BUREAU VERITAS MARINE & OFFSHORE

RULE NOTE

LIFTING APPLIANCES ONBOARD SHIPS AND OFFSHORE UNITS

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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 latest version of these General Conditions is available on the Bureau Veritas Marine & Offshore website.

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Rule Note
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LIFTING APPLIANCES ONBOARD SHIPS AND OFFSHORE UNITS

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CHAPTER 1
GENERAL

Section 1 Principles

1 General

1.1 Scope

1.1.1 This Rule Note applies to lifting appliances fitted on ships or offshore units, and used for:

a) Lifting in harbour or in similar conditions, i.e loading or unloading cargoes, equipment, spare parts or consumable, in environmental conditions not more severe than defined in [6.2.2]

b) Lifting in offshore conditions for various lifting operations, exclusive of the appliances mentioned in item c)

c) Lifting in offshore conditions for launching and recovery of subsea equipment

d) Lifting of personnel

e) Applications defined in SOLAS Convention Chapter II-1/2.

In addition, this Rule Note may also be used for the certification of lifting accessories and the verification of lifting pad eyes.

1.1.2 This Rule Note does not apply to handling apparatus such as, passenger and cargo lifts, lift trucks and lifeboat davits. However, if it is considered as possible and reasonable, this Rule Note may be used wholly or partly by the Society upon special request of the Owner or Manufacturer for appliances not listed in [1.1.1].

1.1.3 The requirements of NR467 Rules for the Classification of Steel Ships and NR445 Rules for the Classification of Offshore Units apply to the scantlings of the fixed parts of the lifting appliances (reference is made to NR467, Pt E, Chap 8) and their connections with the ship/offshore unit structure. However, they do not apply to the scantling of movable parts of these appliances as they are not within the normal scope of classification.

Note 1: The fixed parts of lifting appliances, considered as integral part of hull, are the structures definitively connected by welding to ship hull or offshore unit structure (for instance crane pedestals, masts, derrick heel seating, etc. to the exclusion of the cranes themselves, derrick booms, ropes, rigging accessories, and, generally, any dismountable parts). However, the shrouds of the masts fixed in the ship/offshore unit structure are considered as fixed parts.

1.2 Bureau Veritas interventions

1.2.1 This Rule Note covers the following interventions for the lifting appliances defined in [1.1.1], or as detailed in the relevant articles:

a) Certification activities (see Article [2]):
   - Bureau Veritas certification of lifting appliances in the context of the requirements of International Labour Organization (ILO) Convention (see [2.2])
   - Statutory certification of lifting appliances as per SOLAS regulations as transposed in Flag State National Regulations, when authorized by the ship's Flag State Administration concerned and acting on its behalf (see [2.3]).
   - Certification of lifting appliances as per specific National Regulations, when authorized by the Administration concerned and acting on its behalf (see [2.2] or [2.3] as applicable).

b) Classification activities (see Article [3]):

   The assignment of one or several class notations to a ship or offshore unit as per Article [3].

c) Issuance of the Register of Lifting Appliances and Cargo Handling Gear (see Article [4]).

d) Various interventions at the Owner's or Manufacturer's request as defined in Article [5], in particular:
   - Certification of lifting accessories, see [5.2]
   - Verification of lifting pad eyes, see [5.3].

1.3 Requirements

1.3.1 The Owners' and Manufacturers' attention is drawn to the fact that they are responsible for complying with the legal provisions and the National Regulations of the Government of the State whose flag the ship or offshore unit is entitled to fly or the State under whose authority the ship or offshore unit is operating in the specific case.

1.3.2 The scantling requirements of the constituent parts of cargo gear, especially those of loose gear, are provided either in tables or by formulae. However, components that comply with recognised national or international standards or with similar specifications may be accepted.

1.3.3 The design, construction, installation and survey requirements for lifting appliances covered by this Rule Note are given in the following parts:

- For cranes: Chapter 2, Chapter 5 and as applicable Ch 3, Sec 1; Ch 3, Sec 2 and Ch 3, Sec 3
- For derrick systems: Chapter 2; Ch 3, Sec 4, Chapter 5 and as applicable Ch 3, Sec 3
- For lifting platforms: Chapter 4 and Chapter 5.

2 Certification of lifting appliances

2.1 Scope

2.1.1 The certification procedures of the lifting appliances are defined in [2.2] or [2.3], as applicable.

2.1.2 The certification process results in the issuance of the Register of Lifting Appliances and Cargo Handling Gear and the test certificates mentioned in [2.2] or [2.3], as applicable.

2.1.3 The certification process does not result in the assignment of additional class notations to the concerned ship or offshore unit. It is not mentioned in the Register of Ships of the Society.

2.2 Bureau Veritas certification in the context of ILO Convention

2.2.1 The provisions of this Rule Note are normally consistent with those of the following documents regarding lifting appliances used for loading and unloading ships in harbours:

- International Labour Organization Convention (ILO) No. 32 “Protection against Accidents (Dockers) Convention (Revised), 1932”
- International Labour Organization Convention (ILO) No. 152 “Occupational Safety and Health (Dock Work) Convention, 1979”
- ILO Recommendation No. 160 “Occupational Safety and Health (Dock Work) Recommendation, 1979”.

2.2.2 The certification process of onboard lifting appliance of a ship or an offshore unit includes:

- approval of the drawings and examination of the documents listed in Sec 2
- certification of materials and components as per Ch 5, App 2 including:
  - the test and survey certificates prior to the first use of the items of loose gear such as blocks, hooks, shackles, swivels, chain cables, rings, rigging, lifting beams, etc.
  - the test and survey certificates prior to the first use of the steel wire ropes and fibre ropes
  - the test and survey certificates prior to the first use of the winches
- the test and survey prior to fitting onboard in accordance with Ch 5, Sec 1, [6]
- survey of the fitting onboard in accordance with Ch 5, Sec 1, [10]
- survey and certification of the general tests prior to first use in accordance with Ch 5, Sec 1, [11]
- issuance of the Bureau Veritas Lifting Appliances and Cargo Handling Gear Register.

2.2.3 The forms of certificate issued by the Society correspond to the forms of certificate recommended by the ILO for entering the appliances in the Register of lifting appliances and cargo handling gear.

2.2.4 The test certificates as per [2.2.3] are also used when periodical tests are carried out and when tests are carried out after repair, conversions or changes in elements.

2.3 Statutory certification as per SOLAS regulations as transposed in Flag State national regulations

2.3.1 The statutory certification of lifting appliances according to Flag State Administration National Regulations may be delivered by the Society only when authorized by the Administration concerned and acting on its behalf.

2.3.2 The applicable requirements of SOLAS Chapter II-1/3-13 and the IMO Circular MSC.1/Circ.1663 “Guidelines for lifting appliances” are to be complied with as well as any additional requirements of the National Regulations.

The requirements of this Rule Note for design, construction, installation and survey of onboard lifting appliances are to be complied with.

2.3.3 In the case of a new ship, the shipyard is to provide the Society with information about the lifting appliances and loose gears to be certified. In the case of an existing ship, this information is to be provided to the Society by the Owner.

2.3.4 The statutory certification process of onboard lifting appliance includes:

- approval of the drawings and examination of the documents listed in Sec 2
- certification of materials and components as per Ch 5, App 2 including:
- the test and survey certificates prior to the first use of the items of loose gear such as blocks, hooks, shackles, swivels, chain cables, rings, rigging, lifting beams, etc.
- the test and survey certificates prior to the first use of the steel wire ropes and fibre ropes
- the test and survey certificates prior to the first use of the winches
- the test and survey prior to fitting onboard in accordance with Ch 5, Sec 1, [6]
- survey of the fitting onboard in accordance with Ch 5, Sec 1, [10]
- survey and certification of the general tests prior to first use in accordance with Ch 5, Sec 1, [11] or Ch 5, Sec 1, [12] as applicable
- in-service surveys in accordance with Ch 5, Sec 2
- the issuance and endorsement of the Register of Lifting Appliances and Cargo Handling Gear, unless otherwise instructed by the Flag Administration.

2.3.5 The forms used for the test certificates and the Register of Lifting Appliances and Cargo Handling Gear are those prescribed by the National Regulations.

If the specific National Regulations have not defined special forms of documents, the format of documents of the Society may be used. In this case, the following is to be specified:

- the references of the National Regulations to be applied
- the fact that the Surveyor of the Society acts as a competent person recognized by the Administration concerned
- the test procedures required by the specific National Regulations if different from the procedures provided by the form used for the certificate.

2.3.6 The Register of Lifting Appliances and Cargo Handling Gear may be delivered when the interventions specified in [4.2.1] have been carried out to the Society’s satisfaction, considering the specific requirements of the national regulations, even if some of the above mentioned interventions are not required by those regulations. When the specific National Regulations include provisions in addition to those in [4.2.1], then they are to be complied with.

2.3.7 When the provisions of the National Regulations cannot be complied with or when their application is unclear, it is the responsibility of the Owner or the Manufacturer to take the necessary steps with the concerned Administration in order to obtain the requested exemption or interpretation, and to inform the Society accordingly.

2.3.8 When the test load or the test conditions prescribed by the National Regulations for the lifting appliances or their accessories are more stringent than the provisions of this Rule Note, they are to be taken into account by the Designer to determine the scantlings.

2.3.9 When lifting appliances already in service are concerned, and with the same reserves as those stated above, the minimum interventions required are to be equivalent to those specified in [4.2.1].

3 Lifting appliances covered by the classification of ships or offshore unit

3.1 General

3.1.1 Ships or offshore units fitted with lifting appliances meeting the requirements of [3.4] or [3.5] may be assigned the additional class notations mentioned in [3.2]. The conditions of assignment, maintenance and withdrawal of those class notations are given in Part A of NR467 Rules for the Classification of Steel Ships or Part A of NR445 Rules for the Classification of Offshore Units.

3.1.2 These activities results in the issuance of the Register of Lifting Appliances and Cargo Handling Gear for the concerned ship or offshore unit.

3.1.3 In accordance with the provisions of NR467, Part A, Chapter 1, or NR445, Part A, Chapter 1, and considering the provisions in [3.3], the construction marks ✠, ✠̲ or • are associated with the class notations listed in [3.2.1].

3.2 Class notations

3.2.1 Ships or offshore units fitted with cranes and derrick systems

Ships or offshore units fitted with cranes or derrick systems complying with the applicable requirements of this Rule Note may be assigned the following class notations

- The additional class notation **ALP** for lifting appliances used at harbour
- The additional class notation **(ALP)** for lifting appliances used at harbour and complying with specified National Regulations (see [3.5])
- The additional class notation **ALM** for lifting appliances used in offshore conditions
- The additional class notation **(ALM)** for lifting appliances used in offshore conditions and complying with specified National Regulations (see [3.5]).

The notation **ALM** may be completed by **-EN** when, in addition, the cranes used in offshore conditions comply with the requirements of Ch 3, Sec 1 including additional safety requirements defined in Ch 3, Sec 1, [5].

The notation **ALM** may be completed by **-SUBSEA** when, in addition, the cranes intended to be used for lifting of subsea equipment comply with the requirements of Ch 3, Sec 2.

The notations **ALP** and **ALM** (completed or not by **-EN** or **SUBSEA**) may be completed by **-MR** when the lifting appliances are intended to be used for lifting of personnel in compliance with the requirements of Ch 3, Sec 3.

3.2.2 Ships or offshore units fitted with lifting platforms

Ships or offshore units fitted with lifting platforms complying with the applicable requirements of this Rule Note may be assigned the following class notations:

- The additional class notation **ALP** for lifting platforms used at harbour
- The additional class notation **ALM** for lifting platforms used in offshore conditions.

The notation **ALP** and **ALM** may be completed by **-MR** when the lifting platform is intended to be used for lifting of personnel in compliance with the requirements of Ch 4, Sec 6.

3.2.3 The additional class notations listed in [3.2.1] or [3.2.2] can be assigned only if the ship or offshore unit is or will be registered in the Register of the Society and, as a rule, if the lifting appliances comply with the requirements for the assignment of the corresponding notations.

3.2.4 The assignment of the additional class notation **ALP** or **ALM**, possibly completed by applicable subsidiary notations, normally leads to the issuance of Bureau Veritas certificates on the basis of the International Regulations mentioned in [2.2.1]. It results, in particular, in the issuance of the Register of Lifting Appliances and Cargo Handling Gear (see [4.2]).

The Register of Lifting Appliances and Cargo Handling Gear and the corresponding certificates are, in most cases, accepted internationally; however, upon special request of the Owner, additional certification in compliance with specific National Regulations may be delivered, provided the Society is duly authorized to do so by the relevant National Authorities. The opinion of the Society is to be requested in this respect. This additional certification does not result in the assignment of any notation. As a rule, in the case of discrepancy between the requirements of the National Regulations and those of this Rule Note, the most stringent of them apply. If there is a doubt, the opinion of the Society may be requested.

3.3 Construction marks

3.3.1 The construction mark ✠ may be assigned when the lifting appliances have been surveyed by the Society during their construction, as per the procedure detailed in [3.4.1].

3.3.2 In compliance with the procedure detailed in [3.4.2], the construction mark ✠ may be assigned when the supporting ship or offshore unit is classed after construction and is changing class from an IACS Society at the time of the admission to class.

3.3.3 The construction mark • may be assigned when the procedure corresponds to [3.4.3].

3.4 Conditions for the assignment of ALP or ALM class notation

3.4.1 The additional class notation **ALP** or **ALM** with the construction mark ✠ may be assigned to the supporting ship or offshore unit when the following process is complied with:

- approval of drawings and examination of documents required in Sec 2
- certification of materials and equipment in accordance with NR266 and Ch 5, Sec 1
- construction survey in accordance with Ch 5, Sec 1
- survey of tests prior to fitting onboard, in particular certification of the loose gear in accordance with Ch 5, Sec 1, [7]
- survey of fitting onboard in accordance with Ch 5, Sec 1, [10]
- survey and certification of the general tests prior to first use, in accordance with Ch 5, Sec 1, [11] or Ch 5, Sec 1, [12] as applicable
- issuance of the Register of Lifting Appliances and Cargo Handling Gear.

Lifting appliances are to be submitted to examinations and periodical tests according to Ch 5, Sec 2 in order to maintain the class notations.

3.4.2 The additional class notation **ALP** or **ALM** with the construction mark ✠ may be assigned to the supporting ship or offshore unit when the lifting appliance has been surveyed during its construction by an IACS Member and the following process is complied with:

- examination of the drawings and documents required in Sec 2 and submitted for information (see Note 1)
- examination of materials certificates, construction survey attestations, test certificates for equipment and loose gear, and, if any, of the existing Register of Lifting Appliances and Cargo Handling Gear
- survey of the lifting appliance concerned (see Note 2)
- issuance of the Register of Lifting Appliances and Cargo Handling Gear (see Article [4]).

Lifting appliances are to be submitted to examinations and periodical tests according to Ch 5, Sec 2 in order to maintain the class notations.

Note 1: As a rule, these drawings are to be stamped by the organization that approved them at construction stage.

Note 2: The extent of this survey depends on the existing conditions of certification, on the general maintenance conditions and on the age of the lifting appliances. As a rule, general tests are not required if the existing certification for these tests (tests prior to first use and/or quinquennial renewal of tests) is valid.

3.4.3 When the applied process does not correspond to [3.4.1] or [3.4.2] and when the Society considers that the additional class notations **ALP** or **ALM** may still be assigned, then the construction mark • may be added when the following process is complied with:

- approval of the drawings and examination of the documents required in Sec 2 (see Note 1)
- examination of the certificates delivered after testing at works of loose gear, and, possibly, of the existing Register of Lifting Appliances and Cargo Handling Gear
- survey of the lifting appliance concerned (see Note 2);

  checking of thicknesses of structural elements is to be carried out on the lifting appliances the age of which is equal to or greater than 12 years
- issuance of the Register of Lifting Appliances and Cargo Handling Gear
- examinations and periodical tests according to Ch 5, Sec 2 in order to maintain the additional classification class notations.

Note 1:

- Upon agreement of the Society, the approval of drawings may not be required if proof is given that these drawings have been previously approved by a recognized organization. In such a case, the above mentioned drawings and documents are to be submitted for information.
- When some drawings and documents are not available, the Society is to appreciate whether it is possible to grant the requested class notations, since a Register of Lifting Appliances and Cargo Handling Gear has possibly been delivered by a recognized organization or a National Authority. Measurements or controls carried out aboard, and witnessed by a Surveyor of the Society, may be required.
- The documents mentioned in [4.1.2], to be annexed to the Register of Lifting Appliances and Cargo Handling Gear, are to be submitted.

Note 2: The extent of this survey is to be defined according to the state of the existing certification, the general state of maintenance and the age of the lifting appliances. As a rule, a re-testing is not required if the existing certification relating to these tests (tests prior to first use and/or quinquennial renewal of tests) is valid.

3.4.4 The test certificates, the Register of Lifting appliances and Cargo Handling Gear and its attached documents are to be kept onboard the ship or the offshore unit and are to be made available to the Society's Surveyor upon request.

3.4.5 When the lifting appliances are built under the survey of the Society in accordance with the provisions of [3.4.1], except for the provisions regarding inspection of materials and equipment at works, the additional class notation **ALP** or **ALM**, possibly completed by applicable subsidiary notations, may be granted to the ship or the offshore unit.

In such a case, the Manufacturer is to prove that the materials and equipment used comply satisfactorily with the provisions of this Rule Note. The Surveyor may possible require to check it at random.

3.5 Condition for the assignment of (ALP) or (ALM) class notations

3.5.1 Provisions of [3.4] are, as a rule, to be complied for the assignment of one or several class notations **(ALP)** or **(ALM)**. However when National Regulations include provisions which contradict those of this Rule Note, the provisions of the National Regulations normally prevail.

3.5.2 Attention is drawn to provisions [2.3.7] to [2.3.8].

3.5.3 The periodical surveys are to be carried out by the Society in compliance with the requirements of the National Regulations.

4 Register of Lifting Appliances and Cargo Handling Gear

4.1 General

4.1.1 The Register of Lifting Appliances and Cargo Handling Gear is a document which:

- lists all the lifting appliances of the ship or offshore unit which have been certified
- records the periodical examinations and tests required in Ch 5, Sec 2 as well as the occasional inspections or tests
- contains the possible remarks of the Surveyor
- checks the validity of certification for the concerned lifting appliances.

4.1.2 The following documents or equivalent are to be attached to the Register of Lifting Appliances and Cargo Handling Gear, as applicable:

- general sketch showing lay-out and reference marks of the lifting appliances of the ship or offshore unit
- document showing the main characteristics of each lifting appliance (Safe Working Load (SWL), minimum and maximum working radius or load capacity chart, working area, etc.) and its working conditions (list and trim angles, maximum wind in service, sea condition, etc.), stamped by the Society
- force diagram for each lifting appliance in every working condition (different methods for hoisting, union purchase, etc.) showing the maximum forces applied to the items of loose gear and main structures
- for each lifting appliance, sketch giving useful particulars for correct reeving of ropes and position of every item of loose gear
- for each lifting appliance, list of steel wire and fibre ropes giving their characteristics (specially their minimum breaking load) and list of every item of loose gear with its SWL and its test load
- for complex or special type lifting appliance, a working and maintenance manual prepared by the Manufacturer.

In addition to the above-detailed attachments to the Register of Lifting Appliances and Cargo Handling Gear, the manual relating to the lifting appliance is to include the following information:

- design criteria
- design standards
- list of elements heavily loaded in service
- material specifications
- construction standards
- inspection report during fabrication
- sheaves design standards
- cable specifications
- description and maintenance instruction of brake system
- design standards of pipings and electrical circuits
- diagrams of the latter
- description of safety devices
- instruction for operating, mounting, dismounting and transportation
- instruction for maintenance.

This manual is to be kept near the appliance it is related to.

4.2 Conditions for issuance of the Register of Lifting Appliances and Cargo Handling Gear

4.2.1 A lifting appliance may be recorded in the Register of Lifting Appliances and Cargo Handling Gear when the following interventions are carried out to the Society's satisfaction:

- approval of the drawings and examination of the documents listed in Sec 2
- examination of the test certificates at works of the items of loose gear such as blocks, hooks, shackles, swivels, chain cables, rings, rigging, lifting beams, etc.
- examination of the test certificates of the steel wire ropes and fibre ropes
- survey of the fitting onboard in accordance with Ch 5, Sec 1, [11]Ch 5, Sec 1, [10]

- survey and certification of the general tests prior to first use in accordance with Ch 5, Sec 1, [11] or Ch 5, Sec 1, [12] as applicable.

When lifting appliances already in service are concerned, the following interventions are carried out to the Society's satisfaction:

- examination of the drawings and documents required in Sec 2 which are to be submitted for information (see Note 1)
- examination of the certificates delivered after testing at works of loose gear, and possibly of the existing Register of Lifting Appliances and Cargo Handling Gear
- survey of the lifting appliances concerned (see Note 2).

  Checking of thicknesses of structural elements is to be carried out on the lifting appliances the age of which is equal to or greater than 12 years.

Note 1:

- If the ship does not have a Register of Lifting Appliances and Cargo Handling Gear delivered by a recognized organization or a National Authority, the previously mentioned drawings are to be approved by the Society.
- Upon agreement of the Society, the approval of drawings may not be required if these drawings have been previously approved by a recognized organization. In such a case, the previously mentioned drawings and documents are to be submitted for information. Particular measurements or controls carried out aboard, and witnessed by a Surveyor of the Society, may be required.
- The documents mentioned in [4.1.2], to be annexed to the Register of Lifting Appliances and Cargo Handling Gear, are to be submitted in any case.

Note 2: The extent of this survey is to be defined according to the state of the existing certification, the general state of maintenance and the age of the lifting appliances. As a rule, a re-testing is not required if the existing certification relating to these tests (testing prior to first use and/or quinquennial renewal of tests) is valid.

5 Other type of interventions

5.1 General

5.1.1 Upon special request of a Manufacturer or the Owner, the Society may carry out complete or partial certification of a particular lifting appliance or of special equipment. General approvals may be carried out when standardized equipment are concerned.

These requests are to specify clearly whether special Regulations are to be applied. In the absence of specific instructions, the Society's own rules as stated in this Rule Note are to be applied.

5.1.2 The requests for certification of a lifting appliance or of a category of lifting appliances fitted aboard a ship or an offshore unit which is not classed with the Society are to be specially examined.

5.1.3 Whether ships are classed or not with the Society, the Surveyors of the Society may carry out the periodical surveys required either by International Regulations or by specific National Regulations when the Society is authorized to do so.

In addition, the Surveyor may issue certificates and stamp the Register of Lifting Appliances and Cargo Handling Gear of the ship or of the offshore unit, provided that:

- the general maintenance condition of the lifting appliances is deemed satisfactory, and
- the various existing test certificates are shown to the Surveyor, and
- the documents attached to the Register are available.

5.1.4 At the Manufacturer's or Owner's request, the Society may, in some cases, perform verification calculations through their own processes, using for instance their structure analysis software for forces and stresses analysis.

5.1.5 Upon special request, the Surveyors of the Society may also witness particular tests, ascertain damages or repairs, or deliver attestations.

5.1.6 The above interventions normally result in issuance of technical notes, attestations or certificates, as relevant.

5.2 Certification of lifting accessories

5.2.1 At Owner's request, loose gears used as lifting accessories may be certified in compliance with the technical provisions of Ch 2, Sec 4.

5.3 Verification of lifting pad eyes

5.3.1 At Owner's request, the Society may carry out the verification of lifting pad eyes (lifting lugs) which are permanently attached to the ship or offshore unit structure and are independent of lifting appliances (for instance in engine room), in accordance with the requirements of Ch 5, App 1.

5.3.2 Depending on the SWL of the lifting pad eye, the following certification process generally applies:

- design assessment of the lifting pad eye and its connection with the surrounding structure
- surveys:
  - examination of material certification
  - visual inspection
  - NDT
  - testing
  - marking.

5.3.3 The verification services defined above normally result in the issuance of technical reports or attestations, as the case may be.

5.3.4 Certification of lifting pad eyes in compliance with specific National Regulations may be delivered when the Society is authorized to do so by the competent National Authorities.

5.3.5 The request for verification is to specify clearly whether a specific Regulation or Standard is to be applied. By default the requirements of this Rule Note will be applied.

5.3.6 The examination of the supporting structure of the lifting pad eye is not in the scope of this verification.

6 References

6.1 Bureau Veritas documents

6.1.1 Rule Notes and Rules for Classification

The latest version of the document applies when reference is made to the following Bureau Veritas Rule Notes or Rules for Classification:

- NR216 Rules on Materials and Welding for the Classification of Marine Units
- NR266 Requirements for Survey of Materials and Equipment for the Classification of Ships and Offshore Units
- NR467 Rules for the Classification of Steel Ships
- NR445 Rules for the Classification of Offshore Units.

6.2 Definitions

6.2.1 Design temperature

The design temperature is the lowest temperature at which the lifting appliance is intended to operate.

6.2.2 Harbour conditions

Harbour conditions are generally defined as still water conditions with significant wave height H_s not greater than 0,5 m.

6.2.3 Hinge

A hinge is a mechanical device joining two elements and allowing one to rotate without turning the other.

6.2.4 Lifting appliance

Lifting appliance is used herein to designate the whole of the elements used for suspending, raising or lowering loads or moving them from one position to another while suspended, for instance a crane and the whole of its mechanisms, etc.

6.2.5 Loose gear

Loose gear includes any gear by means of which a load can be attached to a lifting appliance but which does not form an integral part of the appliance or load and which are to be tested separately in compliance with the provisions of Ch 5, Sec 1, [7].

These items may be interchanged between various lifting appliances.

Items of loose gear include the following:

- blocks
- hooks
- shackles
- swivels
- chains
- rings
- rigging screws
- slings
- lifting beams
- hand operated tackles with pitched chains, rings, hooks, shackles and swivels permanently attached to other movable items having similar use that items listed here above.

Note 1: All items in the above list, even when not positioned directly between the load and the lifting appliance (e.g. a luffing tackle), are to be considered as items of loose gear.

6.2.6 Minimum breaking force (MBF)

The minimum breaking force of an element is the static force, in kN, corresponding to its minimum breaking load.

6.2.7 Minimum breaking load (MBL)

The minimum breaking load of an element is the minimum mass, in tons, which causes its breaking when applied vertically.

6.2.8 Normal slewing operation

The term normal slewing operation means conventional handling process of a load by means of a single derrick boom or crane. According to this process, the horizontal handling phase is performed by slewing guy tackles of the derrick boom or the slewing device of the crane (see Fig 1 to Fig 5).

6.2.9 Offlead load

An offlead load is a horizontal load at the boom tip caused by the radial displacement of the hook and/or the radial acceleration of the boom tip, including the effects of crane base inclination.

6.2.10 Pad eye

A pad eye is an item which provides an attachment point to a lifting device using a shackle.

6.2.11 Rated pull (RP)

The rated line pull (RP) of a winch is the maximum rope tension, in kN, that the winch can haul at the relevant layer, in normal service condition.

The rated line pull is defined for a specific reeled layer which is to be specified by the Owner or the Manufacturer. The reeled layer may be the first layer (in contact with the drum) or the outer layer.

6.2.12 Safe Working Load (SWL)

The Safe Working Load (SWL) of a lifting appliance is the maximum mass, in tons, which may be lifted vertically by this appliance at the hanging point of the load (hook or lifting ring) and which may be moved in operation.

Note 1: This mass includes the mass of any lifting accessories not permanently attached to the apparatus (lifting beam and slings for instance).

In such a case, the own masses of the lifting accessories are to be deducted from the SWL in order to obtain the maximum mass which may be hung.

A lifting appliance may have several values of SWL depending on its use.

Note 2: A lifting appliance is not to be used to pull obliquely any object whatever it may be (for example to shift a cargo) if this appliance has not been specially designed to do so.

The safe working load of an item of loose gear is the maximum mass, in tons, which may be borne vertically to it (see Ch 2, Sec 4 for the single sheave blocks).

6.2.13 Safe Working Force (SWF)

The SWF of a lifting appliance is the static force, in kN, corresponding to its SWL.

The SWF of an item of loose gear is the static force, in kN, corresponding to its SWL.

6.2.14 Sidelead load

A sidelead load is a horizontal load at the boom tip caused by the lateral displacement of the hook and/or the lateral acceleration of the boom tip, including the effects of crane base inclination.

6.2.15 Standardized equipment

Standardized equipment are equipment approved by the Society provided that the supplier proves that a prototype has been tested according to this Rule Note or has been submitted to tests considered equivalent by the Society.

6.2.16 Test loads and forces

The test load of a lifting appliance is the mass, in tons, to be applied vertically upon testing onboard the ship or offshore unit.

The test force of a lifting appliance is the static force, in kN, corresponding to its test load.

The test load of an item of loose gear is the mass, in tons, to be applied upon its separate testing when test consists in vertical application of a mass.

The test force, in kN, of an item of loose gear is either the static force corresponding to its test load or the force to be applied when test consists in application of a force.

6.2.17 Union purchase

The terms union purchase system mean handling by means of two derrick booms which remain stationary during loading and unloading: one of the derrick booms is located in way of the hatch, the other in way of the quay, the load is transferred from the one to the other only by means of two cargo runners connected together (see Fig 5).

7 Typical types of lifting appliances

7.1 Deck crane

7.1.1 A typical deck crane is described in Fig 1 and vocabulary is defined in Tab 1.

7.2 Derrick systems

7.2.1 Derrick rig for light lifting loads

A typical derrick rig for light lifting loads is described in Fig 2 and vocabulary is defined in Tab 2.

7.2.2 Derrick rig for medium lifting loads

A typical derrick rig for medium lifting loads is described in Fig 3 and vocabulary is defined in Tab 3.

7.2.3 Twin span tackle derrick for heavy loads

A typical twin span tackle derrick for heavy loads is described in Fig 4 and vocabulary is defined in Tab 4.

7.2.4 Union purchase rig arrangement

A typical union purchase rig arrangement is described in Fig 5 and vocabulary is defined in Tab 5.

