{I_Y}(z-N) \right\rvert 10^{-3}$ | $\left\lvert \frac{M_{WH}}{I_Z} y \right\rvert 10^{-3}$ |
| | $z < N$ | $\left\lvert \frac{M_H}{I_Y}(z-N) \right\rvert 10^{-3}$ | | |
| Tensile stresses | $z \geq N$ | $\left\lvert \frac{M_H}{I_Y}(z-N) \right\rvert 10^{-3}$ | | |
| | $z < N$ | $\left\lvert \frac{M_S}{I_Y}(z-N) \right\rvert 10^{-3}$ | | |

**Table 5 : Hull girder normal stresses - Ordinary stiffeners and primary supporting members subjected to lateral pressure**

| Condition | $\sigma_{S1}$ , in N/mm² **(1)** | $\sigma_{WV1}$ , in N/mm² | $\sigma_{WH}$ , in N/mm² |
|---|---|---|---|
| Lateral pressure applied on the side opposite to the ordinary stiffener, with respect to the plating: | | $\left\lvert \frac{0,625 M_{WV}}{I_Y}(z-N) \right\rvert 10^{-3}$ | $\left\lvert \frac{0,625 M_{WH}}{I_Z} y \right\rvert 10^{-3}$ |
| • $z \geq N$ in general ;<br>$z < N$ for stiffeners simply supported at both ends | $\left\lvert \frac{M_S}{I_Y}(z-N) \right\rvert 10^{-3}$ | | |
| • $z < N$ in general ;<br>$z \geq N$ for stiffeners simply supported at both ends | $\left\lvert \frac{M_H}{I_Y}(z-N) \right\rvert 10^{-3}$ | | |
| Lateral pressure applied on the same side as the ordinary stiffener: | | | |
| • $z \geq N$ in general ;<br>$z < N$ for stiffeners simply supported at both ends | $\left\lvert \frac{M_H}{I_Y}(z-N) \right\rvert 10^{-3}$ | | |
| • $z < N$ in general ;<br>$z \geq N$ for stiffeners simply supported at both ends | $\left\lvert \frac{M_S}{I_Y}(z-N) \right\rvert 10^{-3}$ | | |
| **(1)** When the harbour equipment in still water is always in hogging condition, $M_S$ is to be taken equal to 0. | | | |

**Table 6 : Hull girder normal stresses - Ordinary stiffeners and primary supporting members subjected to wheeled loads**

| Condition | $\sigma_{S1}$ , in N/mm² **(1)** | $\sigma_{WV1}$ , in N/mm² | $\sigma_{WH}$ , in N/mm² |
|---|---|---|---|
| Hogging | $\left\lvert \frac{M_H}{I_Y}(z-N) \right\rvert 10^{-3}$ | $\left\lvert \frac{0,625 M_{WV}}{I_Y}(z-N) \right\rvert 10^{-3}$ | $\left\lvert \frac{0,625 M_{WH}}{I_Z} y \right\rvert 10^{-3}$ |
| Sagging | $\left\lvert \frac{M_S}{I_Y}(z-N) \right\rvert 10^{-3}$ | | |
| **(1)** When the harbour equipment in still water is always in hogging condition, $M_S$ is to be taken equal to 0. | | | |

# 4 Hull girder strength - Metallic hulls

## 4.1 Floating dock

### 4.1.1 Hull girder strength analysis

The floating dock hull girder strength analysis is to be performed according to Ch 1, Sec 2, [5], considering the vertical wave hull girder loads defined in [2.4].

### 4.1.2 Net hull girder section modulus within 0,4L amidship

The net section moduli $Z_{AB}$ and $Z_{AD}$ of floating docks within 0,4L amidships are to be not less than the value obtained in compliance with Ch 1, Sec 2, [5.3.2], considering the operation area coefficient $n_1$ equal to:

$n_1 = 0,20\ H_S$.

## 4.2 Other harbour equipment

### 4.2.1 Hull girder strength analysis

The harbour equipment hull girder strength analysis is to be performed according to Pt B, Ch 3, Sec 1, considering the vertical wave hull girder loads defined in [2.4].

### 4.2.2 Length to depth ratio

a) Steel hulls

In principle, the length-to-depth ratio L/D for harbour equipment made of steel is not to exceed the following values:

- for $\mathbf{1,2 \le H_S \le 2}$

  L / D = 25

- for $\mathbf{H_S < 1,2}$

  L / D = 38 (1 – 1,7n)

Harbour equipment having a different ratio will be considered by the Society on a case by case basis.

b) Aluminium alloy hulls

The length-to-depth ratio L/D of harbour equipment with a rule length L equal to or greater than 40 m will be specially considered by the Society.

# 5 Transverse strength analysis for catamarans

## 5.1 General

**5.1.1** The transverse strength analysis of catamarans is to be performed according to Pt B, Ch 3, Sec 2, [2], considering the additional wave hull girder loads defined in [2.4].