Figure 1 : Deck crane

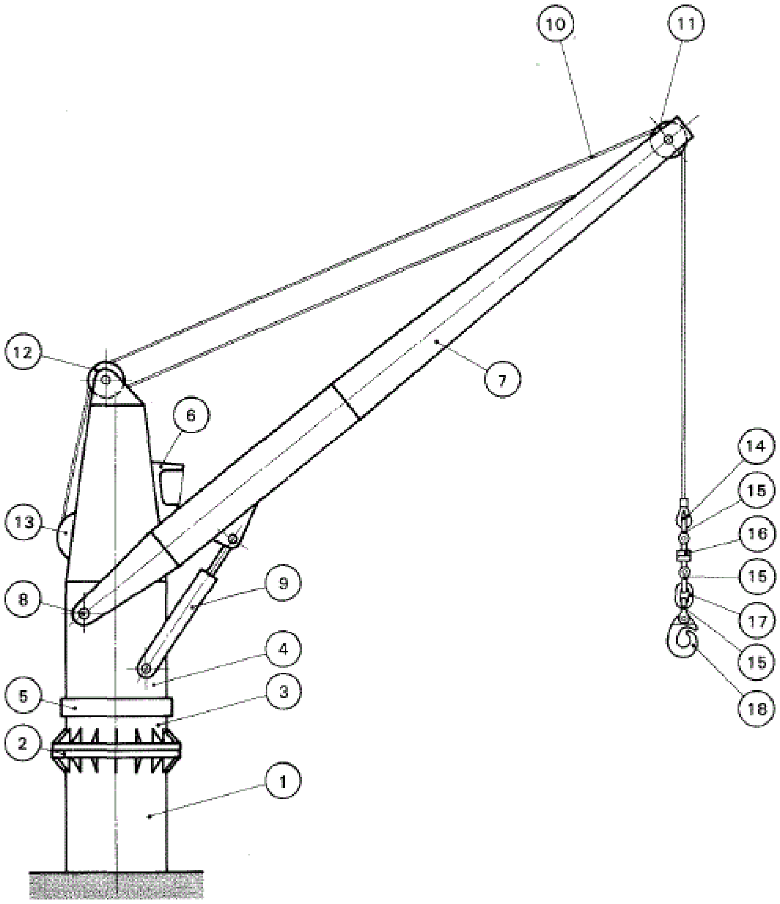


Table 1 : Deck crane

1	Crane pedestal (or crane column, or crane post)	7	Jib (or crane boom)	13	Cargo winch
2	Bolted connection	8	Jib heel pin or boom heel pin	14	Rope terminal (thimble)
3	Fixed lower structure	9	Luffing (or topping) cylinder	15	Shackle
4	Superstructure (or crane body, or revolving superstructure)	10	Cargo runner (or hoisting rope, or lifting rope)	16	Swivel
5	Slewing ring	11	Jib head built-in cargo sheaves	17	Link
6	Driving cab	12	Crane top built-in cargo sheaves	18	Cargo hook (C-hook, or Liverpool hook)

Figure 2 : Derrick rig for light lifting loads

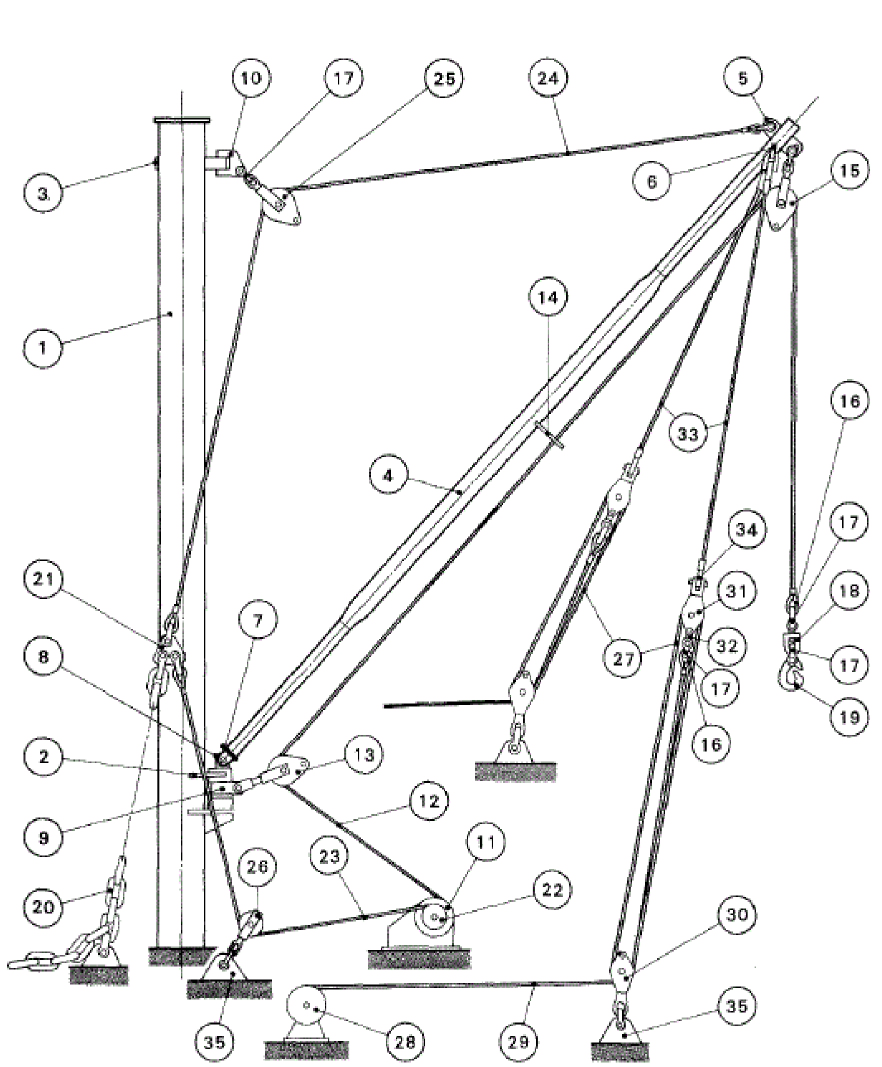


Table 2 : Derrick rig for light lifting loads

1	Mast (or derrick post)	13	Derrick heel cargo lead block	25	Mast head span block
2	Gooseneck seating (or gooseneck bearing bracket)	14	Cargo runner guide	26	Deck topping lead block (may be a snatch block)
3	Mast head span bearing bracket	15	Derrick head cargo block	27	Slewing guy tackles (or vang tackles)
4	Derrick boom	16	Thimble (heart thimble)	28	Slewing winch (or guy winch)
5	Derrick head fitting for cargo block and span rope	17	Shackle	29	Slewing guy rope
6	Derrick head slewing guy fitting	18	Swivel	30	Lower slewing guy block
7	Derrick heel fitting	19	Cargo hook (D-hook or Liverpool hook)	31	Upper slewing guy block

8	Gooseneck	20	Span chain	32	Becket
9	Derrick heel cargo lead block bearing	21	Topping triangle plate	33	Slewing guy pendants (or vang pendants)
10	Span trunnion	22	Declutchable cargo winch warping end (used for topping with no load)	34	Thimble (solid thimble)
11	Cargo winch	23	Topping rope (not used under load)	35	Deck eyeplates
12	Cargo runner (or cargo rope, or hoisting rope, or lifting rope, or cargo fall)	24	Fixed (or standing) span rope		

Figure 3 : Derrick rig for medium lifting loads

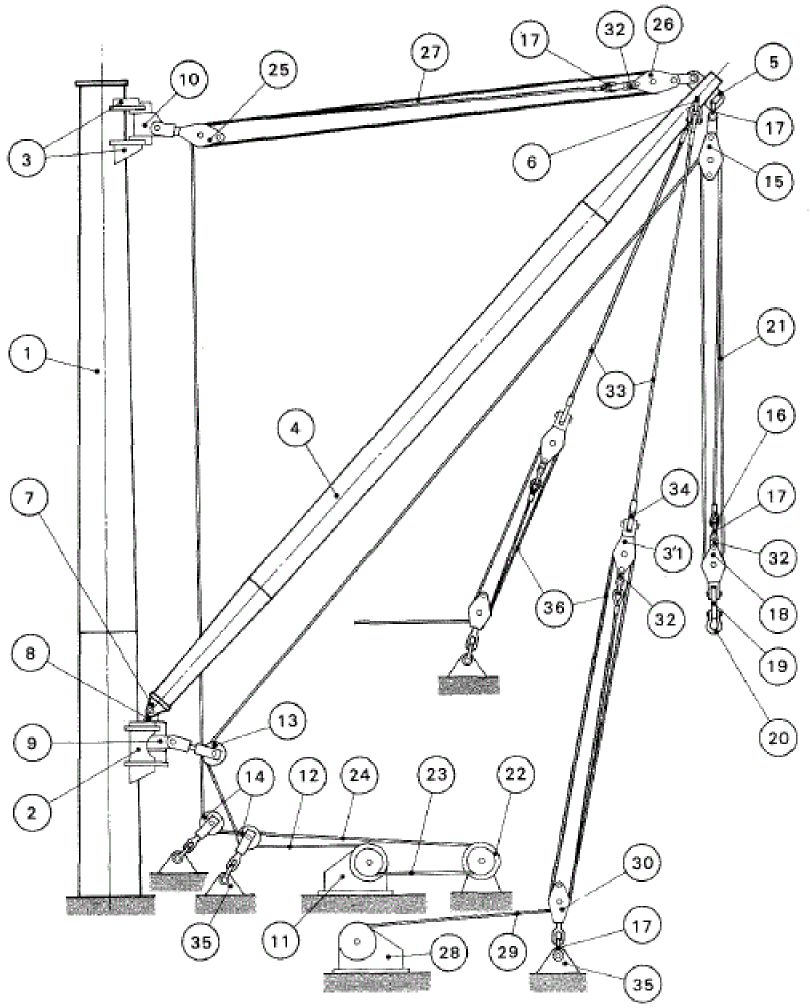


Table 3 : Derrick rig for medium lifting loads

1	Mast (or derrick post)	13	Derrick heel cargo lead block	25	Mast head span (purchase) block (or lower span (purchase) block)
2	Gooseneck seating (or gooseneck bearing bracket)	14	Deck lead blocks	26	Derrick head span (purchase) block (or lower span (purchase) block)
3	Mast head span bearing bracket	15	Upper cargo (purchase) block (or derrick head cargo (purchase) block)	27	Span tackle
4	Derrick boom	16	Thimble (heart thimble)	28	Slewing winch (or guy winch)
5	Derrick head fitting for cargo block and span rope	17	Shackle	29	Slewing guy rope
6	Derrick head slewing guy fitting	18	Lower cargo clock (or lower cargo purchase block)	30	Lower slewing guy block
7	Derrick heel fitting	19	Link eyeplate	31	Upper slewing guy block
8	Gooseneck	20	Bow shackle (or cargo shackle)	32	Becket

9	Derrick heel cargo lead block bearing	21	Cargo tackle	33	Slewing guy pendants (or vang pendants)
10	Span trunnion	22	Indirectly powered topping winch (not used under load)	34	Thimble (solid thimble)
11	Cargo winch	23	Messenger rope (or topping winch driving rope)	35	Deck eyeplates
12	Cargo runner (or cargo rope, or hoisting rope, or lifting rope, or cargo fall)	24	Fixed (or standing) span rope	36	Slewing guy tackles (or vang tackles)

Figure 4 : Twin span tackle derrick for heavy loads

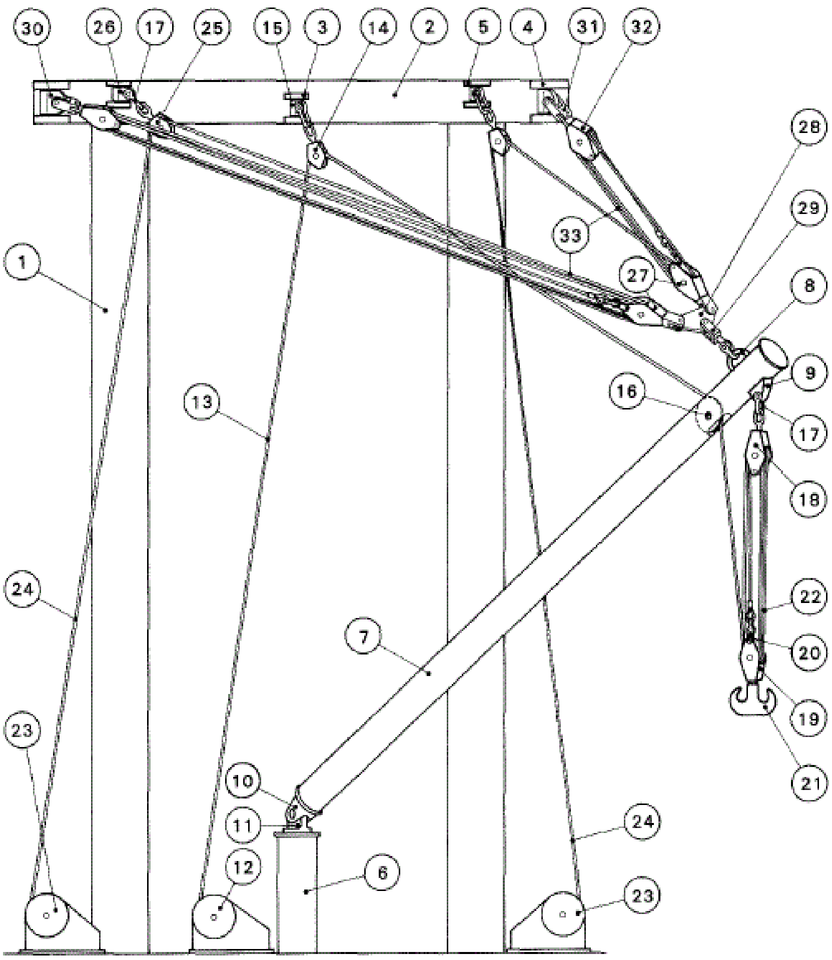


Table 4 : Twin span tackle derrick for heavy loads

1	Portal mast (or portal derrick post)	12	Cargo winch	23	Span winches (used also for slewing motions)
2	Cross tree (or upper transverse beam	13	Cargo runner (or cargo rope, or hoisting rope, or lifting rope, or cargo fall)	24	Span ropes
3	Mast head cargo lead block bearing bracket	14	Mast head cargo lead block	25	Mast head span lead block
4	Mast head span bearing bracket	15	Cargo lead block trunnion	26	Span lead block trunnion
5	Mast head span lead block bearing bracket	16	Derrick head built-in sheave	27	Derrick head span (purchase) block (or lower span (purchase) block)
6	King post	17	Shackles	28	Span triangle plate
7	Heavy derrick boom	18	Upper cargo (purchase) block (or derrick head cargo (purchase) block)	29	Swivel

8	Derrick head span fitting	19	Lower cargo block (or lower cargo purchase block)	30	Span block trunnion
9	Derrick head cargo fitting	20	Becket	31	Double connecting fork
10	Derrick heel fitting	21	Ramshorn hook	32	Mast head span (purchase) block (or upper span (purchase) block)
11	Gooseneck trunnion	22	Cargo tackle	33	Span/slewing tackles

Figure 5 : Union purchase rig arrangement

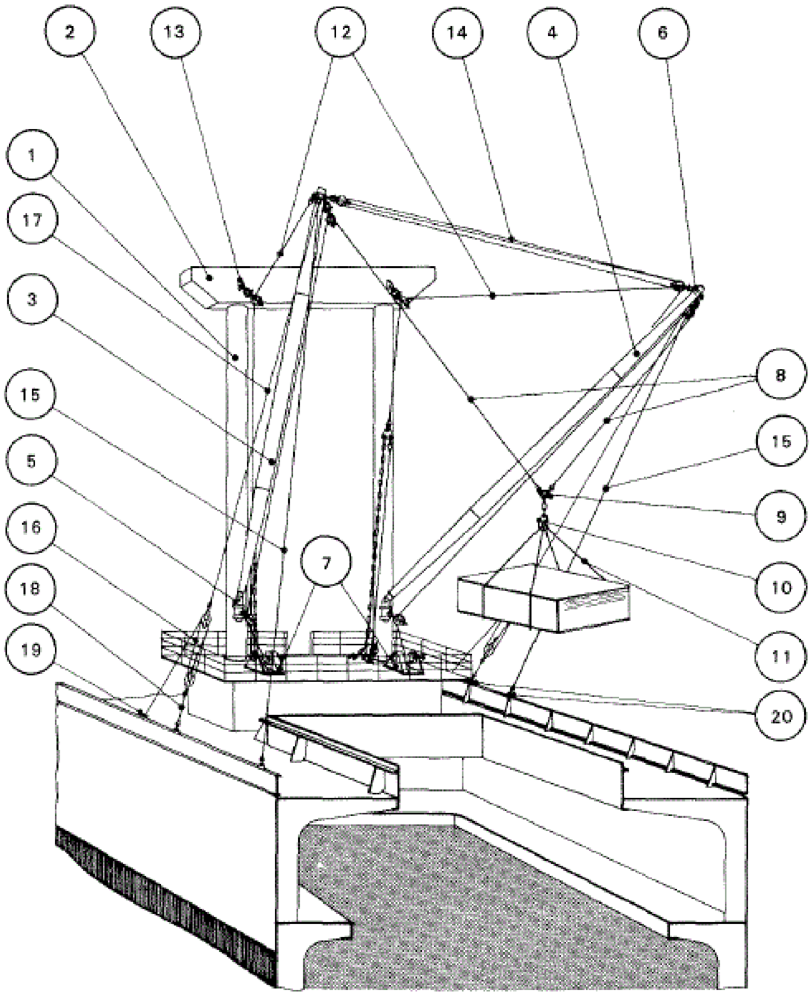


Table 5 : Union purchase rig arrangement

1	Portal mast (or portal derrick post)	8	Cargo runners (or married falls)	15	Preventer (or standing) guys
2	Cross tree (or upper transverse beam	9	Cargo triangle plate	16	Slewing guy tackles (or vang tackles)
3	Derrick boom positioned over the hatch (inboard boom)	10	Cargo hook	17	Upper slewing guy pendants
4	Derrick boom positioned outside the ship (outboard boom)	11	Slings	18	Lower slewing guy pendants
5	Derrick heel gooseneck fitting	12	Fixed (or standing) span ropes	19	Belaying (or horn) cleat
6	Derrick head fitting	13	Mast head span fitting	20	Deck eyeplates
7	Cargo winches	14	Schooner guy tackle (or boom head guy tackle)		

Section 2 Documentation to be Submitted

1 General

1.1 Application

1.1.1 When requested according to certification or classification as per Sec 1, the drawings and documents listed in Article [3] are to be submitted, unless otherwise specified.

1.1.2 Drawings are to include all the data necessary for their understanding, verification and approval.

1.1.3 The Society reserves the right to request the submission of additional documents in the case of non-conventional design or if it is deemed necessary for the evaluation of the system, equipment or components.

2 Lifting platforms

2.1 General

2.1.1 The documents to be submitted for lifting platforms are defined in Ch 4, Sec 1, [1.2].

3 Other lifting appliances

3.1 General

3.1.1 The following drawings and documents are to be submitted for approval:

a) Load charts showing the operating limitations due to outreach and wind speeds.

b) Rigging drawings showing clearly the reeving of the ropes and the number of parts in purchase tackles.

   All the items of loose gear are to be marked and numbered on these drawings. The type of the blocks used (blocks with plain bearings or roller-bearings) is to be specified.

c) Drawings of structural parts of lifting appliances: structure carrying the luffing tackle and the hinged pin of the jib, jib structure, structure of crane post.

   The scantlings and the steel grade of the connecting bolts with the crane post are to be specified.

   Upon special request, a general approval of standardized production may be granted by the Society to the Manufacturer.

   The material specifications are to be shown on construction drawings.

d) List of steel wire and fibre ropes giving construction type, nominal diameter, minimum breaking load and the reference standard.

   The metal cross-sectional area of the wire ropes used for shrouds and stays is also to be specified.

e) List of all items of loose gear, marked in accordance with the drawings requested in item b) specifying the SWL and the test load of each item.

   The construction drawings of items of loose gear as per Sec 1, [6.2.5] and of the other stationary or movable accessories for which no separate test is asked are not required if their scantlings comply with national or international standards, or with approved specifications. In such a case, the standards used are to be specified and the corresponding elements are to be designated according to these standards with mention of steel grade. Upon special request, a general approval of the standards of the Manufacturers may be granted by the Society. The drawings showing specially designed elements are to be submitted for approval in each case.

f) Description of the electrical installations and hydraulic systems as listed in Ch 2, Sec 7, [1.3].

g) Description of safety devices (limit switches, overload cut-out devices, alarms, etc.).

3.1.2 The following drawings and documents are to be submitted for information:

a) General sketch of the ship localizing the lifting appliances and showing the working areas of each of them.

b) Description of the loads and their distribution in each structural elements of the lifting appliance. The maximum forces determined in the various elements are to be described schematically for each lifting appliance on a sketch regarded as the force diagram.

   The force diagrams mentioned above are clearly to show the maximum forces applied to all the loose gear items.

c) All relevant calculations of the structural parts of lifting appliances. When calculations have been computed, they are to be supplied both with computer data and with sufficient explanations to allow to check the calculation process.

3.2 Derrick systems

3.2.1 In addition to the requirements of [3.1], the following drawings, documents and information are to be submitted:

- in addition to [3.1.1], item b), the minimum topping angle of the derrick booms is to be mentioned on forces diagrams for approval
- in addition to [3.1.1], item c), the following drawings are to be submitted for approval:
  - Construction drawings of the masts (derrick posts) giving every detail needed to check their scantlings.

    For complicated type structures, relevant computerized calculations may be required.
  - Construction drawings of the derrick booms.
  - Drawings of structural parts of structure carrying the luffing tackle and the hinged pin of the boom, boom structure, structure of mast.

3.3 Winches

3.3.1 Specifications of winches

Construction drawings of winches are not required when standardized production is concerned, provided references of use in service are supplied to the Society satisfaction.

When prototype is concerned, a technical file is to be submitted for information. This file is to include a detailed technical specification, an operating manual, a general drawing, the constructional drawings of the main items and complete calculations of the Manufacturer. The test program contemplated is to be submitted for approval.

CHAPTER 2
DESIGN REQUIREMENTS

Section 1 General

1 General arrangement

1.1 Means of access

1.1.1 All lifting appliances and equipment are to be provided with means of access.

1.1.2 Vertical and slightly sloped ladders (angle of slope with the vertical < 15°) may be provided with single rungs 25 mm minimum in diameter (circular section rungs) or 22 x 22 mm^2 minimum in section (square section rungs).

Vertical ladders over 3 m in height are to be provided with guard hoops.

1.1.3 Ladders whose angle of slope with the vertical exceeds 15° are to be fitted either with steps or with pairs of rungs, the clear gap of twin rungs being 5 cm maximum.

Such ladders are to be provided with suitable hand-rails.

1.1.4 Ladder uprights are to extend 1 m at least above landing platform.

1.1.5 Catwalks and landings are to be fitted with guard-rails 1 m in height minimum and manrope at mid-height.

1.1.6 Access ladders and catwalks are to be firmly secured at sufficiently close intervals.

1.1.7 Handrails are to resist to a load of 75 kg at mid span.

1.1.8 Handrails, for lifting appliances intended for use in offshore conditions are to be fitted with 2 intermediate rails.

The height of the foot plate is to be not less than 150 mm.

1.1.9 A free distance of at least 0,60 m is to be left between lifting appliances and surrounding buildings of the supporting unit or installation, when they move or rotate.

In the cases when this last provision cannot be complied with, access to these open spaces is to be prevented.

1.1.10 Means of access which are not entirely in accordance with the requirements of this Section may be accepted subject to special examination by the Society.

1.2 Means of escape

1.2.1 Crane operator’s cabins are to be provided with emergency escape and their structure are to be fire resistant.

2 Materials

2.1 General

2.1.1 The requirements of this Article are based, in general, on a design temperature not less than -10°C. Specific requirements for design temperatures below -10ºC and down to -40ºC are given in [2.2.4] for steel plates and sections, [2.4.4] for steel forgings and [2.5.5] for steel castings. Other cases are to be subject to special consideration of the Society.

2.1.2 The materials used to manufacture the fixed parts of the lifting appliances, and their connections with the ship/offshore unit structure (crane posts, masts, seatings, etc.), as well as those used locally to reinforce this structure, are to comply with the requirements of NR216.

However, the use of materials complying with international or national standards and the characteristics of which are similar to those required by NR216 may be accepted by the Society on a case by case basis.

2.1.3 The use of steel with very high mechanical characteristics is to be examined by the Society on a case by case basis.

In such a case, a detailed technical specification stating the manufacturing process, mechanical and chemical properties, forming and welding recommendations and the heat treatment requirements are to be submitted to the Society.

2.1.4 Materials used for manufacturing primary elements of high capacity lifting appliances such as heavy derrick booms, jibs and main load carrying structures of cranes and gantry-cranes, lifting beams, are to comply with NR216.

However the materials used for manufacturing elements other than those as per [2.1.2] may be chosen according to international or national standards or to approved specifications. The selection of materials is to be submitted to the Society for acceptance.

2.1.5 No component part of a lifting appliance and no accessory is to be manufactured in wrought iron.

2.1.6 The use of non-ferrous or synthetic materials is to be especially considered by the Society.

2.2 Steel plates and sections

2.2.1 Steel plates and sections used to manufacture structural components of lifting appliances covered by the present Rule Note are normally in steel grades as defined in NR216. Their specified minimum yield stress is as follows:

- 235 N/mm² for ordinary hull steel grades A, B, D or E
- 315 N/mm² for high tensile steel grades AH32, DH32 or EH32
- 355 N/mm² for high tensile steel grades AH36, DH36 or EH36
- 390 N/mm² for high tensile steel grades AH40, DH40 or EH40.

The above values are valid for thicknesses up to 100 mm.

Higher strength steels may be considered on case-by-case basis subject to Society approval.

2.2.2 The steel grades to be used for manufacturing structural elements as per [2.2.1] (plate welded structures or tubes made out of welded rolled up plates) are defined in Tab 1 according to the plate thicknesses.

Table 1 : Steel grades for plates

Plate thickness t, in mm	Hull steel grade
t ≤ 20	A or AH
20 < t ≤ 25	B or AH
25 < t ≤ 40	D or DH
40 < t	E or EH

2.2.3 As a rule, the requirements in [2.2.2] are applicable to sections (angle bars, flat bars, etc.) which form the load carrying structures and to those used to stiffen plates when they contribute to the general structural strength.

2.2.4 For cranes having a design temperature below -10°C and down to -40°C the steel grades are to be selected as a function of the design temperature and of the structural element thickness.

The required selection criteria for normal and higher strength steels with a minimum specified yield strength less than 420 N/mm² are provided in Fig 1.

The required selection criteria for extra high strength steels with a minimum specified yield strength within the range of 420 N/mm² to 690 N/mm2 as defined in NR216, Ch 3, Sec 5, are provided in Fig 2.

The Charpy V-notch impact requirements for rolled products in normal and higher strength steels are given in NR216, Ch 3, Sec 2.

The Charpy V-notch impact requirements for rolled products in extra high strength steels are given in NR216, Ch 3, Sec 5.

Figure 1 : Steel selection for normal and higher strength steels subject to a design temperature within the range of -10°C to -40°C

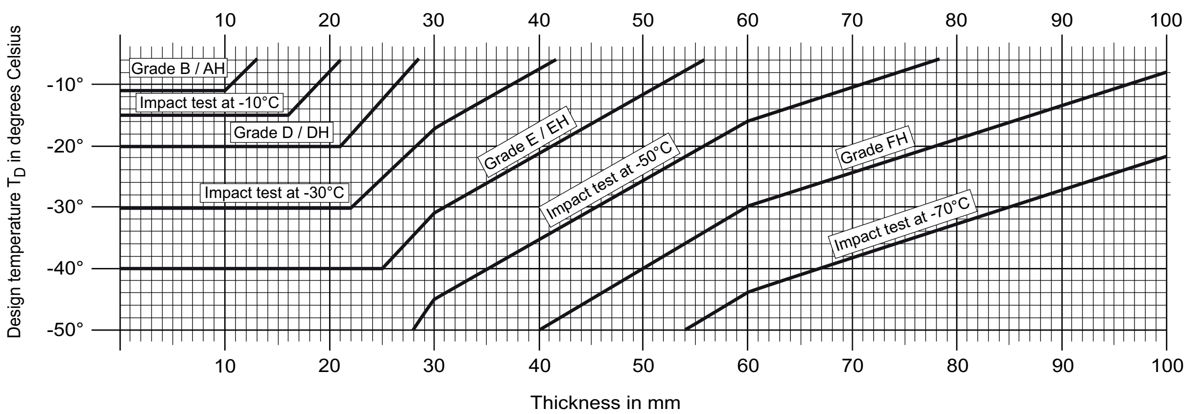
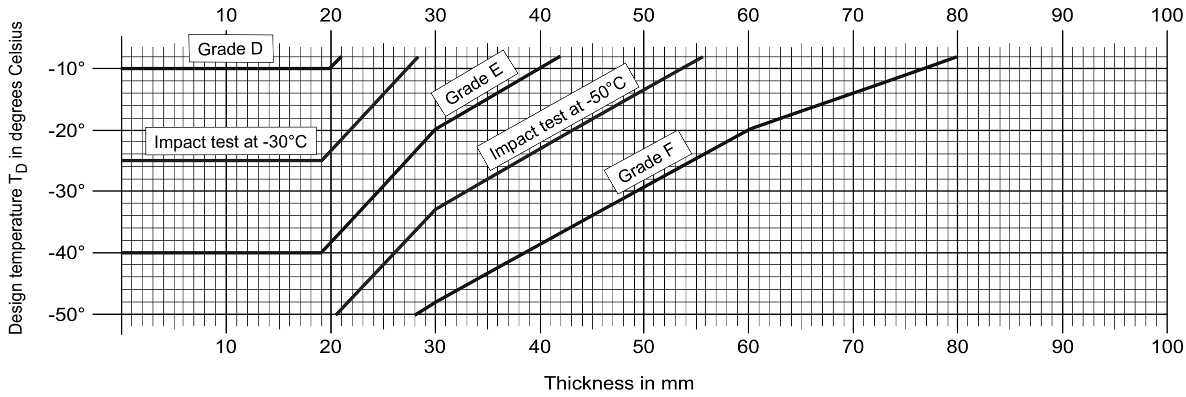


Figure 2 : Steel selection for extra high strength steels subject to a design temperature within the range of -10°C to -40°C



2.2.5 The specifications of the materials used are to be shown on the construction drawings submitted for approval. Failing this, the steel used would be supposed to be normal strength hull steel grade A, as defined in NR216.

2.2.6 When plates of thickness t are cold formed, the folding radius r is not to be, as a rule, lower than the following value:

- when ordinary hull steel is concerned:

  r = 2,5 t

- when high tensile steel is concerned:

  r = 3,0 t

2.2.7 When plates are highly stressed in the through thickness direction, the Society may require the use of grade Z quality complying with NR216, Chapter 3 in order to minimize the risk of lamellar tearing.

2.3 Welding

2.3.1 The selection of materials in welded construction takes into account:

- the degree of importance in the whole structure of the considered element
- the design temperature of the element
- the thickness of the element
- the stress relieving treatment performed after welding.

2.3.2 Hull steel grades to be used for structural part supporting the appliance and welded to the ship structure are to be selected in accordance with the Rules for Steel Ships or the Rules for Offshore Units as relevant.

2.3.3 The structure is usually to be considered as not being stress relieved.

2.4 Steel forgings

2.4.1 The provisions of NR216, Chapter 5 apply to steel forgings.

2.4.2 The minimum specified values for tensile strength and yield stress are to be indicated on the drawings submitted for approval. Other characteristics are to comply with the requirements of NR216, Chapter 5.

2.4.3 The chemical composition and especially the carbon content of the forged parts intended to form a welded assembly are especially defined in NR216, Chapter 5.

2.4.4 For cranes having a design temperature below -10°C and down to -40°C the grades of steel forging are to be selected as a function of the design temperature and of the structural element thickness as required in Fig 1 and Fig 2.

2.5 Steel castings

2.5.1 The provisions of NR216, Chapter 6 apply to steel castings.

2.5.2 The minimum specified values for tensile strength and yield stress are to be specified on the drawings submitted for approval. Other characteristics are to comply with the requirements of NR216, Chapter 6.

2.5.3 The chemical composition and especially the carbon content of the steel castings intended to form a welded assembly are especially defined in NR216, Chapter 6.

2.5.4 Highly stressed steel castings are to be submitted to appropriate non-destructive examination.

2.5.5 For cranes having a design temperature below -10°C and down to -40°C the grades of casting steels are to be selected as a function of the design temperature and of the structural element thickness as required in Fig 1 and Fig 2.

2.6 Iron castings

2.6.1 The provisions of NR216, Chapter 7 apply to iron castings, considering the particulars of [2.6.2] to [2.6.4].

2.6.2 As a rule, the use of grey iron, malleable iron or spheroidal graphite cast iron with either combined ferritic/perlitic structure or perlitic structure is allowed only for the manufacturing of block sheaves or low stressed elements of secondary importance.

2.6.3 The use of spheroidal graphite cast iron (SG iron) instead of cast steel may be accepted by the Society, provided that:

- concerned part is not intended to be part of a welded assembly
- requirements of NR216 for SG irons are complied with
- tensile properties are specified on the drawing submitted for approval.

2.6.4 As a rule, welding is forbidden on iron castings, even for repair of casting defects.

2.7 Bolting

2.7.1 When standardized bolts are used for load carrying connections in the manufacturing of lifting appliances, the screws and nuts are to be of the steel quality grades defined in Tab 2 in accordance with the requirements of the ISO 898-1:2013. For the screws, this table specifies also the tensile strength R and the minimum yield stress R_e which are to be taken into account in strength calculations.

2.7.2 In a bolt (screw + nut), the quality grade mark of the nut is to be the one corresponding to the first figure of the designation symbol of the quality grade mark of the screw, assuming the nut is of normal height (0,8 times the nominal diameter of the screw).

2.7.3 The designation symbol of the steel quality grade mark is to be indicated on each screw and nut used.

2.7.4 For assemblies with prestressed high strength bolts, the quality grade marks of the screws are to be 8.8 or 10.9 and the quality grade marks of the nuts 8 or 10 respectively. The quality of the washers are to be appropriate to the quality grade marks of the screws and nuts.

Screw threading is to be obtained by rolling, exclusive of any other process.

An attestation for conformity of the bolts and screws with recognized national or international standards may be required.

Note 1: Applications for use of bolts with screws of 12.9 quality grade mark will be subject to special consideration.

3 Structural arrangement

3.1 General

3.1.1 As a rule, the crane structures are to be strengthened locally by means of additional stiffeners, transverse web plates, connecting brackets or by local increase in thickness in way of the concentrated applied forces and at places subjected to concentrated stresses due to discontinuity in shape.

3.1.2 As far as possible, strength continuity of the structural parts subjected to tensile stresses is to be ensured by continuous plates or by butt welding. Strength continuity of such structures by means of fillet welds on transverse plate is to be avoided. Use of Z quality plate is recommended for such transverse plate (see [2.2.7]).

In accordance with the above, the crane pedestal structures are to be continuous through the uppermost attachment deck, unless otherwise accepted by the Society.

3.1.3 Drain holes or other draining arrangements are to be provided in the structural parts where sea water or rain may stagnate.

All the structural parts are to be designed to allow inspections and are to be accessible for painting except when small dimensions make it impossible. In the latter case, closed and watertight constructions are to be provided.

3.2 Secondary structure

3.2.1 Secondary structures (cabins, access, etc.) are to be designed in order to:

- resist climatic and live loads to which they are submitted
- bear control and safety devices needed for functioning of the appliance
- ensure protection and safety of personnel.

Table 2 : Steel quality grade marks for screws and nuts

Quality grade marks for screws	6.8	8.8	10.9	12.9
Tensile strength of screws, in N/mm^2	600	800	1 000	1 200
Yield stress (minimum) of the screws, in N/mm^2	480	640	940	1 080
Quality grade marks for nuts	6	8	10	12
Note 1: Alternatively, other steel quality grades defined by national standards may be accepted.				

3.2.2 The structure of the appliance is to be such that in case of accident, the operator remains safe and can use a safe escape.

3.2.3 Finally, it is emphasized that escape routes are to be designed according to the general scheme of the escape routes of the supporting unit or installation.

3.2.4 Operator's cabins are to be of metal and substantial design.

3.2.5 Dangerous parts of the appliance (running gear, open wire conductors, etc.) are to be efficiently guarded.

3.3 Minimum thickness

3.3.1 Thickness of crane pedestals is to be not less than that defined in Tab 3 with respect to the SWL of the crane.

3.3.2 Thickness of the welded components of the load carrying structural parts of the cranes is to be not less than 6 mm.

When tubular profiles (extruded) are concerned, tube thickness is to be not less than 4 mm.

Table 3 : Minimum thickness of crane pedestals

SWL, in t	Minimum thickness t_{min}, in mm
SWL ≤ 1	6,0
1 < SWL < 5	3/8 (SWL + 15)
SWL ≥ 5	7,5

3.4 Diameter/thickness ratio for crane pedestals of circular cross-section

3.4.1 For crane pedestals of circular cross-section, D/t ratio between the external diameter D, in mm, and the thickness t, in mm, of each considered cross-section is not to exceed either 150 nor the value given in Tab 4 according to the SWL of the crane and the design yield stress R_e, in N/mm^2, of the crane pedestal as defined in Sec 3, [2.3.3].

3.4.2 For structural elements of circular cross-section (exclusive of crane pedestals), D/t ratio is not to exceed 2/3 of the value required in [3.4.1].

3.4.3 When the maximum combined stress σ_{cb}, defined by the strength criteria is lower than the allowable stress ηR_e as per Sec 3, [2.3], D/t ratio from Tab 4 may be increased in ratio:

$$\frac{\eta R_e}{\sigma_{cb}}$$

η : Safety factor, as defined in Sec 3, [2.3.2]

R_e : Design yield stress, in N/mm^2, as defined in Sec 3, [2.3.3]

σ_{cb} : Normal combined stress, in N/mm^2, as defined in Sec 3, [2.3.1]

Table 4 : Crane pedestals of circular cross-section: D/t ratio

SWL, in t	D/t ratio
SWL ≤ 5	$\frac{23500}{R_e}$
5 < SWL < 160	$\frac{47000 SWL}{R_e(SWL + 5)}$
SWL ≥ 160	$\frac{45600}{R_e}$

3.5 Width/thickness ratio of plane walls

3.5.1 Ratio b/t between the width b, in mm, of an unstiffened plane wall (or spacing between the stiffeners of this wall) and its thickness t, in mm, is to be not greater than:

$$\frac{b}{t} \le \frac{720}{\sqrt{R_e}}$$

3.5.2 When the maximum combined stress σ_{cb} is lower than the allowable stress η R_e (see Sec 3, [2.3]), the b/t ratio may be taken equal to the following maximum value:

$$\frac{b}{t} \le \frac{900}{\sqrt{R_e}}\sqrt{\frac{\eta R_e}{\sigma_{cb}}} \quad \text{when } \sigma_{cb} \le 0,63\eta R_e$$

$$\frac{b}{t} \le \frac{1610}{\sqrt{R_e}}\sqrt{1 - 0,8\frac{\sigma_{cb}}{\eta R_e}} \quad \text{when } \sigma_{cb} > 0,63\eta R_e$$

Ratio b/t is not to exceed 100.

3.5.3 If the requirements as per [3.5.1] to [3.5.2] do not entirely comply with the strength of plates and associated stiffeners, local buckling is to be justified by calculations, to the satisfaction of the Society (see Sec 3, [2.5]).

3.6 Local scantlings of attachment decks

3.6.1 As a rule, the local thickness, in mm, of the decks on which the pedestal is attached is to be not less than:

$$1,2E\frac{235}{\sqrt{R_{e(d)}}}$$

where:

E : Local spacing, in m, of the deck stiffeners

$R_{e(d)}$: Specified minimum yield stress, in N/mm², of the deck plate steel.

3.6.2 In addition, for crane pedestals of circular cross-section, the local thickness, in mm, of the upper and lower attachment decks is to be not less than the greatest of the two values t_2 and t_3:

$$t_2 = 0,8\,t\frac{D}{H'}\frac{R_{e(c)}}{R_{e(d)}}$$

$$t_3 = 0,5\,t$$

where:

t, D : Thickness, in mm, and external diameter, in m, respectively, of the pedestal at the uppermost deck level

$R_{e(c)}$, $R_{e(d)}$: Specified minimum values of the yield stress, in N/mm², of, respectively, the pedestal plate and the deck plate

H' : Clear height, in m, between the two attachment decks.

The value of t_2 is given assuming that the crane is attached in the middle of a deck area. If the crane is attached to a free edge of deck or connected to it by large brackets, the value of t_2 as obtained here-above is to be multiplied by two.

If the crane is fixed to a strip of deck of length ℓ_d, in m, both sides of which are free and at a distance d, in m, from the farthermost end of this strip of deck, the value t_2 is to be multiplied by $2d/\ell_d$ ratio.

3.6.3 In some cases, checking of the scantlings of the attachment decks by direct calculations may be required, considering the provisions of Sec 3, [4.2].

3.6.4 When the thickness of the attachment decks is not sufficient to meet the requirements given in [3.6.1] to [3.6.3], a thick plate is to be inserted in the deck plating. The dimensions of this inserted plate are not to be lower than twice the dimensions of the cross-section of the crane pedestal. As a rule, use of doubling plates is not permitted.

3.6.5 In addition to the provisions as per [3.6.1] to [3.6.4] and with respect to the longitudinal strength of the ship and to the local stress concentrations, the Society may require local increase of deck thickness and/or fitting of a diaphragm plate inside the crane pedestal where the latter is passing through the deck.

Section 2 Design Loads and Loading Cases

1 Data

1.1 General

1.1.1 Scantlings of shipboard lifting appliances are to be calculated taking into account the static and dynamic loads applied under contemplated operating conditions.

1.1.2 Strength calculations of the various components of cranes are to be made under operating conditions taking into account the forces due to:

- SWL as per Ch 1, Sec 1, [6.2.12] increased by the dead weight of the lower purchase block and permanent attachments provided to hook loads (hook, shackle, permanent lifting beam, spreader or similar lifting aid, etc.)
- dead weight of crane structure and accessories
- ship's static list and trim
- dynamic amplification factor due to operating conditions
- vertical dynamic effect due to hoisting of load (the effects of vertical accelerations due to lifting motions and the effects of vertical oscillations due to snatch and putting down of load are assumed to be included in the vertical dynamic effect)
- in addition to the above, and depending on the type of appliance, other significant effects are to be taken into account (for example, horizontal tangential acceleration due to slewing motion). Radial (centrifugal) acceleration due to slewing motion may be disregarded in case of slewing crane.

1.1.3 Operating conditions and main characteristics of cranes are to be specified, in particular:

- duty category depending on kind and rate of service contemplated
- SWL or diagram of lifting capacity according to jib radius
- maximum permissible list and trim angles
- dead weight of crane component parts and position of respective centres of gravity, in particular weight of lower purchase block and hook, weight of crane jib and weight distribution over jib length, weight of counterbalance, if applicable, and total weight of crane
- hoisting speed
- horizontal tangential acceleration at jib head with crane at maximum radius due to slewing motion, or, alternatively, angular slewing speed and minimum braking time
- maximum wind speed authorized during operation
- type of block sheaves (sheaves with plain or roller bearings)
- dynamic amplification factor.

1.1.4 Efficiency of sheaves and tackles is to be taken into account as specified in App 2, [1.2] and App 2, [1.3] to determine the maximum forces in hoisting and topping ropes.

1.2 Duty category

1.2.1 General

The nature and the intensity of intended crane duty are taken into account by increasing the design loads considered in calculations (excluding wind loads) and also by providing minimum block sheaves diameter.

Depending on the nature of their duty and the rate of operation, the lifting appliances are divided into four duty categories:

- category I: appliances very seldom used at their nominal capacity
- category II: appliances regularly used for loading and unloading cargoes and frequently operated at less than 75% of their nominal capacity.
- category III: appliances extensively used for loads approaching their maximum capacity.
- category IV: appliances used for heavy duty with loads approaching their maximum capacity or for special lifting operations.

Examples of duty categories and associated duty coefficients for harbour lifting and offshore lifting are given for guidance in [1.2.2] and [1.2.3].

When the lifting appliance is granted with several categories of duty, the category of duty associated to a particular hook is defined according to the type of service of this particular hook.

1.2.2 Duty categories and coefficients for harbour lifting

Examples of duty categories for harbour lifting are provided in the following list:

- category I: cranes intended for the handling of spare parts, stores or equipment.
- category II: multi-purpose cranes, appliances intended for the handling of flexible hoses onboard oil tankers or of discharging equipment onboard gas carriers or onboard ships carrying dangerous chemicals.
- category III: appliances intended for the handling of containers when their lifting capacity is approximately that of the weight of containers handled.
- category IV: grab appliances used for handling of loose or granulated products.

The associated duty coefficients Ψ_0 are given in Tab 1.

Table 1 : Coefficient ψ_0 (harbour)

Duty categories	ψ_0
I	1,00
II	1,03
III	1,06
IV	1,20

1.2.3 Duty categories and coefficients for offshore lifting

Examples of duty categories for offshore lifting are provided in the following list:

- category I: gantries handling Blow Out Preventers (BOP).
- category II: main cranes of offshore work units, main and auxiliary hooks.
- category III: whip hook, supply cranes on fixed or mobile platforms.
- category IV: grab appliances.

The associated duty coefficient Ψ_0 is given in Tab 2.

Table 2 : Coefficient ψ_0 (offshore)

Category of duty	ψ_0
I	1,00
II	1,06
III	1,12
IV	1,20

1.3 Dead weights

1.3.1 Manufacturers are to state the dead-weights which are to be considered in the calculations.

1.3.2 For usual low capacity lifting appliances, the weight of the cargo tackle may be disregarded to determine the maximum tension in the cargo runner.

1.4 Secondary structure

1.4.1 Secondary structure (cabins, decks) are to sustain the dead loads, live loads and climatic effects.

Dead loads and live loads are given under the responsibility of the designer.

The operating load on decks or platforms is not to be taken less than 400 kg/m^2.

Environmental conditions to be considered are the same as those considered for main structures.

2 Influence of self motions

2.1 General

2.1.1 Influence of appliances self motion is described by means of Ψ coefficients:

- Ψ_G factors express the effects on dead weights of acceleration/decelerations due to motions, such as revolving and luffing for cranes or sudden start/stop with bumping for travelling gantries
- Ψ_C factors express in particular acceleration/deceleration effects of functional motions of hoisted load.

2.1.2 For cranes, Ψ_{GX}, Ψ_{GY}, Ψ_{GZ}, Ψ_{CX}, Ψ_{CY} and Ψ_{CZ} may be evaluated as indicated in [2.2] and [2.1.3].

2.1.3 Influence of hoisting motion

- Besides, Ψ_{CZ} may be evaluated as follows:

  $\Psi_{CZ} = 1 + 0,3\ a\ V$

  where:

  a : For structures supported by ropes or hydraulic jacks (cranes):

  a = 1

  For rigid structures (gantries or overhead travelling cranes):

  a = 2

  V : Maximum hoisting speed of service load, in m/s, which is to be taken for calculation purposes neither greater than 1,0 nor less than:

  - when a = 1:

    V = 0,50 when SWL ≤ 50 t

    $V = \frac{SWL + 100}{6SWL}$ when 50 t < SWL < 100 t

    V = 0,333 when SWL ≥ 100 t

  - when a = 2:

    V = 0,25

- $\Psi_{GZ} = 1$

Note 1: Maximum hoisting speed of service load V will be specially considered for heavy lift cranes (i.e. cranes with SWL equal to or greater than 160t)

2.2 Influence of slewing motion of cranes

2.2.1 The effect of horizontal tangential accelerations due to slewing (starting and braking), on service loads and crane jib are to be considered.

2.2.2 If acceleration γ_0, in m/s², at the jib head is unknown, the following value is to be applied:

$$\gamma_0 = \frac{2\pi}{60}\frac{N x_0}{t}$$

where:

x_0 : Maximum radius, in m, of the crane (see Fig 1)

N : Maximum slewing speed, in r/min, at maximum radius x_0

t : Braking time, in s, of slewing motion when the crane withstands the SWL corresponding to radius x_0.

Acceleration γ_{Gi} affecting jib dead weight may be determined as follows:

$$\gamma_{Gi} = \gamma_0 \frac{x_i}{x_0}$$

where x_i is the distance, in m, between the centre of gravity of the dead weight of item no.i and the vertical crane axis (see Fig 1).

Note 1: In case the braking time t is not available, γ_0 is to be taken as 0,6 m/s² with the jib at maximum radius.

2.2.3 The horizontal tangential and radial accelerations effect on crane's jib and SWL may be taken into account by considering the following dynamic coefficients:

$$\Psi_{GXi} = \frac{\pi^2 N^2}{30^2} x_i 10^{-1}$$

$$\Psi_{GYi} = \frac{1}{g}\gamma_{Gi}$$

$$\Psi_{CX} = \Psi_{GX0}$$

$$\Psi_{CY} = \frac{1}{g}\gamma_0$$

3 Influence of external conditions

3.1 General

3.1.1 Influence of external operation conditions is described by mean of α coefficients:

- α_G factors express the effects on dead weights of accelerations due to ship motion and accelerations in contemplated environment/sea state
- α_C factors express in particular influence of environmental conditions on hoisted load.

3.1.2 α_{CX} , α_{CY} on the one hand and α_{GX} , α_{GY} , α_{GZ} on the other hand may be calculated as per [3.4] on the basis of:

- $\lambda = \sqrt{\ell^2 + \theta^2}$

  where ℓ and θ are respectively static list and trim angles as per [3.2]
- α_{CZ} coefficient (see [3.3]).

3.2 List and trim

3.2.1 Lifting appliances are to be designed to operate safely in the following possible conditions, as a minimum, for harbour operations:

- trim $\theta = \pm 2°$
- list $\ell = \pm 5°$

whatever the position of the load.

3.2.2 Values different from those defined for list and trim angles may possibly be accepted by the Society provided that special arrangements are made to ensure that they are not exceeded in operation and provided suitable instructions are attached to the ship's Register of Lifting Appliances and Cargo Handling Gear.

3.3 Vertical dynamic amplification factors

3.3.1 For shipboard cranes performing in harbour conditions, the vertical dynamic amplification factor, α_{cz}, is to be taken equal to 1.

Factor α_{GZ} may be evaluated as:

$\alpha_{GZ} = 0,55 + 0,45\ \alpha_{CZ}$

3.4 Horizontal dynamic amplification factors

3.4.1 Factors α_{CX} and α_{CY} may be evaluated as the maximum value of:

$\alpha_{1CX} = \sin(\lambda)\ (0,75 + 0,25\ \alpha_{CZ})$

$\alpha_{2CX} = \sin(\lambda) + 0,30\ (\alpha_{CZ} - 1)$

$\alpha_{1CY} = \sin(\lambda)\ (0,75 + 0,25\ \alpha_{CZ})$

$\alpha_{2CY} = \sin(\lambda) + 0,30\ (\alpha_{CZ} - 1)$

whatever the position of the load.

For normal operating conditions and for a preliminary design, α_{GX} and α_{GY} may be evaluated as:

$\alpha_{GX} = \sin(\lambda) + 0,15\ (\alpha_{CZ} - 1)$

$\alpha_{GY} = \sin(\lambda) + 0,15\ (\alpha_{CZ} - 1)$

4 Loading cases

4.1 General

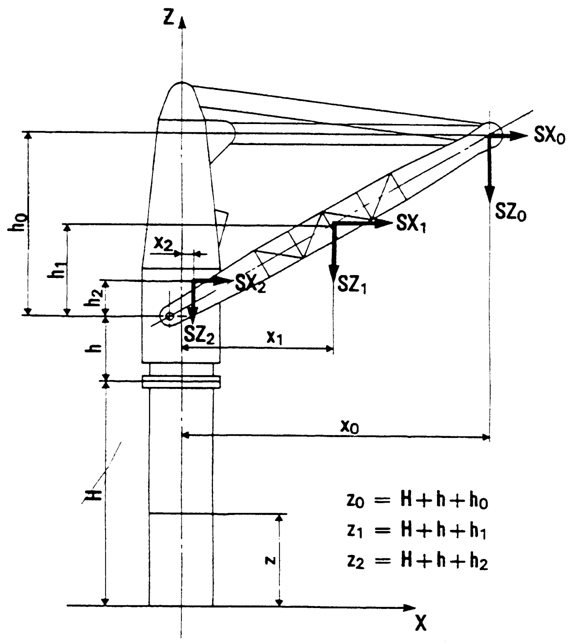
4.1.1 Directions of loads to be considered are defined in relation to a system of orthogonal axes (X, Y, Z) related to the lifting appliance axes X and Z defining longitudinal vertical plane.

For cranes, for example, axes X and Z define a vertical plane where jib axis is included as per Fig 1.

4.1.2 Types of loading to be considered:

- Type SX: forces acting along X axis
- Type SY: forces acting along Y axis
- Type SZ: forces acting along Z axis
- Type SV: forces due to maximum permissible wind (may be evaluated as per App 1).

Figure 1 : Main dimensions, loads and axes



4.1.3 The global loads without considering the wind effect are stated as following:

- On hoisting point
  - vertical load SZ_0, in kN:

    $SZ_0 = \alpha_{CZ}\ \Psi_{CZ}\ (F + G_0)$ along Z
  - horizontal loads SX_0 and SY_0, in kN:

    $SX_0 = [\alpha_{CX} + \Psi_{CX} + (\Psi_{CZ} - 1)\ \sin\lambda](F + G_0)$ along X

    $SY_0 = [\alpha_{CY} + \Psi_{CY} + (\Psi_{CZ} - 1)\ \sin\lambda](F + G_0)$ along Y
- On dead weight of item no.i
  - vertical load SZ_i, in kN:

    $SZ_i = \alpha_{GZ}\ \Psi_{GZ}\ G_i$ along Z
  - horizontal loads SX_i and SY_i, in kN:

    $SX_i = (\alpha_{GX} + \Psi_{GXi})\ G_i$ along X

    $SY_i = (\alpha_{GY} + \Psi_{GYi})\ G_i$ along Y

where:

α_C and α_G: Dynamic amplification factors describing environmental operating conditions (see Article [3])

Ψ_C and Ψ_G: Dynamic amplification factors describing influence of appliance's self motions (see Article [2])

F : SWF corresponding to SWL, in kN

G_0 : Additional force equal to the weight of lower cargo purchase block and permanent attachments provided to hang the load, in kN (see [1.1.2])

G_i : Static dead weight of item no.i of the lifting appliance, in kN.

4.2 Loading cases

4.2.1 Scantlings of crane components are to be determined taking into account the most severe results of loading cases defined in Tab 3, under service conditions and with respect to loads as per [4.1].

4.2.2 In each loading case defined in [4.2.1], the efficiency of sheaves and tackles in the hoisting and lowering conditions is to be considered (see [1.1.4].

4.2.3 Additionally to loading cases defined in [4.2.1], calculations taking into account the maximum permissible wind in service condition are required, generally only for loading case N° II and with wind in same direction as SY type loads, that is, along Y axis.

Table 3 : Loading cases

Loading case No.	Combination of loads (see **(1)**)
I_a	ψ_0 (SZ + SX)
I_b	ψ_0 (SZ – SX)
II	ψ_0 (SZ + SY)

(1) For the direction of loads considered, in particular SX type loads, see Fig 1.

Note 1: The duty coefficient ψ_0 is not to be applied on wind loads (SV), when considered.

Section 3 Structural Assessment

1 General

1.1 Application

1.1.1 This Section provides requirements for the structural scantling of the lifting appliance.

2 Stability and strength criteria

2.1 General

2.1.1 Based on the loads and loading cases defined in Sec 2, the determination of forces and stresses applied on constituent parts of cranes is to be carried out in order to ascertain whether sufficient safety is ensured with respect to the following risks:

- functional instability of crane jib (danger of jack-knifing, i.e. risk of inopportune jib-raising)
- exceeding the yield stress of materials used
- loss of stability due to overall or local buckling of structures or local buckling of plates.

2.1.2 Structures are safe with respect to risks of excessive yielding and of overall or local buckling (see [2.1.5]) when strength criteria defined in [2.3] are complied with.

2.1.3 Structures are safe with respect to local buckling of plate panels when constructional arrangements defined in Sec 1, [3.5] are complied with.

If, exceptionally, the above arrangements are not satisfied, safety with regard to local buckling is to be checked according to the criteria defined in [2.5].

2.1.4 Strength criteria defined in the present Article are applicable only if overall tests of cranes are carried out in compliance with Ch 5, Sec 1. When more stringent testing is required by the applicable National Regulations, the scantlings are to be determined accordingly. In such case the designer has to make appropriate adaptations to the structural arrangements of Sec 1 in order to maintain construction safety.

2.1.5 Note that “buckling” refers to beams and is used to indicate the loss of elastic stability of an entire structure but it is also used to indicate the loss of elastic stability of a sub-structure or a part thereof.

For instance, the strength of a crane jib partly made of two separate lattice legs (see Fig 1) is to be checked with respect to:

a) buckling of the entire jib structure

b) individual buckling of the sub-structure consisting of one leg, taking into account additional stresses due to the buckling of the entire jib structure

c) local buckling of a constituent member of the leg, taking into consideration both the buckling of the entire jib and the buckling of the leg.

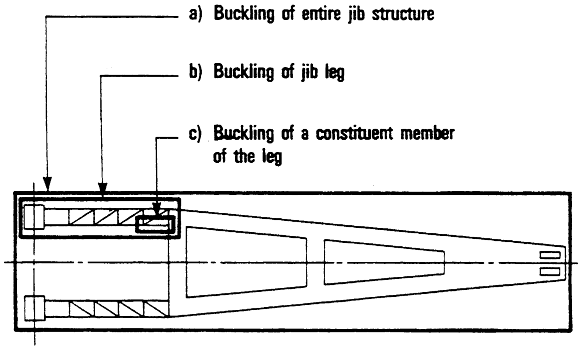
The compressive stress σ_c (to be multiplied by the buckling coefficient ω , see [2.4.3]) for the structure “a” of the entire jib is calculated on the basis of the overall compressive force applied on the jib.

The compressive stress σ_c for the structure “b” of the jib leg is calculated on the basis of the compressive force applied on the considered jib leg, determined according to the overall compressive force and bending moments applied on the jib, that is, according to the jib heel pin response to the forces applied.

The compressive stress σ_c for the constituent member “c” is calculated on the basis of the compressive force applied on this member, determined according to the compressive force and bending moments applied on the jib heel.

The described verifications are only indicated as examples and need not be performed unless they are found necessary due to the slenderness ratio of the element concerned and due to the calculated compression stresses.

Figure 1 : Verification with respect to buckling



2.2 Check of functional stability of crane jib

2.2.1 The risk of inopportune raising of the crane jib (jack-knifing) exists mainly for cranes in which the lifting rope is reeved in one or several parts of rope between the jib head and the upper part of the crane, thus relieving the luffing force required to maintain the jib in a balanced position in the vertical plane.

If there is such a danger, then verifications required in [2.2.2] or [2.2.3], as applicable, are to be made.

2.2.2 For rope supported jib cranes, it is to be checked that the tension in the luffing tackle remains positive for loading case I_b replacing loading SX_0 by loading SX'_0 so that:

$$SX'_0 = \left(1 + \frac{0,047}{\alpha_{CX}}\right) SX_0$$

Note 1: For the application of the present requirement the value of ψ_{CZ}, determined as per Sec 2, [2.1.3], is to be taken not less than:

- 1,25 when $SWL \le 20$ t
- $1 + 5 / SWL$ when $20 \text{ t} < SWL < 50$ t
- 1,10 when $SWL \ge 50$ t.

Normally, this calculation is to be made with the jib at the minimum radius (maximum topping angle) and taking into consideration the efficiency of the lifting tackle sheaves in the "hoisting" condition.

In a number of special cases, calculations may nevertheless have to be made under different conditions, to the satisfaction of the Society.

2.2.3 For hydraulic jack supported jib cranes, it is to be checked, taking into account the requirements of [2.2.2], that the thrust in the luffing jack remains positive.

An exemption to this requirement is, however, possible if the Manufacturer can prove that with the existing arrangements there is no danger of jack-knifing of the jib and they are such that if a pulling force is applied to the jack instead of a compressive force, there is no danger of false manoeuvre.

2.3 Strength criteria

2.3.1 Symbols

The following symbols are used for the stresses, in N/mm², calculated in a particular point:

σ_t : Normal tensile stress due to an overall tensile force:

$\sigma_t \ge 0$

σ_c : Normal compressive stress due to an overall compressive force:

$\sigma_c \le 0$

σ_b : Normal bending stress due to a bending moment:

- when tensile stress:

  $\sigma_b \ge 0$

- when compressive stress:

  $\sigma_b \le 0$

σ_{cb} : Normal combined compressive stress due to an overall compressive force and a bending moment:

$\sigma_{cb} = \sigma_c + \sigma_b$

where:

σ_b : Maximum compressive stress due to a bending moment

τ : Total tangential shear stresses due to shear forces and torsional moment:

$\tau = \tau_x + \tau_y + \tau_0$

These stresses are determined by classical calculation methods of strength of materials, within the elastic field.

2.3.2 Safety factor

The safety factor, η, is defined as follow:

- for calculation of load carrying structures (crane pedestal and fixed parts of overhead cranes excluded) see Tab 1
- for calculation of crane pedestal (see [3.1]):
  - η = 0,63 for loading cases specified in Sec 2
  - η = 0,71 when effects of wind permitted in service are taken into account
- for calculation of fixed parts of overhead cranes:
  - η = 0,5

Table 1 : Safety factor η

Load combination		η
1	Regular loads as specified in Sec 2 without wind	0,67
2	Regular loads as specified in Sec 2 combined with effects of wind permitted in service	0,75
3	Exceptional loads	0,90

2.3.3 Design yield stress

The design yield stress, R_e, in N/mm², is to be taken equal to:

$$R_e = \min\left(R_{eH}, \frac{R_m}{1,2}\right)$$

where:

R_{eH} : Specified minimum yield stress, in N/mm²

R_m : Specified minimum tensile strength, in N/mm²

2.3.4 Allowable stress - tensile and bending load

The following strength criterion is to be complied with in each considered cross-section of structures or structure components which are not subject to an overall compressive force:

$$\sqrt{(\sigma_t + \sigma_b)^2 + 3\tau^2} \le \eta R_e$$

2.3.5 Allowable stress - compressive and bending load

Structural components subject to an overall compressive force are to comply with the following strength criteria at point(s) M corresponding to the middle of the effective length of buckling (see Fig 3):

- when $\sigma_b \le 0$ (1)

$$\sqrt{(\omega\sigma_c + \sigma_b)^2 + 3\tau^2} \le \eta R_e$$

- when $\sigma_b > 0$ (2)

$$\sqrt{[\sigma_c(2 - \omega) + \sigma_b]^2 + 3\tau^2} \le \eta R_e$$

- when $\sigma_b < 0$ (3)

$$\sqrt{\left(\sigma_c\left[1 + \frac{v'}{v}(\omega - 1)\right] + \sigma_b\right)^2 + 3\tau^2} \le \eta R_e$$

where:

ω : Buckling coefficient specified in [2.4.3]

v : Distance, in mm, from the neutral axis of the considered cross-section, to the farthest point of this section

v' : Distance, in mm, between neutral axis and the point opposite to the one at distance v (see Fig 2).

Verification of criterion (1) is sufficient when the section under consideration is symmetrical with respect to neutral axis or when the bending moment compresses the farthest point at distance v in case of asymmetrical section.

Criteria (2) and (3) are to be checked in case of asymmetrical section only when the bending moment compresses the point at distance v′. (Criterion (1) is then not applicable in such a case).

The points of the cross-section (at distance v or v′) subject to the combined stress specified by strength criteria (1), (2) or (3) are indicated in Fig 2.

Strength criteria (1), (2) and (3) can be applied at any point at a distance x, in m, from the end of the buckling length (see Fig 3) by replacing ω with:

$$1 + (\omega - 1)\sin\left|\frac{180x}{\ell}\right|$$

where:

ℓ : Buckling length, in m. defined in [2.4.1].

Figure 2 : Asymmetrical cross-section

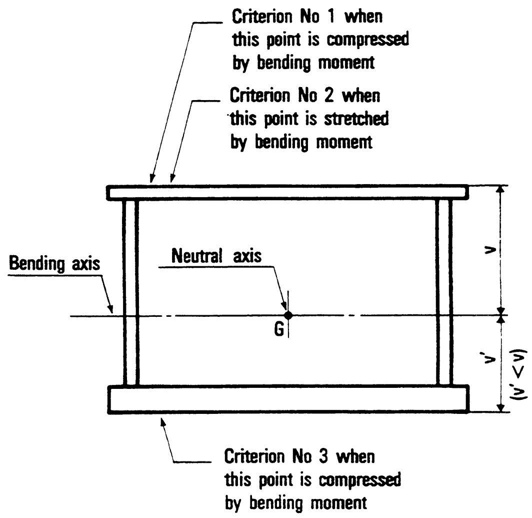
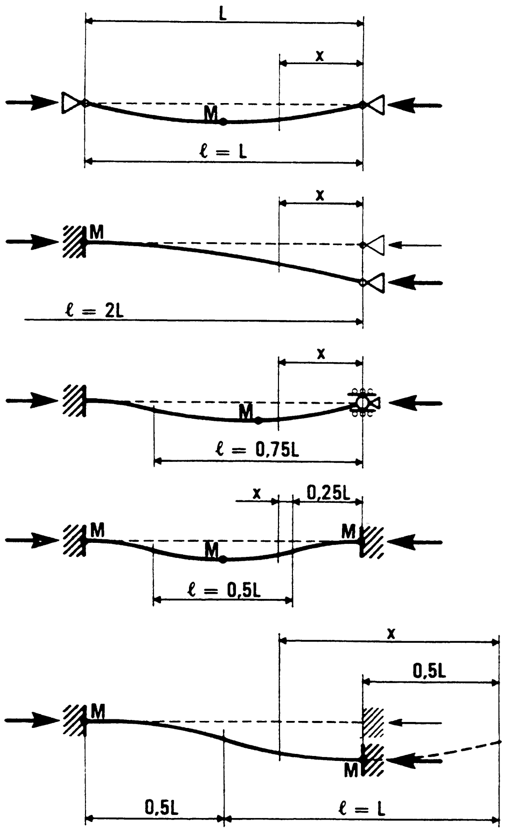


Figure 3 : Effective length of buckling



2.4 Calculation of buckling coefficient for beams

2.4.1 Effective length of buckling

The effective length of buckling ℓ is defined in Fig 3 with respect to the length L of the component under consideration.

2.4.2 Slenderness ratio

Slenderness ratio of the beam is equal to the following value:

$$\lambda = 100\ell\sqrt{\frac{S}{I}}$$

where:

ℓ : Buckling length, in m, defined in [2.4.1]

I : Moment of inertia, in cm^4, of the considered cross-section

S : Cross sectional area, in cm^2.

2.4.3 Buckling coefficient

The buckling coefficient ω is determined with the following formula:

$$\omega = B + \sqrt{B^2 - A}$$

where:

$$A = 112,8 x 10^{-6} \lambda^2 \frac{R_e}{235}$$

$$B = 0,5(A+1) + \zeta(\sqrt{A} - 0,2)$$

with:

R_e : Design yield stress, in N/mm^2, defined in [2.3.3]

λ : Slenderness ratio defined in [2.4.2]

where:

$\lambda < 20 (235/R_e)^{1/2}$, ω = 1 may be applied

ζ : For closed cross-section beams (tubes, box beams, etc.):

ζ = 0,1

For open cross-section beams (lattice beams, angle bars, I, T or U-shape sections, etc.):

ζ = 0,17

For convenience, the values of ω for closed cross section beams are listed in Tab 2 and those for open cross-section beams in Tab 3. These ω values are calculated with a slenderness ratio λ' corrected according to the design yield stress R_e of the steel used:

$$\lambda' = \lambda \sqrt{\frac{R_e}{235}}$$

Table 2 : Buckling coefficient ω for beams with closed cross-section

Corrected slenderness ratio $\lambda' = \lambda (R_e/235)^{1/2}$	Values of ω									
	λ' + 0	λ' + 1	λ' + 2	λ' + 3	λ' + 4	λ' + 5	λ' + 6	λ' + 7	λ' + 8	λ' + 9
20	1,003	1,005	1,007	1,009	1,012	1,014	1,017	1,019	1,021	1,024
30	1,026	1,029	1,032	1,034	1,037	1,040	1,043	1,045	1,048	1,051
40	1,054	1,057	1,061	1,064	1,067	1,071	1,074	1,078	1,082	1,086
50	1,090	1,094	1,098	1,102	1,107	1,111	1,116	1,121	1,126	1,131
60	1,136	1,142	1,148	1,154	1,160	1,166	1,173	1,180	1,187	1,194
70	1,202	1,210	1,218	1,226	1,235	1,244	1,254	1,263	1,273	1,284
80	1,295	1,306	1,317	1,329	1,342	1,354	1,367	1,381	1,395	1,409
90	1,424	1,439	1,454	1,470	1,487	1,503	1,521	1,538	1,556	1,575
100	1,593	1,613	1,632	1,652	1,673	1,693	1,714	1,736	1,758	1,780
110	1,803	1,826	1,849	1,873	1,897	1,921	31,946	1,971	1,996	2,022
120	2,048	2,074	2,101	2,128	2,155	2,182	2,210	2,238	2,267	2,296
130	2,325	2,354	2,383	2,413	2,444	2,474	2,505	2,536	2,567	2,599
140	2,630	2,663	2,695	2,728	2,760	2,794	2,827	2,861	2,895	2,929
150	2,963	2,998	3,033	3,068	3,104	3,140	3,176	3,212	3,248	3,285
160	3,322	3,359	3,397	3,435	3,473	3,511	3,549	3,588	3,627	3,666
170	3,706	3,746	3,786	3,826	3,866	3,907	3,948	3,989	4,030	4,072
180	4,114	4,156	4,198	4,241	4,284	4,327	4,370	4,414	4,458	4,502
190	4,546	4,590	4,635	4,680	4,725	4,771	4,816	4,862	4,908	4,955
200	5,001	5,048	5,095	5,143	5,190	5,238	5,286	5,334	5,383	5,432
210	5,480	5,530	5,579	5,629	5,679	5,729	5,779	5,830	5,880	5,931
220	5,983	6,034	6,086	6,138	6,190	6,243	6,295	6,348	6,401	6,455
230	6,508	6,562	6,616	6,670	6,725	6,780	6,835	6,890	6,945	7,001
240	7,057	7,113	7,169	7,226	7,283	7,340	7,397	7,454	7,512	7,570
250	7,628	7,687	7,745	7,804	7,863	7,922	7,982	8,042	8,102	8,162
Note 1: Intermediate values can be obtained by linear interpolation.										