# 6 Global strength scantling analysis - Structural items made of composite materials or plywood

## 6.1 General

### 6.1.1 Global hull girder longitudinal strength

As a rule, the global hull girder longitudinal strength of units assigned the additional service feature $\mathbf{H_S \le x}$, is to be examined for monohull units and for floats of catamarans, in the following cases:

- units with a rule length L greater than 30 m, or
- units having large openings in decks or significant structural discontinuity at bottom or deck, or
- units with a transverse framing system, or
- units with deck structure made of panels with small thicknesses and stiffeners with large spacings, or
- units with important deadweight, or
- where deemed appropriate by the Society

### 6.1.2 Global strength and local scantling analysis

When deemed necessary by the Society, the hull scantling may be checked taking into account a combination between the global hull girder and local stresses.

### 6.1.3 Global transverse strength of catamaran

As a rule, the global transverse strength of catamaran is to be examined for all types of catamaran.

### 6.1.4 Finite element calculation

The global strength analysis may also be examined with a Finite Element Analysis submitted by the Designer. In this case and where large openings are provided in side shell and/or in transverse cross bulkhead of catamaran, a special attention is to be paid to ensure a realistic modeling of the bending and shear strengths of the window jambs between windows.

## 6.2 Vertical overall longitudinal bending moment

**6.2.1** The vertical overall longitudinal bending moment $M_V$ to be considered for the scantling analysis is to be obtained from the following formulae:

- in sagging condition

$$M_V = M_S + \gamma_W \gamma_{W1} C_{FV} M_{WV}$$

- in hogging condition

$$M_V = M_H + \gamma_W \gamma_{W1} C_{FV} M_{WV}$$

where:

$\gamma_W$ : Coefficient defined as follows:

- for global hull girder longitudinal strength analysis (see [6.1.1]): $\gamma_W = 1,0$
- for global strength and local scantling analysis (see [6.1.2]): $\gamma_W = 0,625$

$C_{FV}$ : Combination factor defined in Tab 2

### 6.3 Strength criteria

**6.3.1** The permissible stresses to be considered for strength check are defined in:

- Pt B, Ch 2, Sec 5, [4], for structural items in composite materials
- Pt B, Ch 2, Sec 5, [5], for structural items in plywood.

## 7 Hull scantlings

### 7.1 General

**7.1.1** The hull scantlings are to comply with the requirements given in Part B, Chapter 4, taking into account the design loads defined in [2] and the load model defined in [3].

**7.1.2** When deemed necessary by the Society on the basis of the harbour equipment's characteristics, the following stresses are also to be determined using direct calculations and taken into account in the calculation of hull girder stresses.

- normal stresses induced by torque and
- shear stresses induced by horizontal shear forces.

## 8 Hull integrity

### 8.1 Freeing ports

**8.1.1** Where bulwarks on weather decks form wells, provisions are to be made for rapidly freeing the decks from water and draining them.

A well is any area on the deck exposed to the weather, where water may be entrapped.

### 8.2 Machinery spaces

#### 8.2.1 Skylight hatches

Engine room skylights are to be fitted with weathertight hatch covers made of metallic material or any other equivalent material. The hatch covers are to be permanently secured to the sides where the lower edge of the opening is at a height above the load waterline of less than 1 m.

#### 8.2.2 Closing devices

Openings in machinery space casings are to be surrounded by a metallic casing of efficient construction. The openings of the casings exposed to the weather are to be fitted with strong and weathertight doors.

#### 8.2.3 Position of non-weathertight openings

In any case, the distance, in m, of the lower edge of a non-weathertight opening to the load waterline is to be such that:

$z_{LE} \geq T + h_2$

#### 8.2.4 Entrances

The sill height, in m, of entrances to machinery space, $h_C$ , above the deck is not to be less than 0,5 m.

Furthermore, this height $h_C$, above the deck, is to be such that:

$z_{hc} \geq T + h_2 + 0,15$

### 8.3 Companionway

**8.3.1** Companionways leading under the bulkhead deck are to be protected by a superstructure or closed deckhouse.

#### 8.3.2 Companion sill height

The sill height above the deck is not to be less than 0,15 m.

Furthermore, this height $h_C$, above the deck, is to be such that:

$z_{hC} \geq T + h_2 + 0,15$

### 8.4 Ventilators

**8.4.1** Ventilator openings below main deck are to have coamings of steel or other equivalent material, substantially constructed and efficiently connected to the deck.

**8.4.2 Coamings**

The coaming height above the deck is not to be less than 0,30 m and this height is to be such that:

$z_{hC} \geq T + h_2 + 0{,}15$.

## 9 Intact stability and freeboard

### 9.1 Intact stability

**9.1.1 Wind force**

The force of wind $F_{WD}$, in kN, on harbour equipment is to be calculated as follows:

$F_{WD} = p_{WD} A_W$

where:

$p_{WD}$ : Wind pressure, in kN/m²

$p_{WD} = 0{,}25(1+n)$

$A_W$ : Lateral area, in m², above water plane, including cargo and equipment windage area.

**9.1.2 Weather criterion**

Where the significant wave height in the operating area exceeds 1,2 m, in addition to the intact stability design criteria defined in the relevant chapters of Part D, the ability of the harbour equipment to withstand the combined effects of beam wind and rolling is to be demonstrated.

### 9.2 Freeboard

**9.2.1** The freeboard $F_B$ of the harbour equipment is to be adapted to the conditions of the operation area in compliance with applicable Regulations of the harbour equipment flag. As a rule, the value of the freeboard, in m, is to be taken not less than:

$F_B = h_2 + 0{,}15$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