Table 3 : Buckling coefficient ω for beams with open cross-section

Corrected slenderness ratio $\lambda' = \lambda\,(R_e/235)^{1/2}$	Values of ω									
	λ' + 0	λ' + 1	λ' + 2	λ' + 3	λ' + 4	λ' + 5	λ' + 6	λ' + 7	λ' + 8	λ' + 9
20	1,004	1,008	1,012	1,016	1,020	1,024	1,028	1,032	1,036	1,041
30	1,045	1,049	1,054	1,058	1,063	1,067	1,072	1,077	1,082	1,087
40	1,092	1,097	1,102	1,108	1,113	1,119	1,125	1,131	1,137	1,143
50	1,149	1,156	1,163	1,170	1,177	1,184	1,191	1,199	1,207	1,215
60	1,223	1,232	1,240	1,249	1,258	1,268	1,277	1,287	1,298	1,308
70	1,319	1,330	1,341	1,353	1,365	1,377	1,390	1,403	1,416	1,429
80	1,443	1,457	1,472	1,487	1,502	1,518	1,534	1,550	1,567	1,583
90	1,601	1,618	1,637	1,655	1,674	1,693	1,712	1,732	1,752	1,772
100	1,793	1,814	1,836	1,858	1,880	1,902	1,925	1,948	1,972	1,996
110	2,020	2,044	2,069	2,094	2,120	2,146	2,172	2,198	2,225	2,252
120	2,279	2,306	2,334	2,362	2,391	2,420	2,449	2,478	2,508	2,538
130	2,568	2,598	2,629	2,660	2,691	2,723	2,755	2,787	2,819	2,852
140	2,885	2,918	2,952	2,986	3,020	3,054	3,088	3,123	3,158	3,194
150	3,229	3,265	3,301	3,338	3,374	3,411	3,448	3,486	3,523	3,561
160	3,599	3,638	3,676	3,715	3,754	3,794	3,834	3,873	3,914	3,954
170	3,995	4,035	4,077	4,118	4,160	4,201	4,244	4,286	4,328	4,371
180	4,414	4,458	4,501	4,545	4,589	4,633	4,678	4,723	4,768	4,813
190	4,858	4,904	4,950	4,996	5,043	5,089	5,136	5,183	5,231	5,278
200	5,326	5,374	5,423	5,471	5,520	5,569	5,618	5,668	5,718	5,768
210	5,818	5,868	5,919	5,970	6,021	6,072	6,124	6,176	6,228	6,280
220	6,333	6,385	6,438	6,492	6,545	6,599	6,653	6,707	6,761	6,816
230	6,871	6,926	6,981	7,037	7,093	7,149	7,205	7,262	7,318	7,375
240	7,432	7,490	7,548	7,605	7,664	7,722	7,781	7,839	7,898	7,958
250	8,017	8,077	8,137	8,197	8,257	8,318	8,379	8,440	8,501	8,563
Note 1: Intermediate values can be obtained by linear interpolation.										

2.5 Verification of plate panels against buckling

2.5.1 As a rule, the verifications of plane plate panels are only required when the structural arrangement as per Sec 1 are not complied with.

In such a case, strength against buckling of plane plate panels is to be proved by relevant calculations which can be made in accordance with applicable provisions of App 4.

Other verification methods in compliance with recognized standards or codes may be accepted.

2.5.2 As a rule, cylindrical plate panels need not to be especially checked. For these plates, the constructional arrangements as per Sec 1, [3.4] are to be complied with.

3 Calculations for special components

3.1 Crane pedestals

3.1.1 Scantlings of crane pedestals are to be determined taking into account the calculation conditions indicated in Sec 2 and strength criteria in [2.3]. Scantlings of crane pedestals which do not comply with the strength criteria of [2.3] may be accepted subject to special examination by the society.

It is to be noted that the fixed part of crane pedestals, i.e. welded to the hull, are considered as part of the normal ship classification (see Ch 1, Sec 1, [1.1.3]).

3.1.2 Alternatively, it may be verified that any cross-section of the crane pedestal complies with the following condition:

$$1000\left(\frac{M}{W}+\frac{Q}{S}\right) \le 0,60 R_e$$

where:

W : Bending modulus, in cm^3, of the considered cross-section

S : Cross-sectional area, in mm^2, of the considered cross-section

$$M = \psi_0 \sum_{i=0}^{i=2} [SZ_i x_i + SX_i (z_i - z)]$$

$$Q = \psi_0 \sum_{i=0}^{i=2} SZ_i$$

ψ_0, SX_i, SZ_i: Defined in Sec 2

x_i, z_i : Distances, in m, defined in Sec 2, Fig 1

z : Distance, in m, from the considered cross-section to the uppermost supporting deck.

This method of verification can only be applied if the following condition is satisfied.

$$H + h < 0,01 D \sqrt{\frac{235}{R_e}}$$

where:

H+h : Height of the crane, in m (see Sec 2, Fig 1)

D : External diameter of the crane pedestal, in mm

Other case may be considered specially by the Society.

3.2 Slewing rings

3.2.1 The slewing ring bearings are to be given scantlings taking into account the overturning moment M and the compressive force Q calculated as per [3.1.2] at the ring level in working conditions.

3.2.2 It is the responsibility of the crane Manufacturer to give an attestation from the ring manufacturer fixing the maximum permissible values for overturning moment and vertical force in the working conditions. These values are not to be lower than those calculated in [3.1.2].

3.3 Bolting of cranes

3.3.1 The steel quality of bolts used for connecting cranes to crane pedestals or for connection of slewing rings is to be not less than grade (property class) 8.8. Normally, bolts of grade quality 12.9 are not accepted.

The threading of screws is to be formed by rolling.

An attestation is to be handed over to the Surveyor certifying that bolts and nuts used are in compliance with recognized national or international standards.

3.3.2 The effective cross-sectional area (nominal stress area), in mm², of the threaded part of a bolt will be taken as equal to the following value:

$$S_b = \frac{\pi}{4}(d_b - 0,94p)^2$$

where:

d_b : Nominal bolt diameter, in mm

p : Thread pitch, in mm.

If the diameter of the screw body is less than d_b – 0,94p, the nominal stress area of the bolt is to be taken as equal to the cross-sectional area of the screw body.

If the thread pitch is not indicated, it is assumed that it is an ISO metric coarse pitch thread complying with ISO 898-1:2013 of which are specified in Tab 4 according to the nominal diameter of the bolt.

Table 4 : ISO metric thread value of thread pitch

Nominal diameter d_b of the bolt, in mm			Thread pitch (coarse thread) p, in mm
10			1,5
12			1,75
14	16		2
18	20	22	2,5
24	27		3
30	33		3,5
36	39		4
Note 1: For higher values of nominal diameter, reference to a recognized standard is to be made.			

3.3.3 The nominal stress area S_b, in mm², of each bolt is to be not less than the following value (see [3.3.2]):

$$S_b = \frac{2150}{nR_e}\left(\frac{4000M}{D_p} - Q\right)$$

where:

M : Maximum overturning moment of the crane, in kN.m, calculated as indicated in [3.1.1] or [3.1.2]

Q : Maximum vertical force, in kN, calculated under the same conditions as M

D_p : Pitch circle diameter of bolts, in mm

n : Total number of bolts assumed regularly distributed on the pitch circle diameter D_p

R_e : Yield stress of bolts, in N/mm² (see Sec 1, [2.7.1]).

3.3.4 The tightening of bolts is to be checked by suitable means and the prestress applied is to be between 70% and 90% of the yield stress of the bolts used.

When the tightening is checked by measuring the torque applied, then the value of this torque is to be specified. If the value, in daN.m, is not included between the minimum value C_{min} and the maximum value C_{max}, given hereunder, relevant explanations may be requested:

$C_{min} = 0,14\ 10^{-4}\ S_b\ d_b\ R_e$

$C_{max} = 0,16\ 10^{-4}\ S_b\ d_b\ R_e$

where:

S_b : Nominal stress area, in mm², of the bolt as per [3.3.2]

d_b : Nominal diameter, in mm, of the bolt

R_e : Yield stress, in N/mm², of the bolt corresponding to its steel quality grade (see Sec 1, [2.7.1]).

Here above values for tightening torques are valid for bolts (screws, nuts and washers) suitably cleaned, without dust or rust, and slightly oiled.

3.4 Pad eyes

3.4.1 The design of the pad eyes is to be checked in accordance with App 3.

3.5 Structural axles and hinges

3.5.1 The axles and hinges are calculated by direct calculation. Arrangements are thus to be submitted to the Society for examination.

3.5.2 The allowable stresses for axle pins and hinges are given in Tab 5

Table 5 : Allowable stresses, in N/mm², for axle pins and hinges

σ_{All}	τ_{All}
$0,65R_e$	$0,34R_e$

3.5.3 For simple arrangement, as shown on Fig 4, the bending moment M, in kN.m, and shear stress τ, in N/mm², may be calculated as follows:

$$M = \frac{F}{4}\left(s + 2j + \frac{v}{2}\right)10^{-3}$$

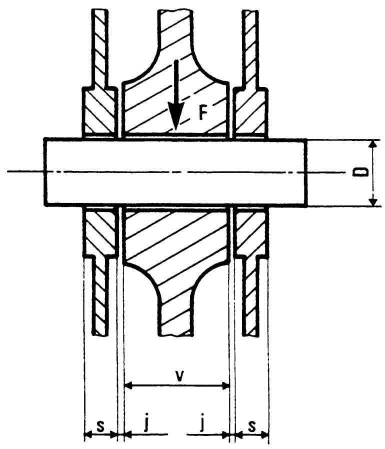
$$\tau = \frac{8F}{3\pi D^2}10^{3}$$

where:

D, v, j, s : Dimensions in mm, as per Fig 4

F : Maximum force, in kN, acting on the axle pin.

Figure 4 : Axle pin



3.5.4 The mean diametrical bearing pressure of axle pin on hinges is not to exceed the design yield stress in test loading conditions of the appliance (bearing without rotation and secured).

3.5.5 For side plate of hinges, the tensile stresses σ, in N/mm² and the shear stress τ, in N/mm² are equal to, respectively:

$$\sigma = \frac{F}{2bt}10^3$$

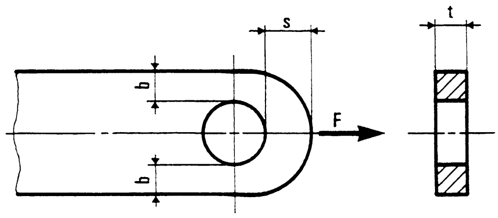
$$\tau = \frac{F}{2st}10^3$$

where:

F : Maximum tensile force acting on the side plate, in operational conditions, in kN

s, b, t : Dimensions in mm, as per Fig 5.

Figure 5 : Hinge



3.6 Crane jibs

3.6.1 Scantlings of crane jibs are to be checked in accordance with the calculation conditions specified in Sec 2 and strength criteria specified in [2.3].

3.6.2 The risks of buckling of the jib is to be considered on the vertical plane (plane XZ of Sec 2, Fig 1) and on the plane perpendicular to XZ including the longitudinal axis of the jib.

In the first case, the jib will be considered hinge supported at both ends and in the second case, fully constrained (both against rotation and translation) at heel.

3.6.3 When the moment of inertia of the jib is not invariable, the buckling coefficient ω defined in [2.4] can be calculated using a fictitious moment of inertia I_f obtained as follows:

$I_f = \xi I_m$

where:

- $\xi = \xi_a = \left[(1-\sqrt{\mu})^2\left(0,0255 + \frac{4}{(\ln\mu)^2}\right)\right]^q$

  with $q = (\cos 90.\nu)^{2.5}$

  when the jib is as shown in figure (a) of Tab 6

- $\xi = \xi_b = (0{,}2.10^{-3} + \mu)^q$ with $q = 0{,}27\ (1 - \nu)^{2,2}$

  when the end constraint conditions and form of the jib are as shown in figures (b) or (c) of Tab 6.

In these two formulae, the values μ and ν are as follows:

$$\mu = \frac{I_1}{I_m} \text{ and } \nu = \frac{L_m}{L}$$

where:

I_1 : Moment of inertia, in cm^4, at one end of the jib length L, in m

I_m : Moment of inertia, in cm^4, which is considered as constant on jib part of length L_m (see Tab 6).

For both cases considered here before, the numerical values of ξ are given in table with respect to the values of μ and ν.

The slenderness ratio of the jib is calculated by the following formula:

$$\lambda = 100\ell\sqrt{\frac{S_m}{I_f}}$$

where S_m is the cross sectional area, in cm^2, of the jib assumed to be constant over the whole length L_m.

3.6.4 For calculation of jibs with lattice webs in the buckling plane, distortions due to shear forces are to be taken into consideration.

In that case, the calculation methods given in [3.6.5] to [3.6.8] can be applied.

3.6.5 There are two examples of cross-sections of beams with lattice webs in Fig 6. The longitudinal elements are hereafter called members (elements of cross sectional area s or S).

3.6.6 The slenderness ratio λ of the entire jib is calculated with the following formula:

$$\lambda = \sqrt{\left(\frac{100\ell}{r}\right)^2 + 26\frac{S+s}{A}}$$

where:

A : Sectional area, in cm^2, of the fictitious solid web equivalent to the two lattice webs with regard to jib distortions due to shear forces. Tab 7 gives the value of a, in cm^2, of the area of the fictitious solid web equivalent to the lattice web depending on the type of lattice. Generally:

when the jib is made up of two identical lattice webs: A = 2a.

when the two lattice webs are not identical:

$A = a_1 + a_2$

with a_1 and a_2 being the values of a, respectively, for each of the two webs

S, s : Sectional areas, in cm^2, defined by Fig 6

ℓ : Effective length of buckling of the jib, in m, corresponding to the buckling plane under consideration (see [3.6.2])

r : Radius of gyration of the jib, in cm, equal to:

- when moment of inertia of the jib is invariable over its whole length:

$$r = \frac{h}{S+s}\sqrt{Ss}$$

- when moment of inertia of the jib is variable (see [3.6.3])

$$r = \sqrt{\frac{I_f}{S+s}}$$

h : Pseudo-height, in cm, of the lattice web equal to the distance between the neutral axes of the members

I_f : Fictitious moment of inertia, in cm^4, calculated as indicated in [3.6.3] according to the moment of inertia in cm^4

$$I_m = \frac{h^2 Ss}{S+s}$$

of the jib for the length L_m (see Tab 6).

Figure 6 : Cross-sections of beams with lattice webs

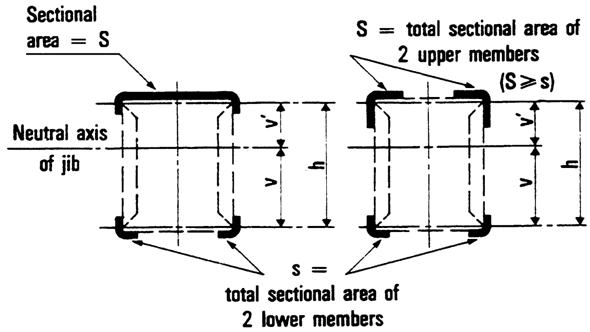
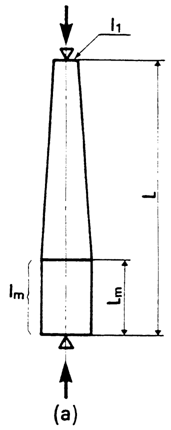
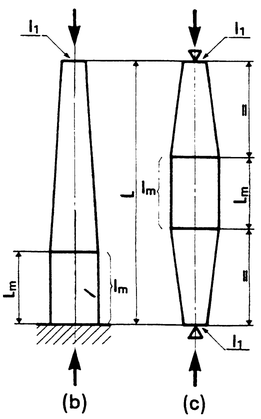


Table 6 : Crane jib with variable inertia - Coefficient ξ



	Jibs as per figure (a) - Values of ξ_a								
μ ν	0	0,2	0,4	0,5	0,6	0,7	0,8	0,9	1,0
0,01	0,173	0,212	0,357	0,479	0,629	0,784	0,911	0,983	1,0
0,02	0,211	0,254	0,401	0,520	0,663	0,806	0,921	0,985	1,0
0,03	0,240	0,284	0,431	0,549	0,685	0,820	0,927	0,986	1,0
0,04	0,263	0,308	0,456	0,571	0,702	0,831	0,932	0,987	1,0
0,06	0,303	0,348	0,495	0,605	0,729	0,847	0,939	0,988	1,0
0,08	0,336	0,382	0,526	0,632	0,749	0,859	0,944	0,989	1,0
0,10	0,365	0,411	0,552	0,654	0,766	0,869	0,948	0,990	1,0
0,15	0,427	0,472	0,606	0,699	0,798	0,888	0,956	0,992	1,0
0,20	0,480	0,523	0,649	0,734	0,823	0,903	0,962	0,993	1,0
0,30	0,570	0,609	0,718	0,789	0,862	0,925	0,971	0,995	1,0
0,40	0,647	0,681	0,774	0,833	0,891	0,941	0,977	0,996	1,0
0,50	0,716	0,745	0,822	0,869	0,915	0,955	0,982	0,997	1,0
0,60	0,780	0,803	0,864	0,901	0,936	0,966	0,987	0,998	1,0
0,80	0,896	0,907	0,937	0,955	0,971	0,985	0,994	0,999	1,0
1,00	1,0	1,0	1,0	1,0	1,0	1,0	1,0	1,0	1,0



	Jibs as per figure (b) and (c) - Values of ξ_b								
μ ν	0	0,2	0,4	0,5	0,6	0,7	0,8	0,9	1,0
0,01	0,290	0,469	0,669	0,764	0,848	0,916	0,965	0,992	1,0
0,02	0,349	0,525	0,710	0,795	0,869	0,928	0,970	0,993	1,0
0,03	0,389	0,561	0,736	0,814	0,882	0,935	0,973	0,994	1,0
0,04	0,420	0,588	0,754	0,828	0,891	0,940	0,975	0,995	1,0
0,06	0,468	0,629	0,781	0,848	0,904	0,948	0,978	0,995	1,0
0,08	0,506	0,659	0,801	0,862	0,913	0,953	0,980	0,996	1,0
0,10	0,537	0,684	0,817	0,874	0,921	0,957	0,982	0,996	1,0
0,15	0,599	0,731	0,847	0,895	0,934	0,964	0,985	0,997	1,0
0,20	0,648	0,767	0,868	0,910	0,944	0,970	0,987	0,997	1,0
0,30	0,723	0,820	0,900	0,932	0,958	0,977	0,991	0,998	1,0
0,40	0,781	0,860	0,923	0,948	0,968	0,983	0,993	0,998	1,0
0,50	0,829	0,892	0,941	0,960	0,975	0,987	0,995	0,999	1,0
0,60	0,871	0,919	0,956	0,970	0,982	0,990	0,996	0,999	1,0
0,80	0,942	0,964	0,981	0,987	0,992	0,996	0,998	0,999	1,0
1,00	1,0	1,0	1,0	1,0	1,0	1,0	1,0	1,0	1,0

3.6.7 The members are to satisfy the following strength criteria at the middle of the effective buckling length of the jib

1) $\left(\frac{10F_c\omega}{S+s}+\frac{1000M_f}{hs}\right)\omega_s \le \eta R_e$

2) $\frac{10F_c(\omega-2)}{S+s}+\frac{1000M_f}{hS} \le \eta R_e$

3) $\left(\frac{10F_c}{S+s}\left[1+\frac{s}{S}(\omega-1)\right]+\frac{1000M_f}{hS}\right)\omega_S \le \eta R_e$

where:

ω : Buckling coefficient of the entire jib calculated as specified in [2.4] for open cross-section beams (see Tab 3) according to the slenderness ratio λ defined in [3.6.6]

ω_s and ω_S: Individual buckling coefficients of the members with, respectively, sectional areas s and S. These coefficients are determined, as indicated in [2.4], considering an effective buckling length equal to ℓ_m (see Tab 7) and the minimum moment of inertia of the member considered

F_c : Overall compressive force, in kN, applied to jib

M_f : Bending moment, in kN.m, calculated at the middle of the effective buckling length of the jib

h : Pseudo-height, in cm, of the web of the cross- section considered (see Fig 6)

S, s : Sectional areas, in cm^2, of members as defined in the Fig 6

η, R_e : Defined in [2.3].

Verification of criterion (1) is sufficient when the section considered is symmetrical with respect to neutral axis (S = s) or when the bending moment compresses the members of area s at distance v, in case of an asymmetrical section.

Criteria (2) and (3) are to be checked only in case of asymmetrical section when the bending moment compresses the members of area S at distance v′ (then criterion (1) is not applicable in this case).

Strength criteria (1), (2) and (3) can be applied at any point at a distance x, in m, from the end of jib buckling length (see Fig 3), by replacing ω with:

$$1+(\omega-1)\sin\left|\frac{180x}{\ell}\right|$$

where ℓ is the buckling length, in m, defined in [2.4.1].

3.6.8 Forces F_1 and F_2, in kN, in lattices (diagonals or struts) with areas s_1 and s_2 respectively (see Tab 7) are determined by means of the following formulae at ends of the effective buckling length of the jib:

- for diagonals with area s_1 of all types of lattices:

  $$F_1 = \frac{T_f+T}{\sin\theta_1}$$

- for diagonals with area s_2 of asymmetrical V shape lattices:

  $$F_2 = \frac{T_f+T}{\sin\theta_2}$$

- for struts with area s_2 of N and K shape lattices:

  $$F_2 = T_f+T$$

where:

$$T_f = \frac{\pi F_c(\omega-1)hs}{100\ell(S+s)}$$

F_c, h, s and S: are defined in [3.6.7]

ℓ : Effective buckling length, in m, of the jib

T : Shear force, in kN, in the section considered

θ_1, θ_2 : Angles defined in Tab 7.

The following strength criteria is to be met:

$$\frac{10F_i\omega_i}{s_i} \le \eta R_e$$

where:

F_i : Force, in kN, calculated as specified above, for lattice with area s_i

ω_i : Individual buckling coefficient of the diagonal or strut considered. This coefficient is calculated, as specified in [2.4], with an effective buckling length equal to ℓ_i (or h for struts: see Tab 7) and the minimum moment of bending inertia of the lattice concerned

η, R_e : Defined in [2.3].

4 Hull connections

4.1 General

4.1.1 The ship/offshore unit structure is to be suitably reinforced in the area of crane attachments in order to avoid excessive local stresses or possible buckling of the deck plating.

4.1.2 Crane pedestals are normally to be attached to two decks at least or to one deck and a deckhouse. In the latter case, the deckhouse is to be of substantial construction and strongly attached to the ship/offshore unit structure in order to give efficient fastening to the crane in all directions.

Efficient supports are to be provided at the lower part of the crane pedestals to withstand the vertical forces acting on them. For this purpose it is recommended to fit cranes in way of a transversal or longitudinal bulkhead.

4.1.3 As indicated in Sec 1, [3.1.2] the structure of crane pedestals is to be continuous through the uppermost deck where they are attached.

4.2 Direct calculations

4.2.1 When direct calculations are made to check the scantlings of the local structures to which the crane is attached, the following strength criterion is to be met:

$$\sqrt{\sigma^2 + 3\tau^2} \leq 0,63 R_{e(d)}$$

or, with the wind effect:

$$\sqrt{\sigma^2 + 3\tau^2} \leq 0,71\ R_{e(d)}$$

where:

σ : Normal stress, in N/mm², calculated considering the bending moments and the tensile and compressive forces

τ : Shear stress, in N/mm², calculated considering the torsional moment and the shear forces

$R_{e(d)}$: Specified minimum values of the yield stress, in N/mm², of the deck plate

4.2.2 The overturning moment M_d, in kN.m, is to be taken equal to the value of M calculated as indicated in [3.1.2].

4.2.3 The total compression force C, in kN, exerted by the pedestal on the ship/offshore unit structure is to be taken equal to the following value, as applicable:

Q value determined as indicated in [3.1.2] increased by the dead weight of the crane pedestal

Note 1: The dead weight, in kN, of the crane pedestal may be taken equal to:

$0,3\ H\ D\ t\ 10^{-3}$

H : Height, in m, of crane pedestal as defined in [3.1.2]

D : External diameter, in m, of the crane pedestal

t : Thickness, in mm, of the crane pedestal.

4.2.4 The horizontal reaction R_d, in kN, exerted by each attachment deck is to be taken equal to:

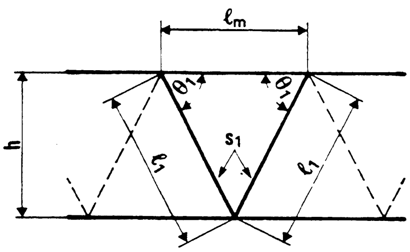
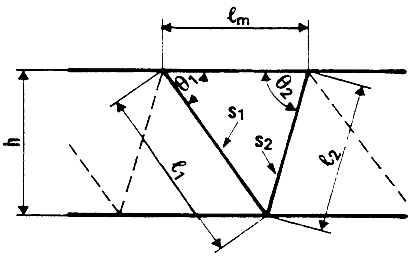
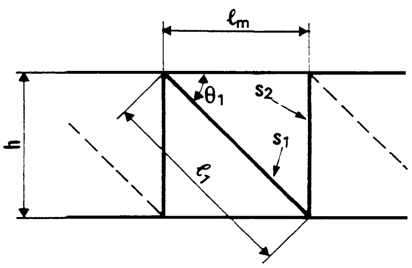
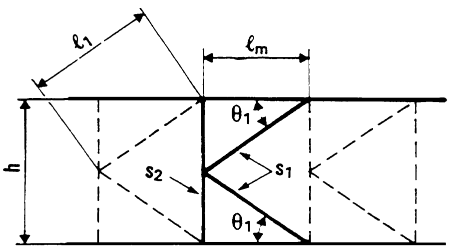
$$R_d = \frac{M_d}{H'}$$

where H' is, in m, the tweendeck height.

4.2.5 As a rule, the reaction force of the deck is to be considered as entirely transmitted to the crane pedestal by shear forces.

In such a case and when crane pedestal of circular cross-section is concerned, in order to calculate the shear stress in the deck (or in the weld) a deck (or weld) sectional area of efficient length equal to 2/3 the external diameter of the crane pedestal is to be considered on both sides of the latter.

Table 7 : Area a of the solid web equivalent to a lattice web

 $a = 1,3h^2\ell_m\frac{s_1}{\ell_1^3}$ or $a = 1,3\ s_1 \sin 2\ \theta_1 \sin\ \theta_1$	 $a = 2,6h^2\ell_m\frac{s_1s_2}{s_1\ell_2^3 + s_2\ell_1^3}$ or $a\ =\ 2,6\sin(\theta_1 + \theta_2)\frac{s_1s_2\sin^2\theta_1\sin^2\theta_2}{s_1\sin^3\theta_1 + s_2\sin^3\theta_2}$
 $a\ =\ 2,6h^2\ell_m\frac{s_1s_2}{s_1h^3 + s_2\ell_1^3}$ or $a\ =\ 1,3\sin2\theta_1\frac{s_1s_2\sin\theta_1}{s_1\sin^3\theta_1 + s_2}$	 $a\ =\ 10,4h^2\ell_m\frac{s_1s_2}{s_1h^3 + 8s_2\ell_1^3}$ or $a\ =\ 2,6\sin2\theta_1\frac{s_1s_2\sin\theta_1}{s_1\sin^3\theta_1 + s_2}$

Section 4 Loose Gear and Removable Accessories

1 General

1.1 Application

1.1.1 This Section applies to loose gear, i.e. all items not permanently attached to the structure of the lifting appliance as defined in Ch 1, Sec 1, [6.2.5].

1.1.2 Loose gears are to be tested separately in compliance with the provisions of Ch 5, Sec 1, [7].

1.1.3 Other removable accessories are not submitted to individual tests prior to fitting onboard, for example span trunnions, goosenecks, etc.

1.2 Materials

1.2.1 If materials used for the construction of loose accessories are not in compliance with these Rules, they are to comply with international or national standards or with other approved specifications.

The choice of materials is to be submitted to the Society for acceptance.

1.2.2 The steel used to manufacture the chains for lifting purposes fall into five quality grade marks shown in Tab 1 according to the provisions of ISO 1834:1999.

1.2.3 For other items of loose gear, the mean breaking stress of which cannot be defined, the quality grade marks are shown on Tab 2.

1.2.4 For inspection of materials at works, refer to provisions of Ch 5, Sec 1, [3.1].

Table 1 : Steel quality grade marks of chains for lifting purposes according to ISO 1834:1999

Quality grade mark	Steel grade	Mean breaking stress σ_m of a chain sample, in N/mm^2
L	Mild steel	$315 \leq \sigma_m < 400$
M	High tensile steel	$400 \leq \sigma_m < 500$
P	Alloy steel	$500 \leq \sigma_m < 630$
S	Alloy steel	$630 \leq \sigma_m < 800$
T	Alloy steel	$800 \leq \sigma_m < 1000$

Table 2 : Steel quality grade marks of items of loose gear (chains excluded)

Quality grade mark	Steel grade	Tensile strength R, in N/mm^2
L	Mild steel	R < 400
M	Ordinary steel	400 ≤ R < 500
P	High tensile steel	500 ≤ R < 630
S	Very high tensile steel	630 ≤ R < 800
T	Special steel	800 ≤ R < 1000
V	Special steel	R ≥ 1000
Note 1: These quality grade marks are only defined for marking of items of loose gear as stated in Ch 5, Sec 1, [13].		

1.3 Constructional arrangements

1.3.1 The welding of items of loose gear of lifting appliances (in case of welded accessories) is to be in accordance with the provisions of Ch 5, Sec 1, [2]. The inspection of welding is to be made in compliance with the provisions of Ch 5, Sec 1, [3].

1.3.2 Loose gear and other accessories are to be designed and built to reduce stress concentration factors as much as possible.

1.3.3 Lubrication of all bearings is to be provided for according to manufacturer's instruction.

1.3.4 It is recommended to use the same dimensions for similar items as much as possible, whatever their position in the rig may be in order to facilitate their checking and interchangeability.

Furthermore, after each examination, it is to be ensured that items are used in the position for which they were originally designed.

1.4 Diameter of block sheaves

1.4.1 As a rule, the diameter D of block sheaves measured to the base of the rope groove is to be not less than the value indicated in Tab 3 according to the nominal diameter d of the rope and the duty category of the crane (see Sec 2, [1.2]).

Table 3 : Diameter of block sheaves

Duty category	Diameter D of block sheaves
I	17d
II	18d
III	19d
IV	20d

1.4.2 When the safety factor η′ of a rope reeved on a block is greater than the minimum value η required by Sec 5, Tab 3, the minimum diameter D_{min} of the sheaves may be reduced to:

$D_{min} = D\,(\eta/\eta')^{1/2}$, without being taken less than 0,89 D.

where:

D_{min} : Minimum diameter in mm

η′ : Safety factor of a rope reeved on a block.

1.5 Loose gear and removable accessories intended for offshore use

1.5.1 When intended for offshore use, a vertical dynamic amplification factor is to be considered for the design, testing and marking of the loose gear item.

The maximum value of the vertical dynamic amplification factor is to be submitted to the Society.

1.6 Loose gear and removable accessories intended for lifting of personnel

1.6.1 When intended for lifting of personnel, loose gear items are to be designed for design load of twice the personnel handling SWL.

1.6.2 Loose gear items used for both non-personnel and personnel lifting are to be permanently marked with both the maximum cargo SWL and personnel handling SWL.

2 Definition of the individual SWL of items of loose gear

2.1 General

2.1.1 As a rule, loose gears are to be chosen in compliance with recognized national or international standards.

2.1.2 The following items of loose gear:

- blocks and head fittings
- shackles
- triangle plates

may be calculated using the rules defined in [3].

2.2 Definition of the individual SWL

2.2.1 As indicated in Ch 1, Sec 1, [6.2.5], the SWL (safe working load) of an item of loose gear is the maximum mass that it is designed to carry vertically, except for single sheave block the SWL of which is defined as indicated in [2.2.4], with regard to [2.2.3].

2.2.2 The individual SWL of items of loose gear can be determined on the basis of the most severe results of the loading cases I_a and I_b as defined in Sec 2, [4.2.1], taking into account that coefficients Ψ_0 and Ψ_{CZ} are equal to 1 except for grab cranes for which coefficient Ψ_0 will be taken equal to 1,20 and G_0 =0.

2.2.3 It is recommended that the SWL of all blocks, especially that of single sheave blocks and the SWL of associated shackles be determined considering that the hauling part of rope is parallel to other rope parts even if this theoretical disposition does not correspond exactly to the actual.

When this recommendation is complied with, it is unnecessary to take into account the efficiency of the block to determine its SWL.

Note 1: However, the SWL of blocks and associated shackles may be determined on the basis of vectorial composition of forces exerted by all rope parts reeved on the block by considering the most unfavourable direction of the hauling part. Attention is drawn to the disadvantage of this procedure that, if, for any reason, the direction of the hauling part of rope is to be modified later (for example, moving of a lead block for reasons of space), the SWL of block and associated shackle may become insufficient.

2.2.4 Single sheave blocks

a) The SWL of a single sheave block (with or without becket) is defined as being equal to half of the maximum mass that the block is designed to carry vertically, when this mass is attached to the head fitting of the block, as shown in Fig 1 (a) and Fig 2 (a).

Note 1: If the recommendation in [2.2.3] is not carried out, i.e. when the direction of the hauling part of rope is not considered parallel to the other parts of rope, the SWL of a single sheave block is not to be less than half of the maximum load exerted on its head fitting.

Note 2: Generally, the head fitting of a block is considered as a part of the block end consequently it is not necessary to assign an individual SWL However, it is to be noted that this item is to be given scantlings for a load equal to double the SWL of the block, in the case of a single sheave block.

Figure 1 : Load which can be lifted with a single sheave block without becket

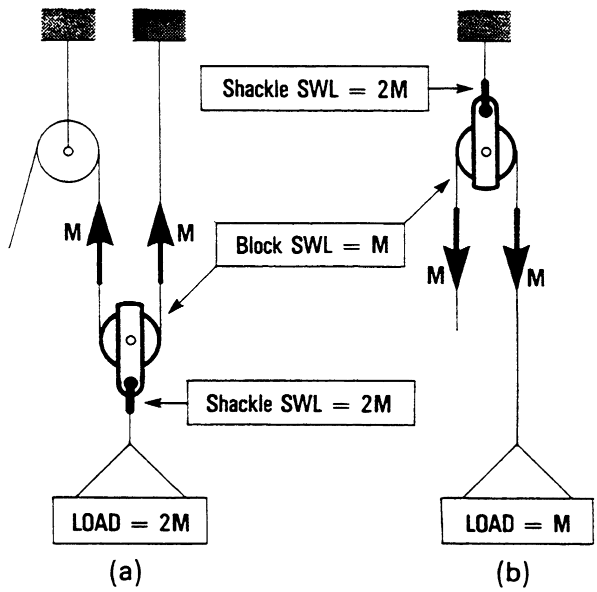
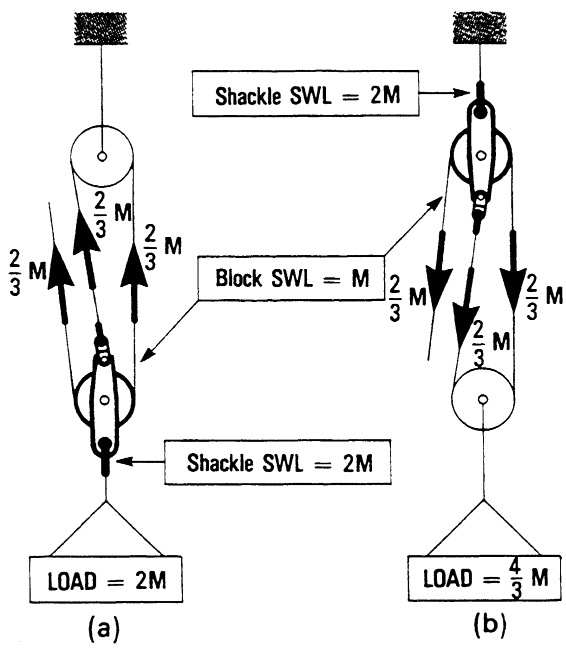


Figure 2 : Load which can be lifted with a single sheave block with becket



b) In the case of a single sheave block without becket, Fig 1(b) shows that it is only permitted to lift a mass equal to the SWL of the block, when this mass is attached to one of the ends of the rope fitted to the block and when the hauling part of rope is parallel to the rope part supporting the load.

c) In case of a single sheave block with becket (SWL = M), Fig 2(b) shows that it is possible to lift a load equal to 4/3 M, when the load is applied on two parts of the rope reeved on the block and when the hauling part of rope is parallel to the two parts supporting the load. The becket is to be assigned an individual SWL equal to 2/3 M.

Note 3: If the recommendation in [2.2.3] is not carried out, that is when the hauling part of rope is not considered parallel to the other parts, the becket is to be assigned a SWL equal to the maximum load exerted by the rope.

Note 4: Attention is drawn to the existence of definitions concerning single sheave blocks with becket which unfortunately differ from the one of the present Rules.

Consequently, before using a single sheave block with becket. it is necessary to make sure that the block is suitable for the intended service, by checking on the force diagrams that the maximum force which will be applied to it, is compatible with the test load indicated on the test certificate. A simple check of the SWL stamped on the block is insufficient.

If a different definition is in force under National Regulations in the country of ship/offshore unit registry, this latter may be used.

2.2.5 Multiple sheave blocks

The SWL of a multiple sheave block is equal to the maximum resultant load admissible on its head fitting (see the recommendation formulated in [2.2.3]).

In case of a multiple sheave block with a becket, an individual SWL is to be assigned to the becket. It is normally defined, taking into account the efficiency of the sheaves by using tension to as defined in App 2, Tab 1, in lowering condition.

2.2.6 Lifting beams

The SWL of a lifting beam, spreader or similar lifting aid is the maximum load that the device is able to lift.

The lifting beam is to be used on lifting appliances for which the SWL is at least equal to the SWL of the lifting beam increased by the weight of the lifting beam.

Some lifting beams may have several SWL corresponding to different modes of suspending the load and/or corresponding to different lifting systems.

An individual SWL is to be assigned to constituent items, such as hooks, shackles, rings, chains or slings.

3 Particular items of loose gear

3.1 Blocks and head fittings

3.1.1 General

The head fittings of blocks may be double lugs, oval eyes, round eyes. For scantling rules, see [3.1.2].

As a rule, the safety coefficient of the different elements making up the block with regard to the breaking strength is not to be less than 4 when the item is supporting its SWL. For the definition of the SWL, see [2.2].

Some elements (pins, straps bearings, head fittings, etc.), as per Fig 3 and Fig 4, may be calculated by applying rules defined in [3.1.3] to [3.1.8].

Figure 3 : Blocks

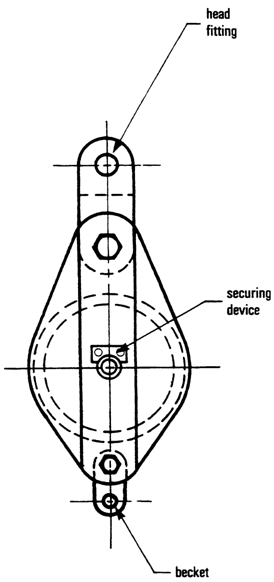
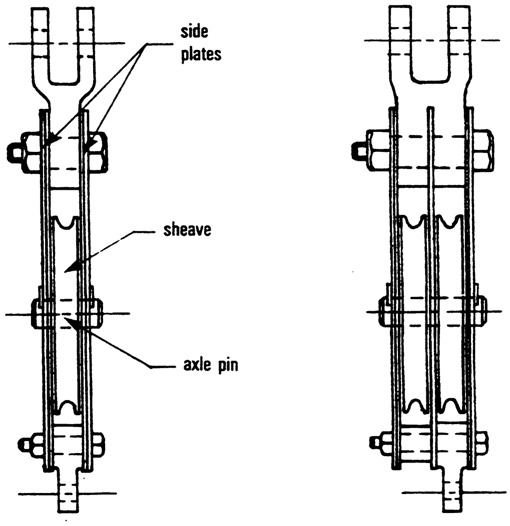


Figure 4 : Blocks



3.1.2 Constructional arrangements

a) Diameter of sheave measured to the base of the rope groove:

Sheave diameters depend on rope diameters.

The ratio between the sheave diameter and the rope diameter is defined in [1.4].

For masts and posts with derrick booms used for loading and unloading of ships, the sheave diameter is to be, at least, equal to 14 times the diameter of the wire rope when the wire rope is operated under load.

This ratio is to be at least equal to 9 when the wire rope is not operated under load (for example in case of derrick systems where topping is not adjusted under load).

In the case of blocks for use with fibre ropes, the sheave diameter is at least equal to 5 times the diameter of the fibre rope used.

b) Groove of sheaves

The groove is to be free of defects liable to damage ropes.

Its depth is normally to be equal to the diameter of the associated rope.

The groove radius is to be 5% greater than the radius of the wire rope. The groove radius needs not to be greater than 10% of the radius of the wire rope, except otherwise recommended by the wire rope manufacturer. Where fibre ropes are used, the groove depth of the sheave is not to be less than one third of the diameter of the fibre rope. The groove radius is to be at least 8% greater than the radius of the fibre rope and not greater than fibre rope manufacturer's recommendation.

c) Axle pins are to be secured against rotation and lateral movement.

d) Blocks are to be designed to prevent ropes from jamming between sheaves and they must be designed to prevent ropes from slipping off the sheave.

e) Blocks with hook-type head fittings are not allowed.

f) Provision is to be made for ensuring good lubrication of all bearings.

3.1.3 Scantling rules - loss due to friction

Where not demonstrated otherwise, a loss due to friction of minimum 5% for sheaves with bushed bearings and minimum 2% for sheaves with roller bearings is to be used (see App 2) in reeving calculations.

3.1.4 Scantling rules for sheave bearings

As a rule, the diametrical pressure on the sheave bearings is not to be greater than 0,15 times the yield stress, in operational condition.

3.1.5 Scantling rules for sheave axles

The sheave axles are calculated by direct calculation.

The bending moment is:

$$M_f = \frac{F}{4}\left(s + 2j + \frac{v}{2}\right)10^{-3}$$

with v not taken as greater than 2D.

The shear stress is:

$$\tau = \frac{8F}{3\pi D^2}10^3$$

where:

s, v, j, D : Dimensions, in mm, as per Fig 5

F : Maximum force, in kN, acting on the axle pin in operational condition.

The allowable stresses for sheave axles are given in Tab 4.

The formulae given in Tab 4 are suitable in the case of constructional arrangements, as shown before and may be used to other items of similar design. Substantially different arrangements are to be submitted to the Society for special examination.

Figure 5 : Axle pin

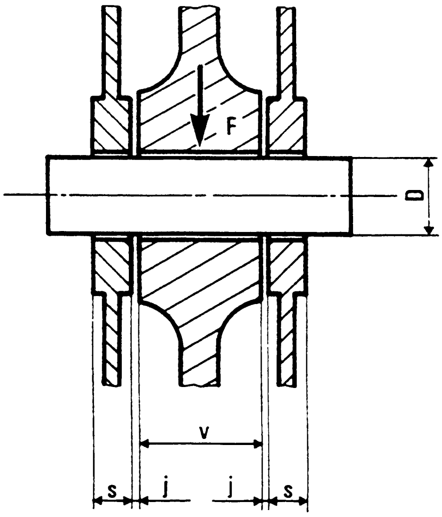


Table 4 : Allowable stresses for sheave axles

		Allowable bending stress, in N/mm²	Allowable shear stress, in N/mm²
Single sheave block		0,45 R_e	0,25 R_e
Multiple sheave block **(1)**	SWL ≤ 25t	0,45 R_e	0,25 R_e
	25t < SWL < 160t	$0,45 \frac{SWL}{0,6\ SWL + 10} R_e$	$0,25 \frac{SWL}{0,6\ SWL + 10} R_e$
	SWL ≥ 160t	0,68 R_e	0,38 R_e

(1) SWL of the multiple sheave block, in t, as defined in [2.2.5]
Note 1: R_e is the design yield stress of the sheave axle, in N/mm², as defined in Sec 3, [2.3.3]
Note 2: For sheave blocks with beckets, tested in two phases as per Ch 5, Sec 1, [7.3.4], the allowable stresses are to be multiplied by (m−1)/m, where m is the total number of rope parts (including the part attached to the becket)

3.1.6 Scantling rules for side plates of blocks

The mean diametrical bearing pressure of axle pin on the side plates of blocks is not, as a rule, to exceed the yield stress, in test loading conditions (bearing without rotation and secured).

For side plates, the tensile stress σ, in N/mm², and the shear stress τ, in N/mm², are equal to, respectively:

$$\sigma = \frac{F}{2bt} 10^3$$

$$\tau = \frac{F}{2st} 10^3$$

where:

F : Tensile force acting on the side plate, in kN, in operational condition

s, b, t : Dimensions in mm, as per Fig 6.

The allowable stresses for side plates are given in Tab 5.

Figure 6 : Hinge

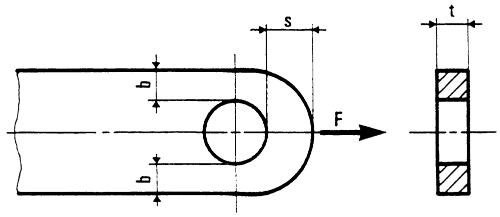


Table 5 : Allowable stresses for side plates

		Allowable tensile stress, in N/mm²	Allowable shear stress, in N/mm²
Single sheave block		$0,25\ R_e$	$0,20\ R_e$
Multiple sheave block **(1)**	SWL ≤ 25t	$0,25\ R_e$	$0,20\ R_e$
	25t < SWL < 160t	$0,25\ \frac{SWL}{0,6\ SWL+10} R_e$	$0,20\ \frac{SWL}{0,6\ SWL+10} R_e$
	SWL ≥ 160t	$0,38\ R_e$	$0,30\ R_e$

(1) SWL of the multiple sheave block, in t, as defined in [2.2.5]
Note 1: R_e is the design yield stress of the side plates, in N/mm², as defined in Sec 3, [2.3.3]
Note 2: For sheave blocks with beckets, tested in two phases as per Ch 5, Sec 1, [7.3.4], the allowable stresses are to be multiplied by (m−1)/m, where m is the total number of rope parts (including the part attached to the becket)

3.1.7 Scantling rules for block head fittings

These components are to comply with national or international standards.

For guidance, these components can be as shown in Tab 7 and be calculated as follows:

It can be checked that the minimum bolt diameter D at bottom of threads, in mm, is not lower than the values specified in Tab 6, with:

$$D = D_o - 1,227\ p$$

where D_o and p are, in mm, the nominal diameter and the thread pitch, respectively.

These formulae in Tab 6 are for mild steels. They can be reduced when using high tensile steel, by multiplying the here before formulae by:

$$k = \sqrt{\frac{235}{R_e}}$$

The design yield stress R_e, in N/mm², is defined in Sec 3, [2.3.3].

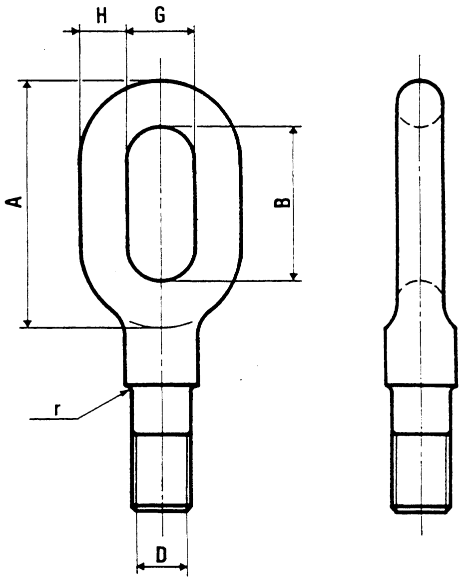
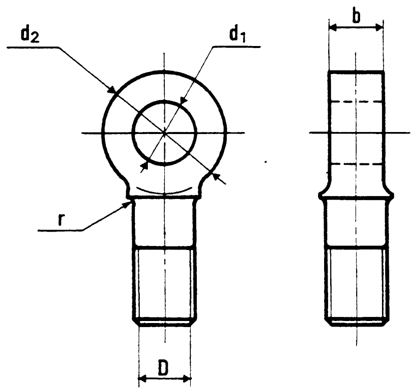
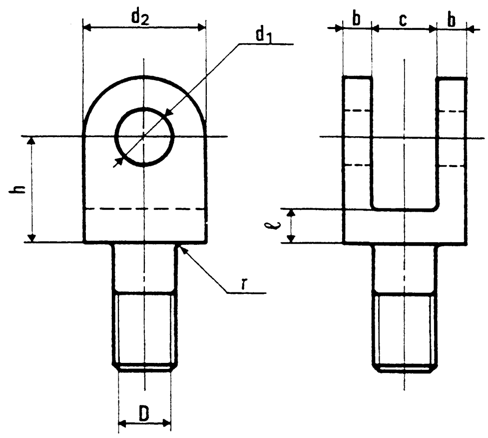
Nuts are to have dimensions adequate for bolt diameters and be fitted with efficient locking devices. The depth of nuts will be about equal to their diameter.

Table 6 : Minimum bolt diameter D at bottom of threads

		D, in mm
Single sheave block		$4,7\ \sqrt{F}$
Multiple sheave block **(1)**	SWL ≤ 25t	$4,7\ \sqrt{F}$
	25t < SWL < 160t	$4,7\ \sqrt{0,6\ F + 100}$
	SWL ≥ 160t	$3,8\ \sqrt{F}$

(1) SWL of the multiple sheave block, in t, as defined in [2.2.5]
Note 1: F is the total tensile force applied to the head fitting, in kN, in operational condition

Table 7 : Block head fittings

Oval eye		D : As calculated in [3.1.7] $H = 0,8\ k^{2/3}\ d$ G = 1,1 d + 4 B = 3,1 d + 4 A = B + 2 H r = 0,15 d k : As defined in [3.1.7] d : Diameter of the associated shackle pin determined as indicated in [3.2.6] for mild steel
Round eye		D : As calculated in [3.1.7] $d_1 = 1,07\ d + 3$ $d_2 = d_1 + k\ d$ b = k d r = 0,15 d k : As defined in [3.1.7] d : Diameter of the associated shackle pin determined as indicated in [3.2.6] for mild steel
Double lugs		D : As calculated in [3.1.7] $d_1 = 1,07\ d + 3$ $d_2 = d_1 + k\ d$ b = 0,5 k d c = 1,1 d + 4 ℓ = 0,6 k d h = 1,15 d + ℓ + 5 r = 0,15 d k : As defined in [3.1.7] d : Diameter of the associated shackle pin determined as indicated in [3.2.6] for mild steel

3.1.8 Scantling rules for beckets

The beckets as per Fig 7 may be calculated as follows:

$d_1 = 1,07\ d + 3$

$d_2 = d_1 + k\ d$

a = k d

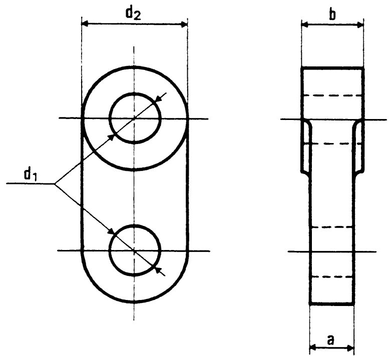
where:

k : As defined in [3.1.7]

d : Diameter of the associated shackle pin determined as indicated in [3.2.6] for mild steel.

The dimension b is to be in accordance with the breadth of the sheave and at least equal to the value a defined above.

Figure 7 : Beckets



3.2 Shackles

3.2.1 The SWL is defined in [2.2].

3.2.2 The pin may be screwed into the eye of the shackle body or consist of a bolt with head and nut or a pin with a securing pin.

Pins are to be properly secured.

3.2.3 Pins of bolt type are to be used for fastening the cargo blocks, span blocks, guy blocks, as well as the rope ends to the derrick head fittings, beckets and mast eyes (for stayed masts).

3.2.4 Bow shackles may be used as cargo shackles.

3.2.5 Shackles used for cargo hooks and cargo hook swivels are to have, as a rule, pins screwed in the shackle body, without nuts.

3.2.6 The scantlings of the straight shackles and of the bow shackles are given hereunder, where:

F : SWF of the shackle, in kN.

a) Straight shackles as per Fig 8

The following formulae are given for mild steels (R_e = 235 N/mm²):

d : Diameter of the shackle pin, equal to:

- when F ≤ 250 kN:

$$d = 4,4\sqrt{F} + 2$$

- when 250 kN < F < 1600 kN:

$$d = \left(4,4\sqrt{F}\sqrt[3]{0,6 + \frac{100}{F}} + 2\right) \times \sqrt{\frac{235}{R_e}}$$

- when F ≥ 1600 kN:

$$d = 3,9\sqrt{F}$$

d_1 = 0,9 d

a = 1,4 d (see [3.2.7])

b = 3,6 d

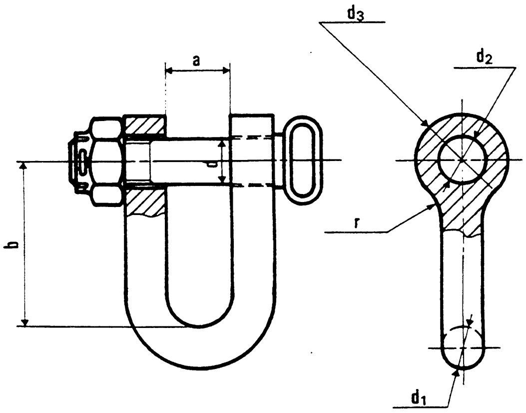
d_2 = 1,01 d + 1

d_3 = 2 d

r = d

with d, d_1, d_2, d_3, a, b and r in mm.

Figure 8 : Straight shackle



b) Bow shackles as per Fig 9

The following formulae are given for mild steels (R_e = 235 N/mm²):

d : Diameter of the shackle pin, equal to values given in item a) above for straight shackles

$d_1 = d$

a = 1,4 d (see [3.2.7])

b = 4 d

d_2 = 1,01 d + 1

d_3 = 2 d

r = d

r_1 = 0,8 a (see [3.2.8])

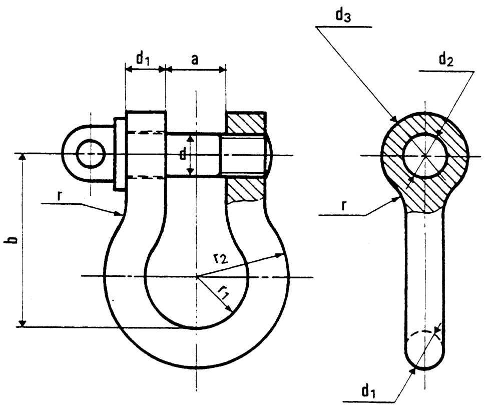
$r_2 = r_1 + d_1$

with d, d_1, d_2, d_3, a, b, r, r_1 and r_2 in mm.

When using high tensile steel, values d, d_1, d_2 and d_3 may be reduced in the proportion $(235/R_e)^{1/3}$.

The design yield stress R_e, in N/mm², is defined in Sec 3, [2.3.1].

Figure 9 : Bow shackle



3.2.7 When the width of jaw is greater than the value a given in [3.2.6] (a > 1,4 d), the diameter d of the shackle pin, determined as indicated in [3.2.6], is to be increased in the proportion $(a/1,4\ d)^{1/3}$.

Other shackle dimensions are obtained using the formulae given in [3.2.6] in terms of the so increased diameter d.

3.2.8 When the inside width radius of a bow shackle body is greater than the value r_1 given in [3.2.6] (r_1 > 0,8 a), the diameter d_1 of the shackle body, determined as indicated in [3.2.6] and possibly in [3.2.7], is to be increased in the proportion $(r_1/0,8\ a)^{1/3}$.

3.3 Triangle plates

3.3.1 The triangle plates, as per Fig 10, may be calculated as follows.

F : SWF of the triangle plate, in kN

d : Diameter of the associated shackle pin determined as indicated in [3.2.6] for mild steel in terms of SWF F.

The formulae are given for mild steels:

d_1 = 1,1 d + 3

a = 0,7 d + 2

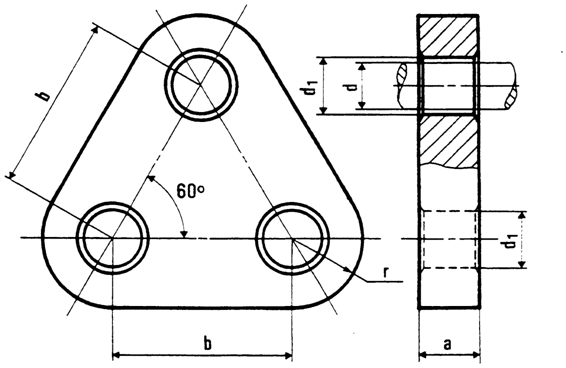
b = 2,5 d + 20

r = 0,5 d_1 + 0,8 d

with d, d_1, a, b and r in mm.

When using high tensile steel, the value a may be reduced.

Figure 10 : Triangle plate



3.4 Chains

3.4.1 Chains used in lifting applications are to be compliant with a recognized standard such as EN 818.

3.5 Other removable accessories (not submitted to individual tests)

3.5.1 Loose accessories not submitted to tests, such as span trunnions, goosenecks, etc., will be chosen, as a rule, in accordance with national or international standards.

4 Lifting beams

4.1 Lifting beams, lifting frames and similar lifting aids (spreaders)

4.1.1 Constructional drawings of lifting beams are to be submitted for Society approval, in compliance with the requirements of Ch 1, Sec 2, [1]. SWL and test loads are to be shown on these drawings.

4.1.2 Steels grades used in construction are to be shown on the scantling drawings and are to be in accordance with the requirements of Ch 5, Sec 1, [3.1]. Welding is to comply with the requirements of Sec 1.

4.1.3 The structural design of the lifting beam is to be checked by direct calculations.

The weight and angles of the slings are to be taken into account.

When the slings are oblique, the stresses due to the horizontal load in the beam are to be combined with the bending stresses.

4.1.4 The SWL of a lifting beam is the maximum load that the lifting beam is able to lift.

4.1.5 For pad eye design, reference is made to App 3.

4.1.6 Stress concentration factors in the lifting beam are to be reduced as much as possible.

4.1.7 The combined stress at any point on the lifting beam is not to exceed the values defined in Tab 8, where the design yield stress R_e is defined in Sec 3, [2.3].

Table 8 : Allowable stress for lifting beams

SWL of lifting beams, in t	Allowable stress σ_a, in N/mm²
SWL ≤ 10	0,45 R_e
10 < SWL < 160	(0,002 SWL + 0,43) R_e
SWL ≥ 160	0,75 R_e

4.1.8 The strength of lifting beams against buckling is to be justified mainly for lifting beams in high strength steel.

For verification of the lifting beam with respect to buckling of the whole structure, the strength criteria defined in Sec 3, [2.3.5] can be applied.

The coefficient η used in these criteria will be taken equal to σ_a / R_e, where R_e and σ_a, are defined in Sec 3, [2.3], and Tab 8 respectively.

Section 5 Ropes

1 General

1.1 Application

1.1.1 This Section deals with the selection and the manufacture of the wire and fibre ropes used in various parts of the lifting appliance, in slings and in grommets.

1.2 General provisions

1.2.1 In this Section all wire and fibre ropes which are reeved through blocks, wound on winches or belayed on cleats are considered as part of the running rigging even if they are not moved under load.

1.2.2 Ropes which are not part of the running rigging such as shrouds, stays, guy pendants and preventer guys, belong to the standing rigging.

1.2.3 Lengthening of ropes by splicing or clamps is not permitted; they are to be made in one continuous length.

1.2.4 The diameter of a wire or fibre rope is the diameter of the circumscribed circumference about its cross-section.

1.2.5 It is the responsibility of the manufacturer of the lifting appliance to select the type of wire ropes or fibre ropes according to the contemplated use, the diameters of the blocks and winch drums, the number of turns on the drums, the instructions of the manufacturer and to the requirements and recommendations of this Section.

1.2.6 Use of wire ropes or fibre ropes, the materials, manufacturing or characteristics of which are not entirely in accordance with the requirements of this section may be accepted subject to special examination by the Society.

2 Rope safety factor

2.1 General

2.1.1 The minimum breaking force (MBF), in kN, of a rope used as a rigging of a lifting appliance is to comply with the following criteria:

$MBF \geq \eta \cdot T$

where:

η : Safety factor, function of the SWL of the lifting appliance, defined in:
- Tab 1 for fibre ropes
- Tab 3 for wire ropes

T : Maximum static rope tension, in kN, to be determined from deadweight and lifted load, without taking into account the following effects:
- dynamic amplification factor
- out of plane effect
- wind
- inclination of the floating unit

but taking into account the efficiency of the sheaves and tackles according to App 2.

2.1.2 For offshore use, the safety factor η is to be taken as the greater of the following:
- $\eta = 0{,}75\ \alpha_{cz}\ \eta_0$
- $\eta = \eta_0$

where:

η_0 : Rope safety factor determined according to [2.1.1].

2.1.3 When a lifting appliance has several SWL values, for example SWL_1 and SWL_2, the MBF of a rope used as rigging of this appliance is not to be less than:
- $\eta_1 \cdot T_1$ if the rope is subjected to SWL_1 only
- $\eta_2 \cdot T_2$ if the rope is subjected to SWL_2 only
- $Max(\eta_1 \cdot T_1;\ \eta_2 \cdot T_2)$ if the rope may be subjected to either SWL_1 or SWL_2, unsimultaneously
- $[Min(\eta_1;\ \eta_2)] \cdot (T_1 + T_2)$ if the rope may be subjected simultaneously to both SWL_1 and SWL_2.

Table 1 : Safety factor η for fibre ropes

SWL of the lifting appliance	Safety factor η
SWL ≤ 10t	See Tab 2
10t < SWL ≤ 160t	$\frac{1200}{0,885 \cdot SWL + 191}$
160t < SWL	3,6

Table 2 : Safety factor η for fibre ropes, when SWL ≤ 10t

Rope diameter, d, in mm	Safety factor η
d ≤ 12	12
12 < d ≤ 17	10
17 < d ≤ 23	8
23 < d ≤ 39	7
d > 39	6

Table 3 : Safety factor η for wire ropes

SWL of the lifting appliance	Harbour and offshore		Subsea	
	Running rigging	Standing rigging	Running rigging	Standing rigging
SWL ≤ 10t	5,0	4,0	5,0	4,0
10t < SWL ≤ 160t	$\frac{1000}{0,885 \cdot SWL + 191}$	$\frac{1000}{0,556 \cdot SWL + 244,4}$	$\frac{1000}{0,571 \cdot SWL + 194,3}$	$\frac{1000}{0,556 \cdot SWL + 244,4}$
160t < SWL	3,0	3,0	3,5	3,0

3 Materials and manufacture of steel wire ropes and fibre ropes

3.1 Steel wire ropes

3.1.1 Steel wire ropes are to be in accordance with the requirements of NR216.

3.2 Fibre ropes

3.2.1 Fibre ropes are to be in accordance with the requirements of NR216.

4 Running rigging

4.1 General

4.1.1 For the running rigging, it is recommended to use steel regular lay ropes with parallel wires (Seale, Warrington, Filler or Warrington-Seale ropes).

4.1.2 Normally, the ropes are to consist of six strands at least laid around a centre core. This core is usually made of fibres. However, if the rope is to be wound around the winch drum in more than two or three layers, the use of a rope with metal core is recommended.

4.1.3 The number of wires in each strand is not to be less than 19 for ropes with fibre core and 31 for ropes with metal core.

4.1.4 The tensile grades 1570, 1770, 1960, 2160 are recommended.

4.2 Cargo runners

4.2.1 The cargo runners are to consist of steel regular lay ropes.

4.2.2 The use of Lang lay ropes having one layer of strands only is not permitted.

4.2.3 Preformed wire ropes are to not be used for single rope lifting.

4.2.4 Non-rotating ropes are to be used only if necessary.

4.2.5 The length of the cargo runner is to be sufficient in any circumstances to allow the appliance to lower the cargo down to the bottom of the hold and also down to the sea level, the crane jib being at the maximum authorized or practicable topping angle. In such conditions at least three safety turns of rope are to remain on the cargo winch drum.

4.3 Span ropes

4.3.1 The span tackle ropes are to consist of steel wire ropes.

4.3.2 The length of the span tackle rope is to be such that, when the crane is at its maximum outreach position, at least three safety turns of rope remain on the span winch drum. Two safety turns are sufficient in stowed position.

4.4 Slewing guy ropes

4.4.1 Synthetic fibre ropes may be used in the slewing guy tackles if the slewing winches are not motorized or if the force applied on the guy unit does not exceed 40 kN. For higher forces steel wire ropes are to be used.

5 Wire and fibre rope terminals accessories

5.1 General

5.1.1 All rope terminations are to be spliced on thimbles or fitted with sockets or equivalent except for terminations of wire or fibre ropes connected to winch drums and except for terminations of fibre ropes belayed over cleats or bollards which may be fitted with packing or with pressed sleeves.

5.2 Spliced terminal loops

5.2.1 Normally, the splices of termination loops of wire or fibre ropes are to include at least five tucks among which three (or four) are to be carried out with all the strands prior to cutting half of them; the two (or single) following tucks being carried out with the remaining half of the strands. The splice terminations are to be strongly tied up by a seizing or by a sleeve.

5.2.2 When cable-laid ropes are concerned, specially for the termination loops of single slings, the splices are to be made as per [5.2.1] with the unit ropes of the cable-laid rope instead of the strands.

5.2.3 Terminal loops with splices carried out by other methods or with pressed sleeves or terminated by a combination of splice and sleeve may be accepted provided they are equivalent in strength. Breaking tests may be required on a sample of such loops. In such a case, breaking is not to occur under a load lower than 0,9 times the guaranteed breaking load of the wire or fibre rope.

5.3 Thimbles

5.3.1 Used thimbles are to be in compliance with recognized standards and suited to the diameter as well as to the breaking load of the associated wire or fibre rope.

They are to be galvanized.

5.3.2 Solid thimbles are recommended when they are connected with straight pins (e.g. shackle pin).

5.3.3 Heart-shaped thimbles with open or welded point are recommended for connection with curved parts (e.g. shackle body).

5.3.4 Normally, individual tests of thimbles are not required but, when provided, they are to comply with the requirements for loose gear (see Ch 5, Sec 1, [7]).

5.4 Rope terminations with sockets

5.4.1 Terminations of ropes with sockets are to comply with recognized standards. The safe working force of a socket is not to be lower than the maximum tension determined in the associated wire or fibre rope.

Sockets or similar end connections (either through sleeving and/or jamming) which do not comply with standards are to be submitted to the Society for approval. Breaking tests on a sample may be required.

5.4.2 As a rule, the termination sockets are to be tested as required for loose gear (see Ch 5, Sec 1, [7]). If these tests are not carried out, a breaking test may be required for one socket of each size in order to prove that the ultimate strength of the connection is not less than 0,9 times the required actual breaking force of the associated wire or fibre rope.

5.5 Clamps

5.5.1 Normally, rope termination pressure connections with rope fasteners or other clamps are not permitted in the various parts of the lifting appliances dealt with in this Rule Note, without special agreement of the Society which may require special tests to be carried out to make sure of the efficiency of the connection.

5.5.2 The use of rope fasteners to lengthen a rope is forbidden.

5.6 Accessories

5.6.1 Accessories for wire or fibre rope connections such as shackles, chains, rings, swivels, beckets, rigging screws, etc. are to comply with the requirements of Sec 4 and are to be tested separately as per Ch 5, Sec 1, [7].

6 Slings and grommets

6.1 General

6.1.1 Slings of usual type are shown on Fig 1.

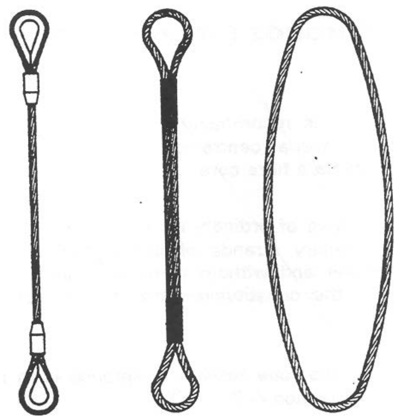
6.1.2 Special type slings are to be specially considered by the Society.

6.1.3 The SWL of a sling or grommet is equal to the maximum mass it can carry vertically in a straight line.

6.1.4 When they are not used in a straight line, for example to surround a load, the slings and grommets are not to be in contact with sharp edges.

6.1.5 The type of slings, the material used, its construction and its SWL are to be suited to the contemplated use and to the shape of the package to be slung up. In particular, in order to determine the SWL of the sling, the angles formed by the sling and the vertical and the fording radii or the parts of the sling in contact with the slung load are to be taken into account.

Figure 1 : Usual types of slings



6.1.6 The end loops of the single slings may be provided with heart shaped thimbles or solid thimbles. When the loops are not provided with thimbles, they are not to be connected to pins of diameter lower than the diameter of the wire rope or cable-laid wire rope forming the sling.

The end loops of the double slings and grommets are not to pass on pins of diameter less than six times the diameter of the constitutive wire rope or cable-laid wire rope.

Other parts of the single slings, double slings or grommets are not to be folded on pins of diameter lower than four times the diameter of the constitutive wire rope or cable-laid wire rope. Moreover, the double slings are to be bent only in the plane perpendicular to the plane of the end loops.

When the requirements of the two above paragraphs cannot be complied with, the slings or grommets used are to have a SWL higher then the one resulting from the force diagram in order to compensate strength loss due to bending.

6.1.7 Slings and grommets are considered as loose gear and as such, are to be tested separately in compliance with the requirements of Ch 5, Sec 1, [7].

6.2 Materials and construction

6.2.1 Slings and specially the ones intended to be bent around a load or a pin are to be of a flexible construction.

They may be made of wire ropes, fibre ropes or cable-laid ropes (cable-laid rope is a regular lay rope obtained by closing six unit ropes around a seventh one or, more scarcely, around a fibre core), these latter ropes complying with the requirements of [3.1] and [3.2] as applicable.

6.2.2 When the slings or grommets consist of a single wire rope, usually the rope is to be of the regular lay type with 6 or 8 strands including at least 19 wires and laid around a metal or fibre core.

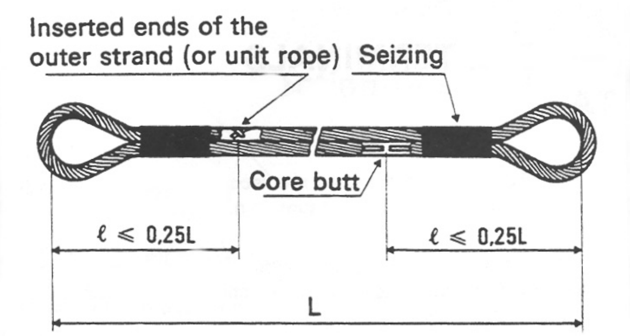
6.2.3 The single slings of heavy SWL may consist in cable-laid ropes made of 6 ropes of regular lay or Land lay type. The use of Lang lay ropes for the making of cable-laid ropes is recommended due to their greater flexibility for equivalent diameter.

6.2.4 Grommet lay, i.e. lay of a single strand turned six times upon itself (or of a single rope to make a cable-laid rope) are to be used to make double slings and grommets to obtain so-called invisible splices. In such a case, it is, however, to be noted that the strand forming the centre core (or the centre rope when a cable-laid rope is concerned) is discontinuous and is not to be taken into account to determine the breaking load. The place where the ends or the metal core are butted together is to be located on the grommet opposite to the place where the ends of the strand (or rope) are inserted inside the cable-laid rope. These places are to be marked to prevent the grommets from being bent in way of these weak points.

Core is to be butted and ends of strand (or rope) inserted near seizing of end loops of double slings (see Fig 2).

6.2.5 Splices of end loops of single slings are to comply with the requirements of [6.2].

Figure 2 : Double sling



6.3 Safety factors

6.3.1 The MBL , in t, of a single sling consisting of a wire rope, fibre rope or cable-laid rope is to comply with the following criteria:

$MBL \geq \eta \cdot SWL$

where:

η : Safety factor as per [6.3.4] for a wire sling or [6.3.5] for a fibre sling

SWL : Safe working load of the sling, in tons

The MBL is to be proven by a test on a sample.

When the MBL of a cable-laid rope is not proved by a breaking test on a sample of the completed cable-laid rope, its MBL is to be considered as equal to 0,85 times the total of the MBL of the constituent wire ropes. These guaranteed MBL are to be proved by breaking tests (the coefficient 0,85 represents the strength loss due to spinning of the cable-laid rope).

6.3.2 The SWL of a double sling or of a grommet made as per [6.2.4] (grommet lay) is to be considered as equal to 10 times the MBL of the outer strand or rope divided by the safety factor as per [6.3.4] or [6.3.5] for a steel or fibre sling, respectively.

Note 1: Coefficient 10 takes into account the strength loss due to spinning and to grommet lay.

6.3.3 SWL of slings or grommets the making of which does not comply with the requirements of this Section will be specially considered by the Society.

6.3.4 The safety factor η of slings or grommets made of steel wires, with respect to their SWL, is shown in Tab 4.

6.3.5 The safety factor η of fibre slings or grommets, with respect to their diameter ϕ and their SWL, is shown in Tab 5.

Table 4 : Safety factor of steel slings

SWL, in t	SWL ≤ 25	25 < SWL < 150	SWL ≥ 150
η	5	$3 + \frac{50}{SWL}$	3,33

Table 5 : Safety factor of fibre slings

SWL, in t	SWL ≤ 25			25 < SWL < 150	SWL ≥ 150
sling diameter ϕ , in mm	ϕ < 24	24 ≤ ϕ < 40	ϕ ≥ 40		
η	8	7	6	$3,6 + \frac{60}{SWL}$	4

Section 6 Winches

1 General

1.1 Application

1.1.1 This Section deals with winches used to operate lifting appliances excluding the other winches (for example mooring winches) which are not part of the lifting appliances and are not considered in this Rule Note.

Note 1: Other winches (mooring, towing,...) are considered as a separate equipment. However, when application is considered as possible and reasonable, this Section may be applied for these equipment.

1.1.2 For winches used in offshore handling system, reference is made to the Rule Note NR595 Classification of Offshore Handling System.

1.2 Documents to be submitted

1.2.1 The documents to be submitted to the Society are listed in Ch 1, Sec 2.

1.3 Definitions

1.3.1 Rated line Pull (RP)

The Rated line Pull (RP) of a winch is the rope tension, in kN, that the winch can haul at a specified layer and in a safe manner.

The Rated line Pull is to be defined for a specific reeled layer. For a winch having a prime mover with a constant torque:

- RP at the first reeled layer (in contact with the drum) gives the maximum rated line pull
- RP at the outermost layer gives minimum guaranteed line pull.

Note 1: When the RP specified at the outer layer is not to be exceeded at an inner layer, a pulling capacity limiter as defined in EN 14492 Power driven winches and hoists may be fitted.

1.3.2 Stall load

The stall load of a winch is the load, in kN, at which the prime mover of a power-operated system stalls or the power to the prime mover is automatically released.

The stall load is to be given in association with the relevant layer.

The stall load corresponds to the maximum torque of the power drive that the winch may provide.

1.3.3 Brake capacity

The brake capacity of a winch is the minimum rated holding force, in kN, of the static brake system at the reeled layer for which the RP is specified.

1.3.4 Required nominal force

The required nominal force is the line pull force that the winch can haul at the outer winding layer, in normal service conditions, when the drum rotates at its maximum service speed (nominal recovery speed) in order to satisfy the intended performance of the lifting appliance.

1.3.5 Pulling capacity limiter

A pulling capacity limiter is a device that prevents the winch to pull-in a load in excess of its rated or allowed overload capacity.

2 Loads

2.1 General

2.1.1 Each winch is to be designed taking into account the design loads specified in [2.2], for the structural assessment of the load bearing structure, and the functional loads defined in [2.3], for the assessment of the lifting appliance performance.

2.2 Design loads

2.2.1 The structural assessment of the winch is to be performed taking into account:

- the maximum rope tension that the winch can haul
- the brake capacity in static service conditions
- the stall load
- the total number of turns of ropes and the corresponding maximum number of rope layers on drums (attention is to be paid to the fact that for an assumed constant rope tension, the applied torque is at a maximum when the rope is at the outer layer).

2.2.2 The calculations of scantlings are to be carried out in compliance with, either international or national standards, or recognized codes or specifications.

Winches which do not fully comply with the requirements of the present Section are to be specially considered.

2.2.3 Stall load

Every winch is to be designed and set up with a stall load as specified in Tab 1, considering the maximum number of rope layers on the drum, but irrespective of speed conditions.

Table 1 : Stall load

RP, in kN	Stall load, in kN
RP < 200	1,25 RP
200 ≤ RP ≤ 500	RP + 50
RP > 500	1,10 RP
Note 1: Attention is drawn to the fact that if more severe test conditions than those provided in Ch 5, Sec 1 are required by the purchaser or National Regulations, it is necessary to ascertain that the above mentioned overload is sufficient to lift the test load provided for the lifting appliance.	

2.3 Functional loads

2.3.1 Required nominal force

To determine the required nominal force defined in [1.3.4], the efficiency of the purchase tackles and of the sheaves on which the rope is wound is to be taken into account.

3 General design principles

3.1 Drums

3.1.1 The capacity of the drum is to be sufficient to allow three layers of rope to be wounded at a maximum; unless satisfactory winding may be proven with a greater number of layers.

3.1.2 In general, three complete turns of rope are to remain on the drum after maximum anticipated rope pay-out except in stowed condition, where two safety turns of rope may be considered as sufficient.

3.1.3 Drum diameter

The diameter of the winch drum is to be determined by the Manufacturer depending on the use provided for the lifting appliance (intensive or occasional use, frequent or rare use at full capacity, fast or slow recovery speed, etc) and on the nature of the wire or fibre rope provided (number of strands, steel or fibre core) in order to ensure a sufficient useful life for the rope.

The values shown in [4.1.5] and [5.3.1] for steel wire ropes are given for guidance but they are to be considered as minimum for lifting appliances regularly used for loading and unloading cargoes and frequently operated at less that 75% of their maximum capacity (for example multipurpose cranes).

For a very rare and/or not intensive use at maximum capacity (for example derrick or crane for spare parts or supply) the indicated ratio between the drum diameter and the rope diameter may be reduced by 2 units.

On the other side, for appliances used intensively under loads near to or equal to their maximum capacity (for example, cranes for containers or grab cranes to unload dry cargoes in bulk) it is recommended to adopt greater drum diameters.

For synthetic fibre ropes, the values indicated for the steel wire ropes may be divided by 2 considering the two previous paragraphs.

3.1.4 Flanges

The drums are to be flanged at both ends so that the rope may be pulled-in or paid-out without the risk of over-riding the end flanges. For this purpose, the flange height is to be such that it projects beyond the outermost rope layer at least by 2,5 times the rope diameter when the rope is fully reeled on the drum in service, test and stowed condition of the lifting appliance. This requirement may not be complied with if the drum is fitted with a special device to avoid over-riding of the end flanges by the rope.

3.1.5 Reeling arrangement

Arrangements are to be such that a reasonably even reeling of the rope is obtained, whatever be the position of the derrick boom or crane jib. For this purpose, it is recommended that:

- the fleet angle of the rope is as small as possible (see Note) and does not exceed 4° in any working position Fig 1 gives the fleet angle when the guide block is in a fixed position)
- the drum diameter is as great as practicable (see [3.1.3], [4.1.5] and [5.3.1])
- the drum is grooved according to the diameter provided for the rope
- a coiling device is provided if need be.

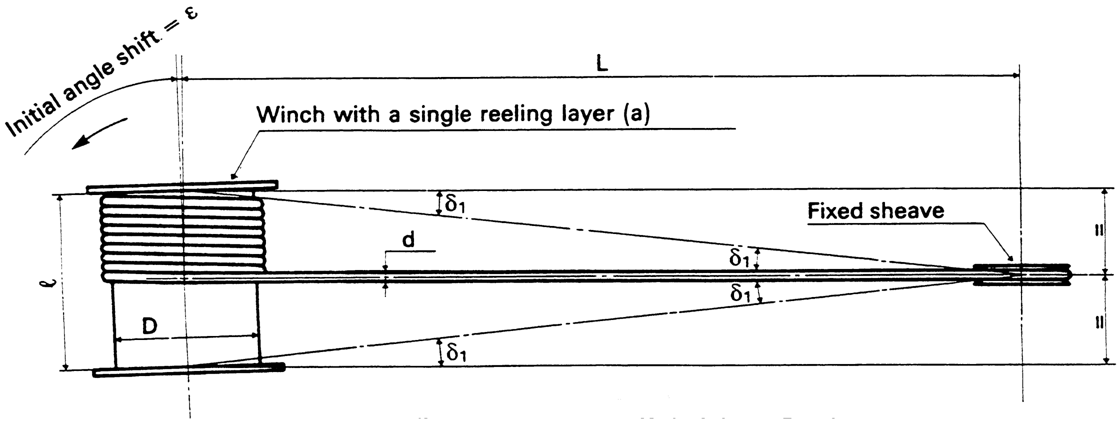
Note 1: When a single rope layer is provided, the drum axis may be shifted by a ε angle (1° approximately) equal to the slope of the spiral formed by the rope (see Fig 1) in order to reduce the maximum fleet angle which would be increased by ε without this shifting as it is the case when several reeling layers are provided (see Fig 2).

3.1.6 Rope attachment to the drum

As a rule, the end of the rope is to be attached to the winch drum in an effective manner in order to withstand without damage twice the maximum rope tension in service conditions.

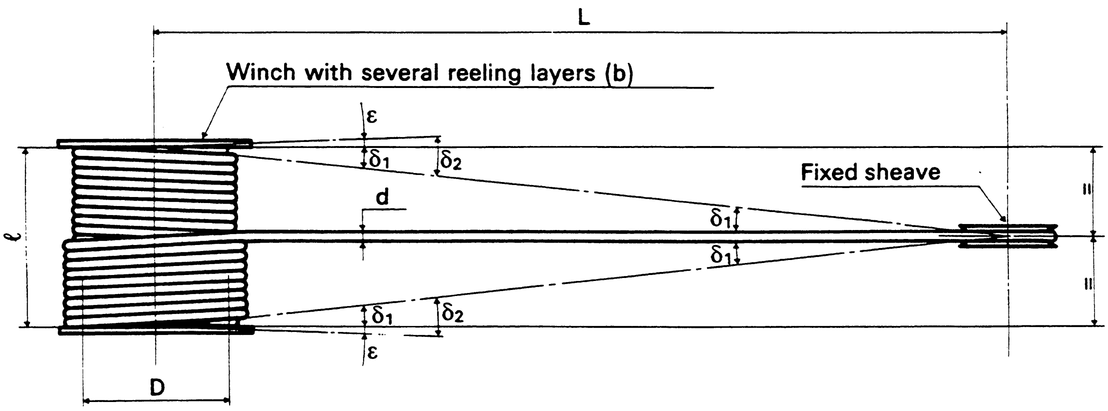
The rope anchorage is to be designed for a breaking out force not leading to a significant damage of the lifting appliance.

Figure 1 : Fleet angles



- Initial angle shift, in degree: $\varepsilon = 18,2\dfrac{d}{D+d}$
- Fleet angle at winch, in degree: $\delta_1 = 28,6\dfrac{\ell}{L}$
- Fleet angle at block: δ_1

Figure 2 : Reeling



- Fleet angle at winch: $\delta_2 = \delta_1 + \varepsilon$ $\delta_2 = 28,6\dfrac{\ell}{L} + 18,2\dfrac{d}{D+d}$
- Fleet angle at block: δ_1

3.2 Seatings

3.2.1 The seats of the winches of closed box construction are to be watertight to avoid internal corrosion.

In case of open constructions, the design is to be such that easy access for painting and maintenance be allowed.

If the seats are bolted to the ship/offshore unit, fitted bolts are to be used, unless efficient stop plates are provided to protect the bolts against shear forces.

4 Hand winches and winches not to be operated under load

4.1 General

4.1.1 The use of hand winches is normally limited to the positioning without any loading.

4.1.2 Topping winches of the lightly powered type are those which operate only when the lifting appliance boom is not loaded (not operated under load).

4.1.3 Drums of hand winches, of indirect driven winches and of lightly powered winches as per [4.1.1] and [4.1.2] (or similar winches intended for other purposes) are to be fitted with locking pawls and ratchet wheels or equivalent arrangements such as irreversible worms. Such locking devices are to be designed to withstand a holding force at least equal to 1,5 times the maximum pull applied to when the derrick boom is loaded in the most severe service conditions.

When not held in open position by hand, pawls are to fall, immediately and automatically, into the locked position.

The locking device of the indirect driven winches and of the lightly powered winches is to be connected to the winch control so that the derrick boom may not be lowered before unlocking of the drum.

An instruction plate in appropriate language (language corresponding to the ship flag and English language is recommended) is to be attached near to the controls of these winches to inform they are not to be operated when the derrick is loaded (e.g. in French/English language: NE PAS MANOEUVRER SOUS CHARGE/DO NOT ADJUST WHEN LOADED).

4.1.4 The lightly powered winches are to be fitted with a brake applied automatically and progressively to the driving motor when the winch control is on “off” position and in case of power failure.

This brake is to be capable to keep the drum in position in withstanding a force equal to 1,5 times the maximum rope tension corresponding to topping with no load at the derrick.

Such a brake is not required on the indirect driven winches provided this brake is fitted to the driving powered winch.

4.1.5 The diameter of the drums is not to be less than 12 times the diameter of the steel wire rope. However for winches driven by a separate powered winch, the diameter of the drum (or of the drum part) where the auxiliary driving rope is wound, is not to be less than 16 times the diameter of the wire rope used.

5 Powered winches and winches operated under load

5.1 Brake

5.1.1 Every self-powered winch which can be operated under load must be provided with an efficient brake capable of withstanding a force at least equal to the one shown on Tab 2 when the test conditions of the lifting appliance comply with the requirements of Ch 5, Sec 1.

Table 2 : Minimum braking force

RP, in kN	Minimum braking force, in kN
RP < 200	1,50 RP
200 ≤ RP ≤ 500	1,20 RP + 60
RP > 500	1,32 RP

5.1.2 The brake required in [5.1.1] is to be automatically applied when the drive is on “off” position or on the neutral position if there is a change-speed gear box. Its action is to be progressive in order to avoid too sudden dynamic shocks.

This brake is also to be applied automatically in the case of power failure in the supply to the motor or control device. In such a case, the cargo winches are to be provided with an emergency device allowing lowering of the suspended load. This device is to allow lowering of a load likely to exert on the drum a pull equal to the stall load of the winch.

5.1.3 On indirect driven winches which may be operated under load, the braking device as per [5.1.1] is not required provided there is such a device on the driving powered winch and there is a drum locking device capable to withstand a force at least equal to 1,5 times the RP of the winch.

5.2 Emergency stop

5.2.1 A hand-operated emergency stop is to be provided to cut off power supply and to bring the brake rapidly into operation.

5.3 Drum diameter

5.3.1 The diameter of the drum is normally not to be lower than the following value:

- 18 times the diameter of the wire rope used for the cargo winches of the derrick booms, the winches of cranes and travelling cranes
- 16 times the diameter of the wire rope used for the span and slewing winches of derrick booms.

Note 1: In general, the reduction by 2 units as per [3.1.3] (3rd paragraph) of the ratio between the drum diameter and the rope diameter applies to the winches of derrick booms.

6 Tests

6.1 General provisions

6.1.1 All the winches either directly or indirectly power-operated are to be tested at the Manufacturer's premises prior to fitting to the lifting appliance and are to be tested aboard the ship/offshore unit.

The indirectly driven winches are to be tested with this external drive.

6.1.2 The tests to be carried out at the manufacturing plant are defined:

- in [6.2] when prototypes are concerned
- in [6.3] when standardized winches are concerned, the type of which has already been submitted either to prototype tests as per [6.2] or to tests considered as equivalent.

6.1.3 Testing methods different from those described in this Section may be accepted provided they are recognized as equivalent by the Society.

6.1.4 Tests aboard the ship/offshore unit are defined in Ch 5, Sec 1.

6.2 Prototype tests

6.2.1 Dynamic tests include running tests with no load, running tests under nominal force at rope drum and overload tests (see [6.2.2], [6.2.3] and [6.2.4]).

Static tests concern braking and locking devices when they are fitted (see [6.2.5] and [6.2.6]).

6.2.2 The running test with no load is carried out at maximum speed and in continuous operation for 5 min in each direction of rotation and for each gear change.

During testing, good operation of control device and oil tightness are checked.

6.2.3 The running test under nominal force at rope drum (RP) applied to the first reeled layer is carried out at nominal speed for 30 min while hoisting and lowering a load corresponding to the RP (as a rule, the rated line pull as per [1.3.1]) through a height of 10 m. The pause between two consecutive cycles is not to exceed 20 s.

Moreover, if the winch is fitted with fixed ratio change- speed gear, good operation of the winch are to be checked for 5 min for each speed ratio with the maximum working load corresponding to each ratio. Upon each speed change-over, automatic application of the brake are to be checked when the control lever is on the neutral position.

If the winch is fitted with a continuous speed variator, a test of speed variation is to be carried out over the whole range of the possible speeds.

After these tests, several dynamic tests of the operation of the brake (at least two when the winch is recovering and two when the winch is rendering) are to be carried out at the maximum service speed.

A cut off in the power supply to the motor and the control device is to be simulated and the coming into operation of the braking device is to be checked in both cases.

The emergency stop is to be tested when the test load is lowered at its maximum speed.

During testing, the following elements are checked or measured:

- satisfactory operation
- oil-tightness
- bearing temperature
- power input
- actual speeds for recovering and rendering
- efficient working of the braking device which is to operate without sudden shocks.

6.2.4 The overload test is carried out during two hoisting/lowering cycles at least, without speed condition, with a load equal to the SWF increased by the overload shown in Tab 1. The brake will be applied to the load which will be stopped at least once during each lowering phase.

For the cargo winches, an emergency stop test is to be carried out and the test load will be lowered in using the emergency device described in [5.1.2].

6.2.5 For the statical test of the braking system, a force equal to the minimum braking force as shown on Tab 2 is to be applied for 5 min.

Drum does not rotate during testing.

6.2.6 If additional locking device is provided:

For the statical test of the locking device, a force equal to 1,5 times the maximum holding force of the winch is to be applied for 2 min.

The test is to be repeated under the same conditions with another engaged tooth.

6.3 Tests of standardized winches

6.3.1 When prototype tests are not required, i.e. when the supplier may prove that a winch of the type concerned has been tested as a prototype as per [6.2] or has been submitted to tests considered as equivalent by the Society, each winch is to be tested in the presence of a Surveyor of the Society under the conditions as per [6.3.2].

6.3.2 Each winch is to be submitted to a running test with no load at nominal speed and in continuous operation for 15 min in each direction of rotation.

During testing, the following elements are checked or measured:

- satisfactory operation
- oil tightness
- bearing temperature
- power input
- actual speeds for recovering and rendering.

Good operation of the brake is to be demonstrated when it is normally driven and in case of cut off in the power supply to the motor and the control device.

If the winch is fitted with fixed ratio change-speed gear, good operation of the winch is to be checked for 5 min for each speed ratio. Upon each speed change-over, automatic application of the brake is to be checked when the control lever is on the neutral position.

If the winch is fitted with a continuous speed variator, a test of speed variation is to be carried out over the whole range of the possible speeds.

Section 7 Electrical Installations and Hydraulic Systems

1 General

1.1 Application

1.1.1 The requirements of this Section are considered as minimum requirements for the classification or certification of lifting appliances. The attention of Owners or Manufacturers is drawn to the fact that National Regulations may include additional provisions, in particular for the safety of workers. It is the responsibility of the parties concerned to see that all applicable requirements are satisfied.

1.2 General

1.2.1 Power operated lifting appliances are to be so designed that any damage to pump, motor, monitoring system, electrical or hydraulic fluid supply will not cause the load to drop, or the appliance to be out of control and thus endanger the life of operator or of the personnel onboard.

Lifting appliances are to be fitted with automatic devices to maintain them in position in the case of power failure or rupture of hydraulic fluid pipe and means are to be provided to lower the load at controlled speed.

1.2.2 The normal power networks of the appliances handling manned submarine craft is to be supplemented by emergency ones.

Drawings showing these provisions are to be submitted.

1.3 Documentation to be submitted

1.3.1 The documents listed in Tab 1 and Tab 2 are to be submitted.

Table 1 : Documents to be submitted for electrical installations

No.	I/A **(1)**	Documents to be submitted
1	A	Single line diagram of the power distribution system
2	A	Schematic diagrams of the motor starter cabinet(s) and control/safety system
3	A	General arrangement diagram of the lifting appliance showing all essential electrical equipment (electric motor, control panels, limit switch, etc) with regards to hazardous area when applicable
4	A	Detailed specification of the safety system
5	A	Justification of the safety character of electrical equipment located in hazardous areas (when applicable)
6	A **(2)**	General arrangement of the operator cabin and workstation
7	A **(2)**	The list of the monitored parameters for alarming/monitoring and safety systems
8	I	Description of the radio control system (when applicable)

(1) A : Documents to be submitted for approval; I : Documents to be submitted for information.
(2) For crane whose SWL exceeds 50 tons.

Table 2 : Drawings, information and data to be submitted for hydraulic system and pressure vessels (hydraulic cylinders, accumulators)

No.	A/I **(1)**	Item
1	A	Diagram of hydraulic system
2	I	General arrangement plan, including nozzles and fittings
3	A	Sectional assembly
4	A	Safety valves (if any) and their arrangement
5	A	Material specifications

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

No.	A/I **(1)**	Item
6	A	Welding details, including at least: • typical weld joint design • welding procedure specifications • post-weld heat treatments.
7	I	Design data, including at least design pressure and design temperatures (as applicable)
8	I	Type of fluid or fluids contained
9	A	Scantling drawings of load carrying hydraulic cylinders (for instance the luffing cylinders of an hydraulic crane)
(1) A : Documents to be submitted for approval; I : Documents to be submitted for information.		

2 Electrical installations

2.1 General

2.1.1 Electrical installations of the lifting appliances are to comply with the requirements stipulated in NR467, Part C, Chapter 2, applicable to them and specially regarding:

- general environmental conditions
- distribution systems
- rotating electrical machines
- transformers
- semiconductors converters
- switchboards
- electrical cables
- electrical accessories
- installation
- testing.

2.1.2 For the application of requirements stipulated in NR467, Part C Chapter 2, the electrical equipment and systems are not to be considered as assuming an 'essential service' except those fitted on lifting appliances covered by a class notation **ALP** or **ALM**.

2.1.3 For lifting appliances not covered by a class notation, the electrical equipment and systems will be accepted subject to submission of the individual works' certificates issued by the manufacturers and satisfactory performances during the testing of the lifting appliances.

Reference is made to Ch 5, App 2, Tab 1.

2.2 Design arrangements

2.2.1 Electric motors, equipment and cables are to be duly protected against:

- overcurrent
- ingress of liquids, depending on their location
- ingress of solid foreign bodies, depending on their intended use
- moisture and corrosion in sea water atmosphere
- accidental shocks, depending their on location.

2.2.2 The index of protection against ingress of liquids and solid bodies of electrical equipment, in relation to their location is generally that specified in NR467, Pt C, Ch 2, Sec 3, Tab 2.

2.2.3 As general rule, no electrical equipment is to be installed within areas considered as hazardous due to generation, formation or accumulation of explosive gas or vapours or flammable particles. When for operational purpose, this requirement cannot be satisfied electrical installations are to comply with requirements specified in NR467, Pt C, Ch 2, Sec 3, [10].

2.2.4 Cables are to be carefully protected against mechanical damage. Cables and protective supports are to be installed to avoid strain and chafing and to allow free displacement during operation of the lifting appliance.

2.2.5 Unless otherwise accepted by Society, all exposed non current carrying conductive parts are to be earthed.

2.2.6 The electrical installations are to be made and tested onboard the ship/offshore unit to the satisfaction of the Surveyor of the Society.

The tests are to be performed in accordance with requirements of NR467, Pt C, Ch 2 Sec 15.

Moreover, good operation of the motors, of their various monitoring circuits and of their protective devices are to be proved with the various source of power utilized. Also, good operation of the safety equipment fed with electric power are to be checked.

2.2.7 Black-out test of main power source is to be made under real or simulated conditions to check that it will not result in an immediate danger for the lifting gear operators or crew (see [1.2.1]).

3 Hydraulic and pneumatic systems

3.1 Hydraulic systems

3.1.1 Hydraulic installations of the lifting appliances are to comply with the applicable requirements of NR467, Pt C, Ch 1, Sec 3 and NR467, Part C, Ch 1, Sec 10 taking into account [3.1.3] to [3.1.7].

3.1.2 Except for lifting appliances covered by a class notation **ALP** or **ALM**, pumps and hydraulic motors need not be certified by the Society at the manufacturer's works provided that they are produced in series and manufactured according to a recognised standard. In addition, their acceptance is subject to the submission of manufacturer's test certificates and to satisfactory performance during the testing of the lifting appliances.

Reference is made to Ch 5, App 2, Tab 1.

3.1.3 The design pressure of a piping system is the pressure considered by the manufacturer to determine the scantling of the system components. It is not to be taken less than the maximum working pressure expected in this system or the highest setting pressure of any safety valve or relief device, whichever is the greater.

3.1.4 Hydraulic equipment are to be duly protected against:

- overpressure
- oil pollution (abrasive particles)
- corrosion
- accidental shocks.

3.1.5 The general principle specified in [1.2.1] are to be taken into account for the design of hydraulic fluid systems.

3.1.6 Pressure pipes are to satisfy the applicable requirements of NR467, Pt C, Ch 1, Sec 10.

Flexible pipes are to be of approved type as per requirements of NR467, Pt C, Ch 1, Sec 10.

Reference is made to Ch 5, App 2.

3.1.7 Hydraulic systems is to be hydraulic tested after assembly onboard under the conditions defined in NR467, Pt C, Ch 1, Sec 18.

3.2 Hydraulic cylinders

3.2.1 The minimum thickness t of the steel cylindrical shell of luffing or slowing hydraulic cylinders is given, in mm, by the following formula:

$$t = \frac{pD}{(2K - p)e}$$

where:

p : Design pressure, in MPa

D : Inside diameter of the cylinder, in mm

e : Efficiency of welded joint as defined in NR467, Pt C, Ch 1, Sec 10, [2.4.2]

K : Permissible stress, in N/mm²

Where not otherwise specified, the permissible stresses K, may be taken as the minimum of the values obtained by the following formulae:

$K = R_{m,20} / A$

$K = R_S / B$

Coefficient of utilisation A and B are defined in Tab 3

$R_{m,20}$: Specified minimum tensile strength at ambient temperature, in N/mm²

R_S : Minimum between R_{eH} and $R_{p\,0.2}$ at the design temperature T, in N/mm².

Table 3 : Coefficients of utilisation

	Steel	Cast steel	Nodular cast iron
A	2,7	3,4	4,5
B	1,8	2,3	3,5

The thickness obtained is "net" thickness, as it does not include any corrosion allowance. The thickness obtained by the above formula is to be increased by 0,75mm.

The Society reserves the right to increase the corrosion allowance value in the case of vessels exposed to particular accelerating corrosion conditions. The Society may also consider the reduction of this factor where particular measures are taken to effectively reduce the corrosion rate of the vessel.

Irrespective of the value calculated by the formula, the thickness t is not to be less, in mm, than the following:

$t = 3 + D/1500$

No corrosion allowance needs to be added to the above value.

Note 1: the formula of t is applicable if the ratio external diameter/inside diameter is equal to or less than 1,5, if not the cylinder is subject to special consideration.

3.2.2 The thickness of the bottom and of the head of the cylinder is to comply with the applicable requirements of NR467, Pt C, Ch 1, Sec 3.

In this calculation the reinforcement of the cover due to the fixation of the cylinder (often welded on the cover) with the crane is not taken into account.

3.2.3 Scantlings of piston rods are to be checked for buckling according to the following strength criterion:

$\omega \, \sigma_c \leq 0,55 \, R_e$

where:

ω : Buckling coefficient defined in Sec 3, [2.4.3] with effective length of buckling equal to twice the maximum reach of cylinder rod

σ_c : Compression stress, in N/mm^2

R_e : Design yield stress, in N/mm^2, considered in calculations of cylinder rod resistance (see Sec 3, [2.3.3]).

3.2.4 Cast steel or spheroidal graphite ferritic cast iron shells of hydraulic cylinders are to be ultrasonic-tested for internal soundness.

3.2.5 Fastening of cylinder bottoms and of cylinders are to be checked by direct calculations. Combined stress are not to exceed $0,55 \, R_e$.

For welded bottoms, all welds are to be checked using appropriate non-destructive methods.

3.2.6 Cylinders are to be hydraulic tested prior to fitting onboard under the conditions defined in NR467, Pt C, Ch 1, Sec 3.

3.3 Pneumatic equipment

3.3.1 Design is to be established on the same basis as hydraulic equipment.

3.3.2 It is to be demonstrated that level of safety is not less than that which would be achieved by hydraulic equipment ensuring same functions and performances.

Section 8 Control and Safety Systems

1 General

1.1 Application

1.1.1 The present Section provides general requirements for the design, construction and testing of control and safety systems for lifting appliance.

1.1.2 The attention of the Owners, the Operators or the Manufacturers is drawn to the fact that additional provisions may be required by applicable National Regulations.

1.2 Safety principles

1.2.1 Lifting appliances are to be designed so that any damage to pump, motor, monitoring system, electrical or hydraulic fluid supply will not cause the load to drop or the appliance to be out of control and thus endanger the life of operators or of the personnel onboard.

1.2.2 Lifting appliances are to be fitted with automatic devices to maintain them in position in the case of power failure or rupture of any hydraulic fluid pipe under pressure. In such a case means are to be provided to lower the load at controlled speed.

1.3 General provisions

1.3.1 The control systems of lifting appliances covered by a class notation **ALP**, **ALM** are to comply with the requirements stipulated in NR467, Part C, Ch 3 as applicable to essential services. It includes:

- general environmental conditions
- computer based systems
- constructional requirements
- installation requirements
- testing and electromagnetic interferences.

1.3.2 The general principle specified in Sec 7, [1.2.1] is to be taken into account for the design of control and safety devices.

2 Control devices

2.1 General

2.1.1 Control devices are generally to be provided with automatic transfer to neutral position (dead man's control) which automatically actuates the braking device. Efficient means are to be provided to lock the control device in this position.

2.1.2 Control levers or wheels are to be so designed that the motion for their actuation corresponds as far as practicable to the motion of the load or lifting appliance, in particular:

- for load lifting, upward topping, winch recovering, braking manoeuvres, the operator is to pull the lever or turn the wheel clockwise
- for load lowering, downward topping, winch rendering or brake release manoeuvres, the operator is to push the lever or turn the wheel counterclockwise
- for right-hand side slewing manoeuvres, the operator is to push the lever to the right or turn the wheel clockwise and vice-versa.

2.1.3 The force required to apply the brake is not to exceed:

- 160 N (hand brakes), and
- 320 N (foot brakes).

2.2 Radio controls

2.2.1 Radio controls may be admitted provided that the system provides the same safety level as a hardwired system.

The emergency stop functions are to meet the category 3 requirements of the ISO 13849-1:2015 Safety of machinery - Safety related parts of control systems - Part 1: General principles for design.

In addition special precautions are to be taken to prevent that parasitic electromagnetic interference affect the radio control equipment which could lead to an unsafe situation.

3 Safety devices

3.1 Emergency stop

3.1.1 An emergency stop device is to be provided at each control station of powered lifting appliances or apparatus to stop their motions, in case of emergency, in cutting off the power-supply. This device are to be so designed and located as to prevent its being actuated inadvertently.

3.2 Limit switches

3.2.1 Limit switches are to be provided on cranes lifting and luffing manoeuvres as well as on travelling gantry cranes lifting/ translation and carriage translation manoeuvres.

When actuated, the limit switch is to stop the manoeuvre in course without preventing the reverse of the motion that triggered it off, and it is to be possible to re-engage it.

Operation indicator is to be provided at control station for each limit switch.

For crane whose SWL does not exceed 10 tons, indicators may be omitted provided that the crane operator has an unobstructed view of the crane movements.

In general, it is not to be possible to overrun limit switches, except when lifting appliance is to be in stowed position or examined for maintenance.

3.2.2 Limit switches are also to be provided whenever slewing of cranes is to be limited for any reason.

3.3 Load indicator

3.3.1 Cranes whose lifting capacity varies according to span, or whose SWL exceeds 50 t, are to be provided with a load indicator unless a load moment indicator is fitted.

Such indicators are to trigger off a visual alarm whenever the load or moment reaches 94% of the permissible value (with a permissible allowance of ± 4%).

An audible alarm is to be triggered off when this permissible value is overstepped by 6% (with a permissible allowance of ± 4%).

If load (or load moment) indicator automatically cuts off driving power when lifting capacity is exceeded, its setting will never exceed 110% of SWL (or 110% of the permissible moment). In this case, it is to be possible to manoeuvre the lifting appliance back to a more favourable position.

3.3.2 In every case when the SWL of the lifting appliance is not constant, the diagram of the permissible loads all over the working area is to be posted at the control station.

3.4 Other indicators

3.4.1 Level indicator (listmeter and trimmeter) is to be provided at control station when list and trim angles are limited to pre-set figures requiring either prior ballasting of the ship/offshore unit or reballasting during manoeuvres.

3.5 Protecting devices

3.5.1 All machinery dangerous parts (engines, gears, chain and bet gearing) are to be effectively guarded, unless they are in such a position or of such a construction as to be as safe as they would be if effectively guarded.

3.5.2 All removable parts likely to become loose or to be displaced from their housing due to vibrations, dynamic forces or accidental shocks are to be provided with appropriate brakes or locking devices.

A device is to be provided to prevent lifting out of derrick boom goosenecks.

3.6 Alarms

3.6.1 An alarm signal is to be provided at lifting appliance control station in case of electric motor failure or power failure.

3.6.2 A low pressure alarm at the discharge of the pump and a hydraulic tank low level alarm are to be provided at the control station.

The low level alarm is to be activated before the quantity of lost oil reaches 100 litters or 70% of the normal volume in the tank, whichever is the less.

For hydraulics cranes not fitted with an electrical control system, the low level and the low pressure alarms may be waived if the level gauge, the pressure gauge and the temperature gauge indicators are always visible by the crane operator. In addition, a warning label is to be placed on the tank reminding that, prior to start any operation of the crane, the oil level is to be checked.

It is reminded that the hydraulic tank level gauge is to comply with NR467, Pt C, Ch 1, Sec 10, [2.9.2]. The Society may permit the use of oil-level gauges with flat glasses and self-closing valves between the gauges and hydraulic oil tanks.

Special consideration could be given for installations with small hydraulic tanks located outside the machinery spaces.

3.6.3 Gantry cranes are to be fitted with audible and visual warning signals. These signals are to be activated when the crane is travelling.

Appendix 1 Loads due to Wind on Structures

1 General

1.1 Application

1.1.1 This Appendix provides guidance for the assessment of the loads due to the wind. Other method may be accepted when duly justified.

1.2 Wind pressure

1.2.1 The design wind speed given in Sec 2, [4.1.2] is the speed V_{10} of the wind at the height of 10 m above sea level. The wind speed V prevailing at the height of H above sea level may be obtained through following formula:

$$V = V_{10}\sqrt{2,5\frac{H+66}{H+180}}$$

where H is given in m.

1.2.2 The basic aerodynamic pressure p_0 , in daN/m²,is given by the formula:

$$p_0 = \frac{V^2}{16}$$

where V is given in m/s.

1.2.3 The design aerodynamic pressure p_d , in daN/m², is equal to:

$p_d = p_0 \, C_d$

where:

p_0 : Basic aerodynamic pressure defined in [1.2.2]

C_d : Drag coefficient depending on the shape and making-up of the elements. See Tab 1.

Regarding truss tower of square-shaped cross-section:

- when $\varphi < 0,08$:
  the truss may be neglected
- when $\varphi > 0,40$:
  the element may be considered as solid, equivalent to its envelope, and C_d may be taken equal to 1,0.

Where:

φ : Filling truss ratio, i.e. ratio of the area of the solid element to the envelope area of the truss element.

1.2.4 Shading effects of one beam with respect to another are not to be considered when:

$b / h \geq 6$ or $b / (\varphi h) > 20$

where:

b : Net distance, in m, between the beams

h : Height, in m, of the shading beams

φ : Filling truss ratio.

In the other cases, the following down scaling coefficient β is to be applied to the shaded part of the beam:

- when $\varphi > 0,6$:
  $\beta = \beta_0$
- when $\varphi \leq 0,6$:
  $\beta = \beta_0 + (1,1 - \beta_0)\,(1 - 1,67\,\varphi)^{c}$

where:

$$\beta_0 = 0,1\frac{b}{h} + 5,7\left[10^{-5}\left(\frac{b}{h}\right)^5\right]$$

$$c = \left(\frac{5h}{b}\right)^{0,2}$$

1.2.5 The effect of the wind onto the load may be also evaluated according to previous principles. For the 10 ft standard container, C_d will be taken as 1,2.

Table 1 : Drag coefficient C_d

Element		Drag coefficient C_d
type	made of	
Solid beams of length L and height h (I type, H type, etc)		1,16 + 0,022 L/h
Round-shaped beams		0,6
Plane truss	beams of any section	2 – 0,8 φ
	pipes	0,60 (2 – 0,8 φ)
Truss tower of square-shaped cross-section, with wind perpendicular to one face	beams of any section	3,2 – 2 φ
	pipes	0,70 (3,2 – 2 φ)
Truss tower of square-shaped cross-section, with wind along a diagonal	beams of any section	1,20 (3,2 – 2 φ)
	pipes	0,85 (3,2 – 2 φ)
Truss tower of triangular cross-section	beams of any section	3,2 – 4 φ with $C_d \geq 2,0$
	pipes	0,70 (3,2 – 4 φ) with $C_d \geq 1,4$

Appendix 2 Efficiencies of Sheaves and Tackles

1 General

1.1 Application

1.1.1 Efficiencies of sheaves and tackles are to be taken into account in order to determine the maximum loads transmitted to the structure and the maximum ropes tensions.

1.2 Efficiency of sheaves

1.2.1 The efficiency coefficient k for sheaves with plain or bushed bearings is assumed to be equal to 0,95 for normal-sized sheaves.

1.2.2 The efficiency coefficient k for the sheaves on ball-bearings or roller-bearings is assumed to be equal to 0,98 for normal-sized sheaves.

1.3 Efficiency of the tackles

1.3.1 The efficiency of the tackles depends on the number of parts of rope n of the purchase.

Fig 1(a) and (b) determine the tensions t_0, t_1, ..., t_i, ..., t_{n-1} and t_n in each part of rope of the tackle submitted to a unit force. The tackles shown on these figures have the same number of parts of rope n and are equivalent.

1.3.2 The tensions t_0, t_i, t_n and t_{n-1} may be obtained in applying the following formula for a tackle with n parts of rope:

- when hoisting the load:

$$t_0 = k^{n-1}\frac{1-k}{1-k^n}$$

$$t_i = \frac{t_0}{k^i}$$

$$t_n = \frac{1}{k}\frac{1-k}{1-k^n}$$

$$t_{n-1} = t_n k$$

- when lowering the load:

$$t_0 = \frac{1-k}{1-k^n}$$

$$t_i = t_0 k^i$$

$$t_n = k^n\frac{1-k}{1-k^n}$$

$$t_{n-1} = \frac{t_n}{k}$$

The formula giving the tension t_i in the rope when a unit force is applied to the tackle remain valid when $i > n$ and allow direct calculation of the rope tension when it is reeved on lead blocks after the tackle. The rope tension at the j^{th} lead block after the tackle is:

- when hoisting:

$$t_{n+j} = \frac{t_0}{k^{n+j}}$$

- when lowering:

$$t_{n+j} = t_0 k^{n+j}$$

1.3.3 Tab 1 gives the values for t_0, t_{n-1} and t_n, upon hoisting and lowering when a unit force is applied to the tackle.

For a non unit force F, the rope tensions T_i are:

$T_i = F\ t_i$

1.3.4 The efficiency of the tackles and lead blocks is to be taken into account to determine the required minimum breaking load of the steel and fibre ropes.

1.3.5 The efficiency of the tackles and lead blocks is usually taken into account to determine the SWL of the items of loose gear; however it may be neglected partly or wholly when its effect is not significant for the purpose of choosing standard items of loose gear.

Figure 1 : Tension in the rope parts of a tackle

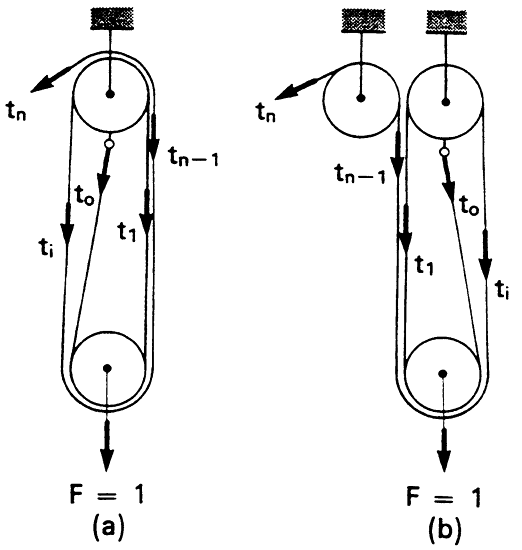


Table 1 : Tension in rope parts of a tackle

Number of parts of rope n	Roller bearing blocks k = 0,98						Plain bearing blocks k = 0,95					
	Hoisting			Lowering			Hoisting			Lowering		
	t_0	t_{n-1}	t_n	t_0	t_{n-1}	t_n	t_0	t_{n-1}	t_n	t_0	t_{n-1}	t_n
1	-	1,0	1,02	-	1,0	0,98	-	1,0	1,05	-	1,0	0,95
2	0,495	0,505	0,515	0,505	0,495	0,485	0,487	0,513	0,540	0,513	0,487	0,463
3	0,327	0,340	0,347	0,340	0,327	0,320	0,316	0,351	0,369	0,351	0,316	0,301
4	0,242	0,258	0,263	0,258	0,242	0,238	0,231	0,270	0,284	0,270	0,231	0,220
5	0,192	0,208	0,212	0,208	0,192	0,188	0,180	0,221	0,233	0,221	0,180	0,171
6	0,158	0,175	0,179	0,175	0,158	0,155	0,146	0,189	0,199	0,189	0,146	0,139
7	0,134	0,152	0,155	0,152	0,134	0,132	0,122	0,166	0,174	0,166	0,122	0,116
8	0,116	0,134	0,137	0,134	0,116	0,114	0,104	0,149	0,156	0,149	0,104	0,099
9	0,102	0,120	0,123	0,120	0,102	0,100	0,090	0,135	0,142	0,135	0,090	0,085
10	0,091	0,109	0,112	0,109	0,091	0,089	0,079	0,125	0,131	0,125	0,079	0,075
11	0,082	0,100	0,102	0,100	0,082	0,080	0,069	0,116	0,122	0,116	0,069	0,066
12	0,074	0,093	0,095	0,093	0,074	0,073	0,062	0,109	0,114	0,109	0,062	0,059
13	0,068	0,087	0,088	0,087	0,068	0,067	0,055	0,103	0,108	0,103	0,055	0,053
14	0,062	0,081	0,083	0,081	0,062	0,061	0,050	0,098	0,103	0,098	0,050	0,048
15	0,058	0,076	0,078	0,076	0,058	0,056	0,045	0,093	0,098	0,093	0,045	0,043
16	0,053	0,072	0,074	0,072	0,053	0,052	0,041	0,089	0,094	0,089	0,041	0,039
17	0,050	0,069	0,070	0,069	0,050	0,049	0,038	0,086	0,090	0,086	0,038	0,036
18	0,047	0,066	0,067	0,066	0,047	0,046	0,035	0,083	0,087	0,083	0,035	0,033
19	0,044	0,063	0,064	0,063	0,044	0,043	0,032	0,080	0,085	0,080	0,032	0,030
20	0,041	0,060	0,061	0,060	0,041	0,040	0,029	0,078	0,082	0,078	0,029	0,028

Appendix 3 Pad Eye Design

Symbols

P_L : Design load on pad eye, in kN, as defined in Article [3]

R_e : Design yield stress, in N/mm^2, as defined in Sec 3, [2.3.3].

1 General

1.1 Application

1.1.1 This Appendix provides guidelines for the design of pad eyes fitted on lifting appliances or intended for lifting operations.

1.1.2 The prescriptive requirements provided in the present Appendix are for typical pad eye design as shown on Fig 1. For pad eye of an unusual type, the Society may require additional verifications.

1.2 Recognized standards

1.2.1 Standards and codes of practice recognized for pad eye design are listed below:

- AISC 360-10, American Institute of Steel Construction
- EN 1993 - Eurocode 3 - Design of Steel Structure.

Other standards may be accepted by the Society on a case-by-case basis.

2 Pad eye design

2.1 Geometry

2.1.1 Pad eyes dimensions shown in Fig 1 are in mm.

2.1.2 In order to prevent lateral bending moments, pad eyes are to be aligned with the rope or the sling to the centre of lift, with a maximum manufacturing tolerance of ± 2,5°.

2.1.3 The diameter of holes in pad eyes is to match the shackle used, clearance between shackle pin and pad eye hole is not to exceed 6% of the nominal shackle pin diameter.

2.1.4 The tolerance between pad eye thickness and inside width of shackle is not to exceed 25% of the inside width of the shackle.

2.1.5 Pad eyes are to be so designed as to permit free movement of the shackle and sling termination without fouling the pad eyes.

2.2 Welding

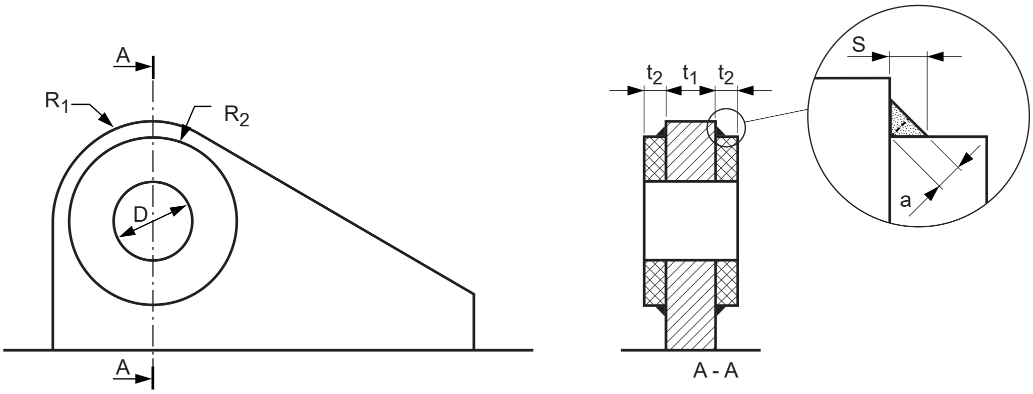
2.2.1 Welding of pad eyes on their supporting structure is to be made with full penetration.

3 Design load

3.1 Pad eye fitted on the lifting appliance

3.1.1 When fitted on the lifting appliance, the design load on a pad eye, P_L, is to consider the design load and loading cases defined in Sec 2 including dynamic effects.

Figure 1 : Typical pad eye



4 Structural assessment

4.1 General

4.1.1 Typical pad eyes are to comply with the strength criteria specified in this Article. Pad eyes with special design may need a local Finite Element Model to obtain the actual stresses.

4.1.2 Both the shear tear out, bearing pressure, Hertz contact stress and cheek plates welding criteria are to be satisfied.

4.2 Shear tear out

4.2.1 The shear tear out occurs in two directions.

The shear tear out stress is to comply with the below criterion:

$$\frac{P_L}{2\left[(R_1 \times t_1 + 2R_2 \times t_2) - \frac{D}{2}(t_1 + 2t_2)\right]}10^3 \leq 0,4R_e$$

4.3 Diametrical bearing pressure

4.3.1 Diametrical bearing pressure is to comply with the below criterion:

$$\frac{P_L}{D_P \times (t_1 + 2t_2)}10^3 \leq 0,9R_e$$

D_P : Pin diameter in mm.

4.4 Hertz contact stress

4.4.1 Hertz contact stress is to comply with the below criterion:

$$18,69\sqrt{\frac{P_L \times E \times (D - D_P)}{D \times D_P \times (t_1 + 2t_2)}} \leq 2,5R_e$$

where:

E : Young's modulus (206 000 MPa for steel).

4.5 Cheek plates welding

4.5.1 When cheek plates are fitted on the pad eye, the cheek welding stress is to comply with the below criterion:

$$\frac{P_L \times t_2}{a \times \pi R_2 \times (t_1 + 2t_2)}10^3 \leq 0,4R_e$$

where:

a : Weld throat in mm.

4.6 Pad eye connection to the structure

4.6.1 Any critical section of the connection with the structure is to be checked against Von Mises combined stress, σ_{VM}, with the below criterion:

$\sigma_{VM} \leq 0,85\ R_e$

Appendix 4 Buckling Assessment of Plane Plate Panels

Symbols

E : Young's modulus, in N/mm², to be taken equal to:

- for steels in general:

  $E = 2,06.10^5$ N/mm²

- for stainless steels:

  $E = 1,95.10^5$ N/mm²

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

R_e : Design yield stress, in N/mm², of the plating material as defined in Sec 3, [2.3.3]

a, b : Lengths, in m, of the sides of the plate panel, as shown in Fig 1

t : Thickness, in mm, of the plate panel

η : Safety factor defined in Sec 3, [2.3.2]

1 General

1.1 Application

1.1.1 The requirements of this Appendix apply for the buckling check of plating subjected to in-plane compression stresses, acting on one.

Rectangular plate panels are considered as being simply supported. For specific designs, other boundary conditions may be considered, at the Society's discretion, provided that the necessary information is submitted for review.

1.2 Sign convention for normal stresses

1.2.1 The sign convention for normal stresses is as follows:

- tension: positive
- compression: negative.

2 Buckling assessment

2.1 Compression and bending

2.1.1 For plate panels subjected to compression and bending along one side, as shown in Fig 1, side "b" is to be taken as the loaded side. In such case, the compression stress varies linearly from σ1 to σ2= ψ σ1 (ψ ≤ 1) along edge "b".

Figure 1 : Buckling of a simply supported rectangular plate panel subjected to compression and bending

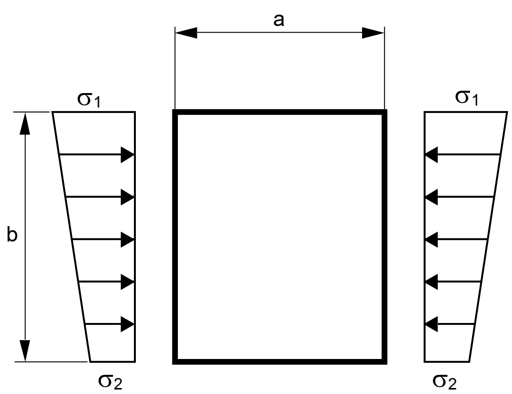


Table 1 : Buckling factor K_1 for plane panels

Load pattern	Aspect ratio	Buckling factor K_1
$0 \le \psi \le 1$	$\alpha \ge 1$	$\frac{8,4}{\psi + 1,1}$
	$\alpha < 1$	$\left(\alpha + \frac{1}{\alpha}\right)^2 \frac{2,1}{\psi + 1,1}$
$-1 < \psi < 0$		$(1+\psi)K_1' - \psi K_1'' + 10\psi(1+\psi)$
$\psi \le -1$	$\alpha \frac{1-\psi}{2} \ge \frac{2}{3}$	$23,9\left(\frac{1-\psi}{2}\right)^2$
	$\alpha \frac{1-\psi}{2} < \frac{2}{3}$	$\left(15,87 + \frac{1,87}{\left(\alpha\frac{1-\psi}{2}\right)^2} + 8,6\left(\alpha\frac{1-\psi}{2}\right)^2\right)\left(\frac{1-\psi}{2}\right)^2$

Note 1:

$\psi = \frac{\sigma_2}{\sigma_1}$

K_1' : Value of K_1 calculated for $\psi = 0$

K_1'' : Value of K_1 calculated for $\psi = -1$

2.2 Critical stresses

2.2.1 Compression and bending for plane panel

The critical buckling stress σ_{cr} is to be obtained, in N/mm², from the following formulae:

$$\sigma_{cr} = \sigma_E \quad \text{for } \sigma_E \le \frac{R_e}{2}$$

$$\sigma_{cr} = R_e\left(1 - \frac{R_e}{4\sigma_E}\right) \quad \text{for } \sigma_E > \frac{R_e}{2}$$

where:

σ_E : Euler buckling stress, to be obtained, in N/mm², from the following formula:

$$\sigma_E = \frac{\pi^2 E}{12(1-\nu^2)}\left(\frac{t}{b}\right)^2 K_1 \varepsilon 10^{-6}$$

K_1 : Buckling factor defined in Tab 1

ε : Coefficient to be taken equal to:

- $\varepsilon = 1,00$ for $\alpha \ge 1$
- $\varepsilon = 1,05$ for $\alpha < 1$

with $\alpha = a / b$.

2.3 Checking criteria

2.3.1 For plate panels subjected to compression and bending on one side, the critical buckling stress is to comply with the following formula:

$$\eta\sigma_{cr} \ge |\sigma_F|$$

where:

σ_{cr} : Critical buckling stress, in N/mm², defined in [2.2.1]

σ_F : Maximum compression stress, in N/mm², acting on side "b" of the plate panel.

In equivalence to the previous criteria on the critical buckling stress, the thickness, in mm, is to comply with the following formulae:

$$t = \frac{b}{\pi}\sqrt{\frac{12|\sigma_F|(1-\nu^2)}{\eta E K_1 \varepsilon}}10^3 \quad \text{for} \quad \sigma_E \le \frac{R_e}{2}$$

$$t = \frac{b}{\pi}\sqrt{\frac{3R_e^2(1-\nu^2)}{E K_1 \varepsilon\left(R_e - \frac{|\sigma_F|}{\eta}\right)}}10^3 \quad \text{for} \quad \sigma_E > \frac{R_e}{2}$$

CHAPTER 3
SPECIAL APPLICATIONS

Section 1 Offshore Cranes

1 General

1.1 Application

1.1.1 The present Section provides additional requirements for the certification of lifting appliances intended to perform lifting operations at sea and installed on ships, floating units or fixed offshore facilities.

1.2 Lifting of personnel

1.2.1 When in addition to lifting operation in offshore conditions, the lifting appliance is intended to perform lifting of personnel, it is to comply with Sec 3 in addition to the present Section.

1.2.2 The lifting appliance is to be able to operate at a speed equal to the ratio of the wave height to its period, when a consistent system of units is used.

1.2.3 Operational procedure for lifting of personnel are to be included in the operating manual described in [1.4.1].

1.3 Other codes and standards

1.3.1 The technical provisions of the following codes and standards may be considered by the Society:

- EN 13852-1:2013 Cranes - Offshore cranes - General purpose offshore cranes.
- EN 13852-2:2004 Cranes - Offshore cranes - Floating cranes

Other codes and standards may be considered by the Society.

1.4 Document to be submitted

1.4.1 The following documents are to be submitted in addition to those listed in Ch 1, Sec 2:

- Load chart including de-rating of the SWL with respect of the environmental conditions (sea states, wind) for approval
- Dynamic amplifications factors for information
- When a motion compensation or rope tensioning system as specified in [3.5] is fitted, the following is to be submitted for information:
  - description of the system
  - operational limitations
  - FMEA report.
- For information, operating manual with instructions for:
  - the controls and systems specified in Articles [4] and [5]
  - the verification of the environmental conditions prior to use the lifting appliance.

In addition, when the crane is provided with additional safety features as described in Article [5], the following documents are to be provided for information:

- Rated capacity limiter:
  - description of the system
  - testing procedure
- Overload protection system:
  - description of the system
  - FMEA report
  - testing procedure
- Emergency operation system:
  - description of the system
  - testing procedure.

2 Design loads

2.1 General

2.1.1 For the purpose of application of Chapter 2, the provisions of this Article are to be considered in addition to the ones of Ch 2, Sec 2.

2.1.2 The design of the lifting appliance performing lifting in offshore conditions is to be assessed considering in particular the following design loads:

- loads due to self-motions and accelerations of the lifting appliance applied on its deadweight and on the lifting load (see Ch 2, Sec 2, [2])
- loads due to the motions and accelerations of the crane support unit and the unit supporting the lifted cargo (see [2.3] and [2.4])
- loads due to ship/offshore unit inclinations [2.5])
- wind loads (see [2.6])
- other out of plane influence ([2.7]).

Other design loads due to self-motions of the lifting appliances and deadweight are to be taken from Ch 2, Sec 2.

2.2 Duty categories

2.2.1 Duty category of the lifting appliance performing lifting in offshore conditions is to be selected based the specific provisions of Ch 2, Sec 2, [1.2].

2.3 Vertical dynamic amplification factors

2.3.1 General

The vertical dynamic amplification factor at the hook due to the motions and accelerations of the crane support unit and the unit supporting the lifted cargo, α_{CZ}, is to be calculated from the following formula:

$$\alpha_{CZ} = 1 + \frac{V_R}{g}\sqrt{\frac{C}{R_i}}$$

Where:

C : Stiffness of the lifting appliance, in N/m, calculated from the hook to the pedestal as specified by the crane manufacturer. The stiffness values with respect to lifting appliance configuration, luffing angle and height of hook are to be justified.

R_i : Rated capacity, in kg, for a given sea state.

V_R : Relative velocity between the boom tip and the load at the time of pick-up, in m/s, to be taken equal to:

$$V_R = \sqrt{V_D^2 + V_C^2}$$

With:

V_D : Vertical velocity of the unit supporting the lifted cargo, in m/s.

V_C : Vertical velocity of the boom tip of the lifting appliance, in m/s. For lifting appliances supported by a bottom fixed structure $V_C = 0$ m/s.

The above velocities are to be taken from a recognized standard (e.g. EN 13852) or justified by the Party applying for certification.

As an alternative, the vertical acceleration may be obtained by direct analysis when duly justified.

Note 1: Fitting of shock absorbing devices are to be specially considered, with a view to reducing the provisional α_{CZ}.

2.3.2 Alternative for SWL of up to 100 t

As an alternative to [2.3.1], when the crane support unit is a monohull and the Safe Working Load of the lifting appliance is not more than 100 t, the vertical dynamic amplification factor, α_{CZ}, may be taken as a guidance from Fig 1 with respect to the maximum significant wave height H_S intended.

2.3.3 The vertical dynamic amplification factor applied on the dead weights, α_{GZ}, is to be assessed based on the crane supporting unit accelerations.

As an alternative, α_{GZ} may be assessed using the formula specified in Ch 2, Sec 2, [3.3.1].

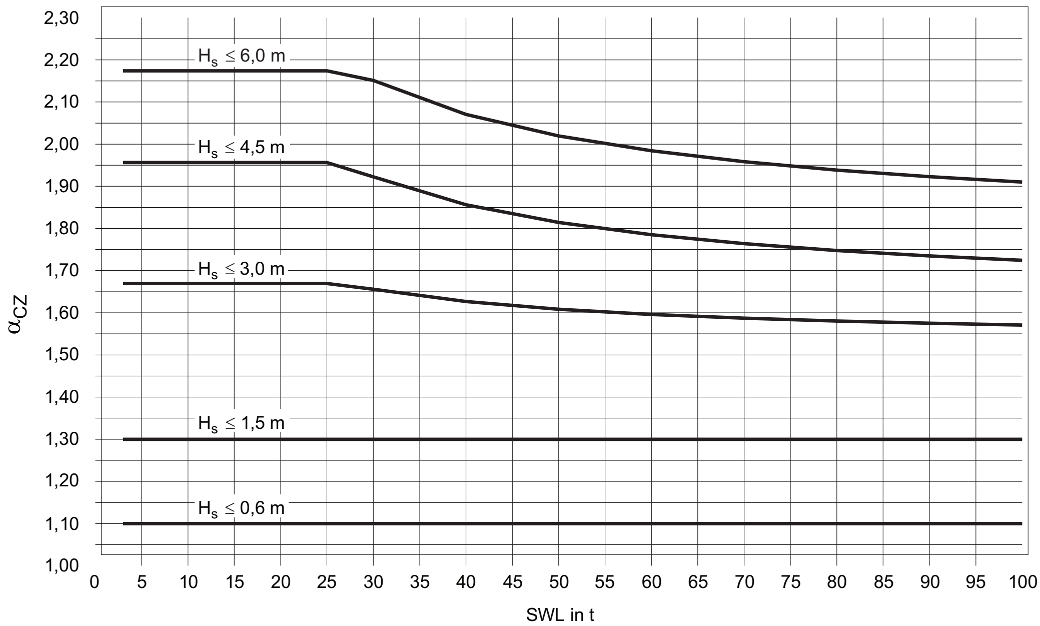
For lifting appliances supported by a bottom fixed structure, α_{GZ} is taken equal to 1.

2.4 Horizontal dynamic amplification factors

2.4.1 The horizontal accelerations are to be calculated based on the motions and accelerations of the crane support unit.

As an alternative, the horizontal motions and accelerations may be assessed using the formulae specified in Ch 2, Sec 2, [3.4].

Figure 1 : Guidance for vertical dynamic amplification factor assessment



2.5 Inclination of the supporting unit

2.5.1 When the lifting appliance is installed on a floating unit the effects of the unit's static inclinations are to be considered.

2.5.2 The minimum list and trim of the floating units are to be taken from Tab 1.

Table 1 : Minimum list and trim

	List	Trim
Surface unit	5°	2°
Column stabilized unit	3°	3°
Tension Leg Platform	0°	0°
Bottom fixed structure	0°	0°

2.5.3 Values different from those defined for list and trim angles may possibly be accepted by the Society provided that special arrangements are made to ensure that they are not exceeded in operation and provided suitable instructions are attached to the ship’s Register of Lifting Appliances and Cargo Handling Gear.

2.6 Wind loads

2.6.1 Wind loads are to be considered with the following minimum velocities:

- 25 m/s for lifting appliance in service
- 63 m/s for out of service or stowed position.

Note 1: Lower values of wind velocities may be possible provided that special arrangements are made to ensure that they are not exceeded in operation and provided suitable instructions for the crane operator are written in the operating manual.

2.6.2 Guidance on the calculations of the loads due to wind on structures is provided in Ch 2, App 1.

2.7 Out of plane loads

2.7.1 The effects of offlead and sidelead are to be considered, taking into account, as a minimum:

- the wind load on the lifted cargo

Note 1: As a minimum, the horizontal wind force on a standard 10 feet container is to be considered.

- the inclinations specified in [2.5]
- the offlead displacement of the load, O, on the supply vessel deck relative to the boom tip, in m:

$$O = 2,5 + 1,5 H_S$$

H_S : Significant wave height, in m

- the sidelead displacement of the load, S, on the supply vessel deck relative to the boom tip, in m:

$$S = 0,5 x O$$

3 Equipment and machinery

3.1 Rope

3.1.1 The safety factors for wire and synthetic ropes are to comply with the requirements given in Ch 2, Sec 5, [2].

3.2 Slewing system

3.2.1 The slewing system of the lifting appliance is to be able to sustain the wind load and the side lead effects.

3.3 Power system

3.3.1 The crane prime mover and power system is to be compatible with the crane operation in the most extreme conditions allowable.

3.4 Winches

3.4.1 As a rule, the anticipated vertical dynamic amplification factor is to be considered in the specified rated pull (RP) of the winch.

3.5 Motion compensation system

3.5.1 When a motion compensation or a rope tensioning system is fitted on the lifting appliance, it is to be designed so that a single failure of a component may not cause a loss of load.

This is to be justified by a Failure Modes and Effect Analysis.

3.5.2 These systems are generally of the following types:

- active heave compensation system (AHC)
- passive heave compensation system (PHC)
- active rope tensioning system (ART)
- passive rope tensioning system (PRT).

3.5.3 The failure in operation of a motion compensation or a rope tensioning system is to be displayed at the control station.

4 Controls, indicators and safety systems

4.1 General

4.1.1 When the operator cannot have a direct view on the hoist drums, a remote watch system is to be fitted.

4.1.2 The operator is to be provided with a system enabling him to communicate with personnel in charge of supervision of lifting operations.

The operator is to be able to warn personnel around that he is undertaking operation which may present hazards to these personnel.

4.1.3 Fire extinguishers are to be fitted in the operator cabin and in the machinery cabin when a significant fire hazard exists.

4.1.4 It is to be possible to illuminate the appliance and surrounding obstructions, both in order to allow the operator to observe at night the handling environment and to comply with the requirements of general provisions relating to aircraft movements.

4.1.5 It is recommended to fit cranes with an additional simple system indicating boom angle, in direct view of the operator.

4.2 Safety systems

4.2.1 Ranking of the safety features

Tab 2 provides guidance in the ranking of the safety features.

Table 2 : Ranking of the safety features

Order of precedence	Safety features	
1st	Emergency stop	Manual overload protection system
2nd	Automatic overload protection system	
3rd	Other limiters	
4th	Indicators	

5 Additional safety features

5.1 General

5.1.1 When the lifting appliance complies with the requirements of the present Article, the supporting unit on which it is installed is eligible for the class notation **ALM-EN**.

5.2 Indicators and alarms at the control station

5.2.1 List of indicators and alarms

The instrumentation is to include, but not be limited to, the following indicators displayed at the crane control station:

a) Rated capacity indicator as described in [5.2.2]

b) Slack rope indicator as described in [5.2.3]

c) Crane inclination indicator

d) Crane position indicator

e) Wind speed indicator

f) Alarm system with clear text indicating the failure of:
   - general failure of the control system
   - failure in the power system
   - failure of the constant tension or motion compensation system.

5.2.2 Rated capacity indicator

Rated capacity indicators are to be provided for cranes with variable rated capacity or a rated capacity of more than 5 t.

Rated capacity indicators are to continuously display the actual hook load and the radius with an accuracy of 2,5% of the maximum rated capacity.

An alarm system is to indicate when the actual hook load reaches a predefined margin in accordance with the selected significant wave height.

5.2.3 Slack rope indicator

A slack rope indicator which detects slack rope at the hoisting and luffing winches and gives an alarm is to be provided.

5.3 Limiting devices

5.3.1 Rated capacity limiter

A rated capacity limiter is to be provided on hoisting, luffing, telescoping and folding motions to automatically prevent the rated capacity of the crane to be exceeded.

5.4 Overload protection systems

5.4.1 When intended to comply with EN 13852-1:2013, Offshore lifting appliances are to be provided with a manual overload protection system (MOPS).

In addition, offshore lifting appliances may be provided with an automatic overload protection system (AOPS).

The MOPS and AOPS are to comply with the relevant requirements of the standard EN 13852-1:2013.

5.4.2 When intended to comply with EN 13852-2:2004, Offshore lifting appliances are to be provided with an Emergency Load Release System (ELRS).

The ELRS is to comply with the relevant requirements of the standard EN 13852-2:2004.

5.4.3 The functional ranking of these systems is to comply with [4.2.1].

5.4.4 Overload the protection systems are to be overridden when the crane is used for lifting of personnel.

Note 1: Alternative gross overload systems or methods may be specially considered.

5.4.5 Overload protection systems are to be designed so that a single failure of a component may not cause a loss of load.

This is to be justified by a Failure Modes and Effect Analysis (FMEA).

5.5 Emergency operation system (EOS)

5.5.1 When intended to comply with EN 13852-1:2013, offshore cranes are to be fitted with an EOS complying with the relevant requirements of EN 13852-1:2013.

5.5.2 Purpose of the EOS is to keep the crane operational with reduced speed in case of single failure on:

- the power supply
- the control system.

Section 2 Subsea Cranes

1 General

1.1 Application

1.1.1 This Section provides additional requirements for the certification of lifting appliances intended to perform subsea lifting operations in offshore conditions and installed on ships, floating units or fixed offshore facilities.

1.1.2 The requirements of Chapter 2 and Sec 1 are to be complied with unless otherwise specified in the present Section.

1.1.3 The specific requirements for the Launch and Recovery Systems used to handle a diving bell are specified in NR610 Classification of diving systems.

1.2 Documents to be submitted

1.2.1 The following documents are to be submitted in addition to those listed in Ch 1, Sec 2 and Sec 1:

- Load charts for subsea lifting based on the prescriptions under Sec 1, [1.4.1].

2 Design loads

2.1 General

2.1.1 For the purpose of application of Chapter 2, the provisions of this Article are to be considered in addition to the ones of Ch 2, Sec 2.

2.1.2 The SWL of a subsea lifting appliance is to be taken as the mass of the lifted load.

2.1.3 When using a subsea lifting appliance, the possible overweight of water and solids swept along during ascent so as suction resistance due to the sea ground is to be anticipated.

2.2 Vertical dynamic amplification factors

2.2.1 The amplification factors for subsea lifting are to be based on the sea & operating conditions justified by an analysis of the accelerations or model predictions taking into consideration the ship/offshore unit motions and the effects of the load passing through the air/water interface (also called splash zone).

2.2.2 Normally, for operations up to a significant wave height of 1,5 m, the dynamic amplification factor (α_{CZ}), as defined in Ch 2, Sec 2, is not to be less than 2,0.

2.3 Out of plane motions

2.3.1 In general, the offlead and sidelead angles are assumed to be 10° minimum while the lifted load is within the air/water interface.

3 Controls, indicators and safety systems

3.1 General

3.1.1 Lifting appliances intended to perform subsea lifting are to be provided with indicators of the length of the paid-out rope.

Section 3 Lifting of Personnel

1 General

1.1 Application

1.1.1 The present Section provides additional requirements for the certification of lifting appliances intended to personnel lifting applications, on harbour or offshore conditions.

1.1.2 The present Section does not apply to:
- life-saving appliances within the scope of application of the IMO LSA code and rescue boat launching appliances
- lifts
- escalators
- conveyors.

1.2 Lifting appliance used in offshore conditions

1.2.1 When the lifting appliance is intended to personnel lifting in offshore conditions, it is to comply with the relevant requirements of Sec 1 in addition to the present Section.

1.2.2 Where overload protection systems (MOPS and/or AOPS) are used, they are to be overridden and locked out when personnel lifting mode is selected.

1.2.3 Where active heave compensation systems, active rope tensioning systems, passive heave compensation systems and passive rope tensioning systems are used, they are to be overridden and locked out when personnel lifting mode is selected.

Note 1: Motion compensation systems specifically engineered for personnel lifting may be accepted when duly justified and documented. A Failure Modes and Effects Analysis may be required.

1.2.4 In general, the lifting appliance is to be able to operate at a speed equal to the ratio of the wave height to its period, when a consistent system of units is used.

1.3 Document to be submitted

1.3.1 The following documents are to be submitted in addition to those listed in Ch 1, Sec 2:
- load chart including personnel handling SWL, when relevant
- description of the winches and their braking systems
- operating manual with instructions for lifting of personnel.

2 Safety principles

2.1 Communication

2.1.1 The crane operator is to remain in continuous direct communication with the personnel to be lifted or with a person who has direct visual contact with the personnel being lifted.

2.2 Environmental conditions

2.2.1 Unless otherwise stated in the instructions of use, personnel lifting operations are to be normally restricted to:
- sea conditions where the significant wave height does not exceed 2,0 m
- conditions where the wind speed does not exceed 10 m/s
- visibility conditions: daylight or equivalent.

3 Design loads

3.1 General

3.1.1 The Safe Working Load considered for personnel lifting is not to exceed 50% of the Safe Working Load considered for the design of the appliance used for cargo lifting.

3.1.2 When a lifting appliance is designed solely for personnel lifting:

- the design load is to be the double of the SWL
- the duty category as defined in Ch 2, Sec 2, [1.2] is to be ranked to next following category.

4 Equipment and machinery

4.1 Ropes

4.1.1 Ropes used for personnel lifting are required to have a minimum safety factor, η, equal to twice the safety factor given in Ch 2, Sec 5, [2] without being taken less than 8.

4.1.2 When wire ropes are used, non-rotating cables are to be fitted.

4.2 Loose gear

4.2.1 Hooks, cargo blocks and other items of loose gear used for personnel lifting are to be designed with at least twice the personnel handling SWL and tested with at least twice the proof load specified in Ch 5, Sec 1.

4.2.2 Items of loose gear intended to be used for both personnel and cargo lifting are to be marked with both cargo and personnel lifting SWL.

4.3 Winch brakes

4.3.1 In addition to normal brake, the winch is to be equipped with a mechanically and operationally independent secondary/redundant brake with separate control system.

4.3.2 Each brake is to operate directly on the winch drum but other arrangements such as a fully independent load path may be considered acceptable.

4.3.3 It is to be possible to override the self applying brake system in case of emergency, in order to operate the lifting hoist, in full safety.

4.3.4 The normal and secondary/redundant brakes are to be tested independently, under the loads indicated in Ch 2, Sec 6, Tab 1 and Ch 2, Sec 6, Tab 2.

5 Controls, indicators and safety systems

5.1 General

5.1.1 There is to be only one control location of the lifting appliance.

5.1.2 The control station is to be equipped with a switch for the purpose of selection between cargo and personnel lifting modes, including a continuous warning light indicating that the personnel lifting mode is activated.

5.1.3 Both normal and secondary/redundant brakes are to be automatically activated when controls are in neutral position, or in case of the emergency stop is activated, or in case of any failure in the control or power system.

5.1.4 When the personnel lifting mode is activated, overload protection systems and motion compensation systems, if installed, are to be overridden as per [1.2.2].

5.1.5 Lifting appliances used for personnel lifting are to be fitted with means to luff down and lower load at controlled speed in case of electrical power failure, rupture of any hydraulic fluid pipe under pressure or in the event of failure in the control system.

6 Lifting accessories used for personnel lifting

6.1 Baskets

6.1.1 Design of baskets or other specialized equipment for personnel lifting is to be according to a recognised standards such as EN 14502-1:2010.

6.1.2 In accordance with IMO OSV Code (Code of safe practice for the carriage of cargoes and persons by offshore supply vessels), personnel baskets and all associated riggings are to be designed to achieve a 10:1 load factor of safety.

Section 4 Derrick Systems

1 General

1.1 Application

1.1.1 The present Section provides additional requirements for the certification of derrick systems intended to perform lifting operations in harbour conditions.

2 Hypotheses for calculation

2.1 General

2.1.1 As these appliances are used in harbour conditions only, no dynamic effect due to ship motions need to be taken into account. However, calculations proving good behaviour of the lifting appliances in stowed position during navigation may be required by the Society.

2.1.2 The scantlings of the masts and of their accessories are to be calculated taking into account the most critical loading case.

2.1.3 As a rule, the strength of the lifting appliances need not to be checked under test conditions when the tests are performed in accordance with the requirements of Ch 5, Sec 1, [11]. However, these checks may be necessary when national provisions require compliance with more severe test conditions.

2.2 Loading cases

2.2.1 When several derrick booms are rigged on the same mast, the following conditions of use are to be considered:

- loading or unloading cannot be carried out at the same time on starboard and portside
- two derrick booms, the one being located forward of the mast and the other aft of the mast may be used simultaneously in normal slewing operation
- a derrick boom of SWL ≥ 60 t is always to be used alone.

2.2.2 Any arrangement inconsistent with those provided in [2.2.1] is to be clearly specified on the documents submitted for approval and is to be recorded in the ship's Register of Lifting Appliances and Cargo Handling Gear. Moreover, the fixing of an instruction plate on the mast may be required when special use conditions are provided.

2.3 Dead-weights

2.3.1 It is the Manufacturers responsibility to evaluate and state the dead-weights. These will be considered in the calculations taking into account [2.3.2].

2.3.2 When masts rigged with derrick booms are concerned, the weight of the derrick boom and of the tackles fixed at the top of the derrick boom are to be considered.

For this purpose, a vertical force f equal to the weight of the cargo tackle increased by half the weight of the span and slewing guy tackles and increased by half the weight of the derrick boom is considered as applied at the top of the derrick boom.

As a rule, this vertical force is not to be taken as less than 0,10 times the SWF of the derrick boom.

If the precise weights are unknown, this vertical force is to be at least considered as equal to the following value:

- when $P \leq 20$ t

  $f = 0{,}10\ F$
- when $20\ t < P < 160$ t

  $$f = \frac{12{,}6 + 0{,}07\ P}{140} F$$
- when $P \geq 160$ t

  $f = 0{,}17\ F$

where:

F : SWF, in kN, of the derrick boom corresponding to its SWL P, in t.

For the corresponding calculations, in the case of work with union purchase rig, the SWF taken into account to appraise this vertical force is to correspond to the SWL of the derrick boom in normal slewing operation.

In the usual conditions, the other dead-weights may be disregarded, in particular that of the mast itself.

2.4 Position of the derrick booms

2.4.1 Topping angle

a) As a rule, the force diagrams and the calculations concerning the scantlings of the masts are carried out considering the minimum topping angle of the derrick booms (minimum angle of the derrick boom to the horizontal when trim and list are equal to zero).

b) The minimum topping angle of the derrick booms is not to be less than 15° in any case.

When it is unspecified, it is to be taken equal to 15° for derrick booms of low lifting capacity (SWL lower than or equal to 20 t) or to 25° for derrick booms of higher capacity.

c) A diagram of forces or calculations may be required in the position corresponding to the maximum topping angle of the derrick boom, (especially when there are non-negligible eccentricities between the connecting points of the span and cargo tackles at derrick boom head) in order to determine compression and end moments induced in the derrick boom.

d) As a rule, the maximum topping angle is not to exceed 75°. When this angle is not specified, it is to be considered as equal to 75°.

2.4.2 Slewing angle

a) The maximum slewing angle (angle formed in an horizontal plane by the projection of the derrick boom upon its maximum outreach and a direction parallel to the longitudinal axis of the ship) or the maximum outreach of the derrick booms is to be taken into account to determine the forces in the slewing guy tackles, if any, or in the span tackles of two span tackle type masts.

b) If the maximum slewing angle is not specified, it is to be considered as equal to 75° for the derrick booms the SWL of which is lower than or equal to 20 t. In any other case, this angle must be specified.

c) Attention is drawn to the rule in [2.1.2] according to which calculation may be required in an intermediate position. For example, for a square-tube mast, a calculation is to be made when the derrick boom is located in a vertical plane passing through a diagonal of its cross-section, i.e. when the section modulus of the mast is at a minimum.

2.4.3 Working area

a) In general, the working area of the derrick booms is determined by the minimum and maximum topping angles and the maximum slewing angle.

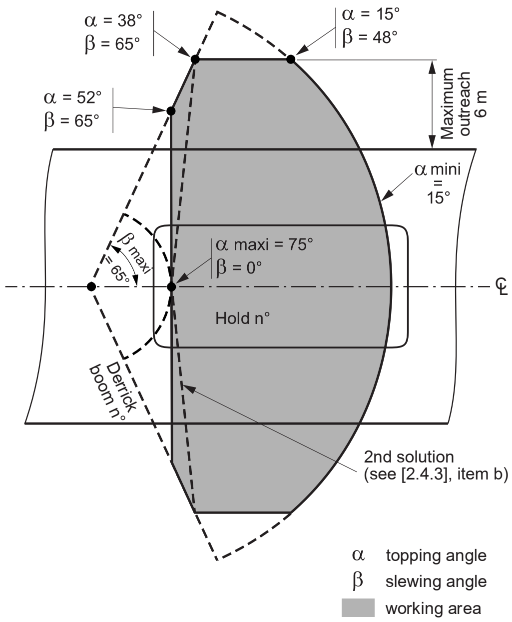
However, this area may be reduced for instance in fixing a maximum outreach value and a minimum distance between the derrick boom head and the transverse plane of the ship passing through the derrick heel pin. In such a case, the working area is to be defined by a plan view of the ship. Fig 1 shows an example of a working area).

b) Attention is drawn to the fact that especially for the two span tackle type masts, the positions of the derrick boom corresponding to the maximum topping angle associated to the maximum slewing angle are to be excluded from the working area, in general, since they may either correspond to instability of the rigging system or result in abnormally high forces in the span tackles and the derrick boom.

For this type of mast, the second solution to limit the working area as shown on Fig 1 is recommended.

c) The working area of the derrick booms is to be specified on the documents attached to the Register of Lifting Appliances and Cargo Handling Gear by stating the limits for topping and slewing angles. When other limits are provided. a sketch of the same type as the one shown on Fig 1 must be attached to the Register.

Figure 1 : Example of the working area of a derrick boom



2.5 List and trim

2.5.1 List and trim of the ship is to be considered in compliance with Ch 2, Sec 2, [3.2].

In addition, for derrick systems, the requirements of [2.5.2] and [2.5.3] are to be taken into account.

2.5.2 If the actual values of list and trim are lower than or equal to the values as per [2.5.1], the latter are to be considered as minimum values unless otherwise agreed with the Society.

In such a case, the effect of the list and trim may be neglected in the calculations except when otherwise specified.

2.5.3 If the actual values for list and trim are higher than the minimum values as per [2.5.1] the actual values are always to be taken into account in the calculations.

For a given value of the outreach, the list angle φ of the ship, in degrees, is assumed to lie between two values φ_1 and φ_2:

$\varphi_1 \leq \varphi \leq \varphi_2$

with:

$$\varphi_1 = 5 + (\varphi_m - 5)\frac{y}{y_m}$$

$$\varphi_2 = -5 + (\varphi_m - 5)\frac{y}{y_m}$$

where:

φ_m : Maximum permissible list angle when the derrick boom is in the extreme outreach position

y_m : Transverse distance between the ship centre line and the projection on the deck of the derrick boom head when its outreach is at a maximum (see Fig 2)

y : Transverse distance between the ship centre line and the projection on the deck of the derrick boom head for a considered position of the derrick boom (see Fig 2).

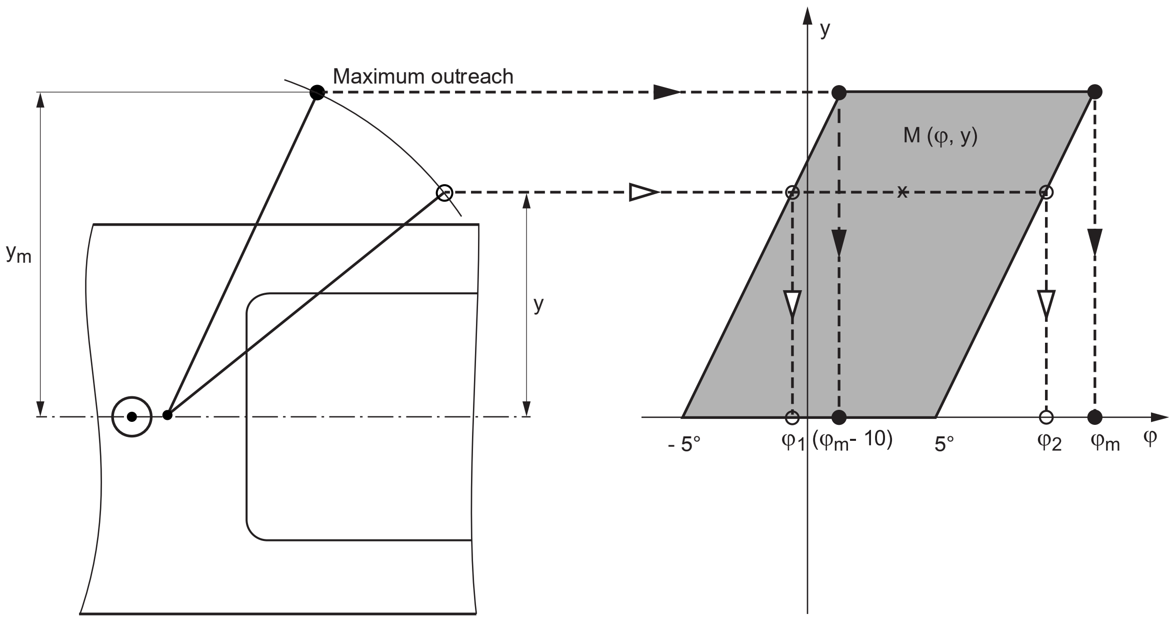
These conditions are plotted on Fig 2 by the shaded portion of the plane which contains the whole of the points M (φ, y); its abscissa φ is one of the permissible list angles for the considered outreach to which the above distance y corresponds.

In particular, the maximum list value φ_m will be taken into account in the calculations when the derrick boom is in the extreme outreach position. Calculations considering intermediate list values within the limits previously defined may be required by the Society when considered necessary.

2.6 Efficiency of sheaves and tackles

2.6.1 Efficiency of sheaves and tackles is to be taken into account as specified in Ch 2, App 2.

Figure 2 : Permissible list angles versus derrick boom outreach



3 Force analysis in rigging and derrick booms

3.1 General

3.1.1 The requirements of [3] to [7] apply to conventional rigging, ie. rigging of the type with two slewing tackles independent from each other and independent from the span tackle.

The masts of the type with two span tackles and the special rigging, in particular those which include constant tension or expanding slewing tackles, slewing tackles which are not independent from the span tackle, derrick booms rotating freely around their longitudinal axis or non-vertical goosenecks will be especially examined by the Society.

3.1.2 The maximum forces induced in the rigging elements and the derrick booms are to determined either by force diagrams or by calculations.

3.1.3 As per [2.3.2], the vertical force f which takes into account the dead weights of the derrick boom and tackles fixed to it is to be applied at the derrick boom head.

3.1.4 Trim and list angles may be neglected if they do not exceed the values given in [2.5.1], except in the following cases:

- when masts of two span tackle type or special riggings are concerned
- when masts the SWL of which are higher than or equal to 50 t are concerned
- in the cases as per [4.1.1].

3.1.5 The methods for determining forces as per [5], [6] and [7] apply when list and trim angles may be neglected.

4 Force analysis in slewing guy tackles

4.1 General

4.1.1 The forces in the slewing guy tackles are to be determined either by force diagrams or by calculations in the following cases:

- when list and trim angles are higher than the values as per [2.5.1]
- when the slewing tackles are fixed at a vertical distance from the axis of the derrick heel pin greater than 0,3H, with:

  H : Vertical distance between the derrick heel pin and the mast head topping bracket
- when H / L ratio is above 1,25 with:

  L : Length of the derrick boom
- when the angle δ (see Fig 3) formed by the projections on an horizontal plane of the derrick boom at its maximum slewing angle and of the slewing guy tackle fixed on the opposite side to the outreach direction is lower than:
  - δ = 15° if SWL of the derrick boom is below 5 t
  - δ = (10° + SWL) if SWL, in t, of the derrick boom is comprised between 5 t and 15 t
  - δ = 25° if SWL of the derrick boom is above 15 t.

At the project stage, it is recommended to arrange the slewing guy tackles so that the angle δ be higher than or equal to 25°. This angle is never to be below 10°.

Figure 3 : Determination of force in a slewing guy tackle

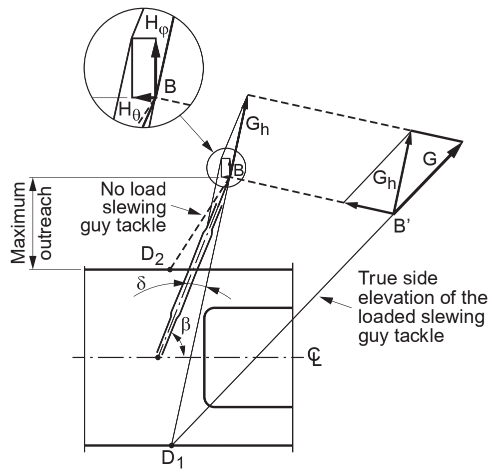


Table 1 : Minimum forces in the slewing tackles

SWL of the derrick boom P, in t	Minimum force in the slewing tackles G, in kN
P < 1	10 P
1,0 ≤ P < 1,5	10
1,5 ≤ P < 2,0	12,5
2,0 ≤ P < 2,5	15
2,5 ≤ P < 3,0	17
3,0 ≤ P < 3,5	20
3,5 ≤ P < 4,0	22
4,0 ≤ P < 4,5	25
4,5 ≤ P < 5,0	27
5,0 ≤ P < 6,0	30
6,0 ≤ P < 7,0	32
7,0 ≤ P < 10	35
10 ≤ P < 13	37
13 ≤ P ≤ 16	40
16 < P	2,5 P

4.1.2 The force applied in a slewing guy tackle may be determined from force diagrams of the same type as those given on Fig 3 considering the horizontal components H_φ and H_θ resulting from list angle φ and trim angle θ of the SWF F increased by the dead weight t, i.e.:

$H_\varphi = (F + f) \sin \varphi$ and

$H_\theta (F + f) \sin \theta$

4.1.3 The scantlings of the slewing guy tackles are to be examined at their attachment with the derrick boom, considering the minimum force G given in Tab 1 which depends on the SWL P of the derrick boom or, in the cases as per [4.1.1], considering the actual force determined from the force diagrams if the value of the force thus determined is higher than the one given in Tab 1.

5 Force analysis in derrick booms for normal slewing operation with cargo runner parallel to the derrick boom

5.1 General

5.1.1 Forces may be determined by calculations or by means of a force diagram of the same type as the one shown on Fig 4 using the coefficients given in Ch 2, App 2, Tab 1.

5.1.2 The maximum force on the lower cargo block is equal to the SWF F of the derrick boom.

5.1.3 The maximum resultant force R_B on the upper cargo block is obtained when the derrick boom is near the vertical position. It is assumed as equal to the following value considering the number of parts of rope n_1 of the cargo tackle:

$$R_B = F\left(1 + \frac{1}{n_1}\right)$$

5.1.4 The tension F_B in the cargo runner is obtained in using the coefficient t_n deduced from Ch 2, App 2, Tab 1 (when hoisting) corresponding to the number of parts of rope n_1 of the cargo tackle:

$F_B = F_{tn}$

The maximum tension T_L in the cargo runner is obtained upon hoisting the load considering the efficiency coefficient k of the derrick heel cargo lead block:

$T_L = F_B / k$

5.1.5 The maximum resultant force R_c on the cargo lead block at the derrick heel is obtained considering the derrick at its minimum topping angle and at such a slewing angle that the angle γ formed by the derrick boom and the direction of the cargo lead rope be at a minimum.

R_C value may be determined from the force diagram shown on Fig 4 or by the following formula considering the coefficients k and t, as per [5.1.4]:

$$R_C = Ft_0\left(1 + \frac{1}{k}\right)\cos\frac{\gamma}{2}$$

If the direction of the cargo lead rope is unknown, the following value may be taken:

$R_C = 2F / n_1$

5.1.6 The maximum force S applied on the span tackle at the end of the derrick boom is obtained considering the derrick at the lowest position corresponding to the minimum topping angle α. It may be determined either by means of the force diagram shown on Fig 4 or by the following formula:

$$S = \frac{a}{H}(F + f)$$

where:

$$a = \sqrt{L^2 + H^2 - 2LH\sin\alpha}$$

L , H : See Fig 4

f : Dead weight (see [2.3.2]).

The values herebefore mentioned apply only if the mast head span fitting point and the pin of the derrick boom heel are located approximately on the same vertical line.

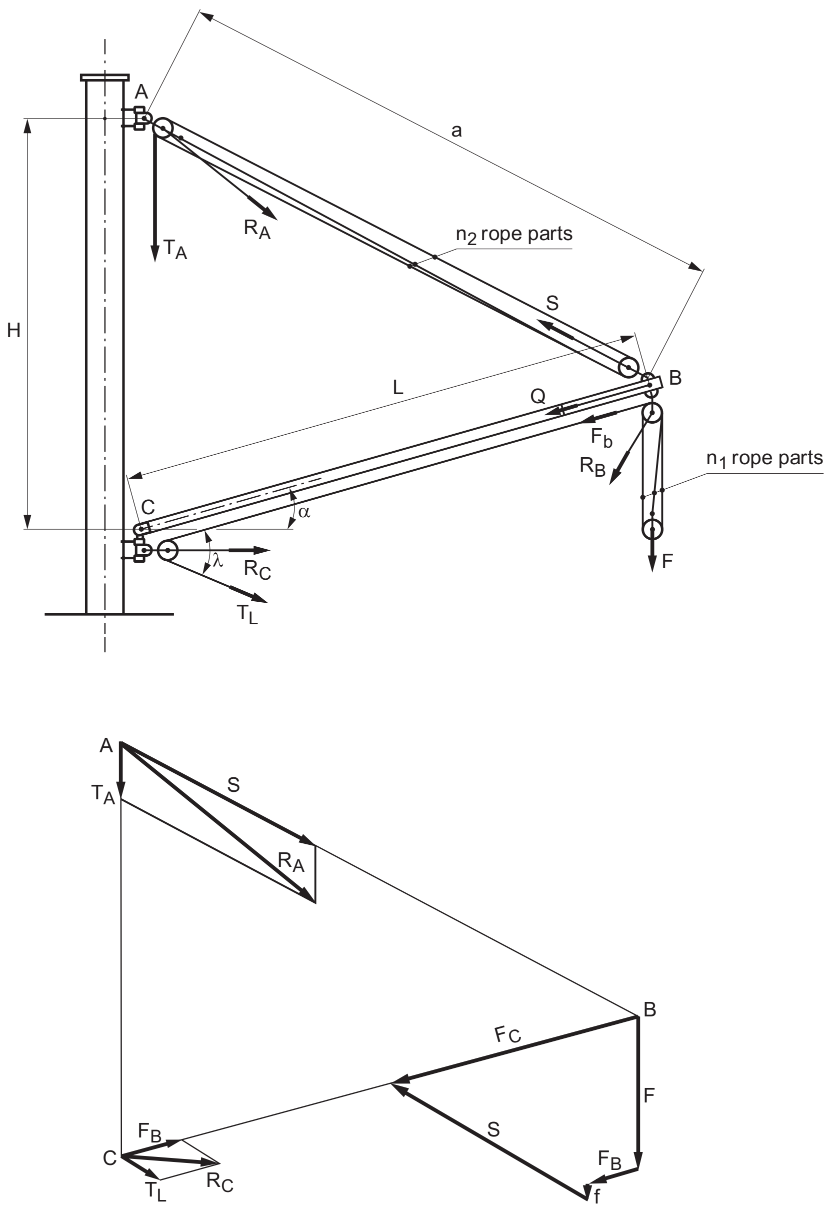
5.1.7 The maximum tension T_A in the span rope is deduced from the S value, considering the coefficient t_n shown in Ch 2, App 2, Tab 1 (when hoisting) corresponding to the number of parts of rope n_2 of the span tackle:

$T_A = S\ t_n$

When the topping angle cannot be modified under load, the tension T_A is equal to:

$T_A = S / n_2$

Figure 4 : Derrick boom for normal slewing operation with cargo runner parallel to the derrick boom



5.1.8 The maximum resultant force R_A on the mast head span block is obtained considering the derrick boom at its lowest position. It may be determined in adding geometrically force S to force T_A which is exerted on the span lead rope.

The force R_A may also be obtained by the following formula considering the coefficient t_n as per [5.1.7]:

$$R_A = S\sqrt{1 + t_n^2 + 2t_n\frac{H - L\sin\alpha}{a}}$$

When the topping angle cannot be modified under load, coefficient t_n is to be replaced by $1/n_2$, where:

n_2 : Number of parts of rope in the span tackle.

This formula is valid only if the span lead rope is vertical. If its direction is unknown, the following value may be taken:

$$R_A = S\left(1 + \frac{1}{n_2}\right)$$

5.1.9 Compression in the derrick boom is considered to be of constant value Q, whatever the topping angle. It may be determined either by the force diagram shown on Fig 4, in this case:

$Q = 1{,}25\ (F_C - F_B) + F_B$

or by the following formula:

$$Q = 1{,}25\ \frac{L}{H}(F + f) + Ft_n$$

where:

t_n : Coefficient given in Ch 2, App 2, Tab 1 (when hoisting) according to the number of ropes n_1 of the cargo tackle.

Note 1: In both expressions, the coefficient 1,25 takes roughly into account the additional compressive force due to the force exerted by the loaded slewing tackle. This coefficient may be taken equal to 1 provided the additional compressive force here before mentioned is estimated and taken into account.

6 Force analysis in derrick booms for normal slewing operation with cargo runner parallel to the span tackle

6.1 General

6.1.1 The forces may be determined either by calculation or by means of a force diagram of the same type as the one shown on Fig 5, the coefficients to be used are given in Ch 2, App 2, Tab 1.

6.1.2 The maximum force on the lower cargo block is equal to the SWF F of the derrick boom.

6.1.3 The maximum resultant force R_L on the upper cargo block is found considering the sheave efficiency coefficient k and the coefficient t_{n-1} (when lowering) given in Ch 2, App 2, Tab 1 corresponding to the number of parts of rope n_1 of the cargo tackle:

$R_L = F\ (1 - t_{n-1})$

6.1.4 The tension F_B in the cargo runner is obtained using the coefficient t_n (when hoisting) given in Ch 2, App 2, Tab 1 corresponding to the number of parts of rope n_1 of the cargo tackle:

$F_B = F\ t_n$

The maximum tension T_L in the cargo runner is obtained when hoisting the load considering the sheave efficiency coefficient k of the mast head cargo lead block:

$$T_L = \frac{F_B}{k}$$

The maximum resultant force R_B in the derrick head built-in cargo sheave is obtained when the derrick is near the vertical position. It is considered as equal to the following value if n_1 is the number of parts of rope of the cargo tackle:

$$R_B = 2\frac{F}{n_1}$$

6.1.5 The maximum resultant force R_C in the mast head cargo lead block is obtained when the derrick is in the lowest position when hoisting the load.

The value R_C may be determined either by means of the force diagram shown on Fig 5 or by the following formula, considering the force F_B and the coefficient k as per [6.1.4]:

$$R_C = F_B\sqrt{1 + \frac{1}{k^2} + \frac{2}{K}\frac{(H - L\sin\alpha)}{a}}$$

where:

$$a = \sqrt{L^2 + H^2 - 2LH\sin\alpha}$$

This formula is valid if the cargo lead rope le vertical only. If its direction is unknown, the following value may be taken:

$$R_C = \frac{2F}{n_1}$$

6.1.6 The maximum force S exerted on the span tackle at the derrick boom head is obtained considering the derrick at its lowest position corresponding to the minimum topping angle α. It may be determined either by means of a force diagram as shown on Fig 5 or by means of the following formula:

$$S = \frac{a}{H}(F + f) - Ft_n$$

where:

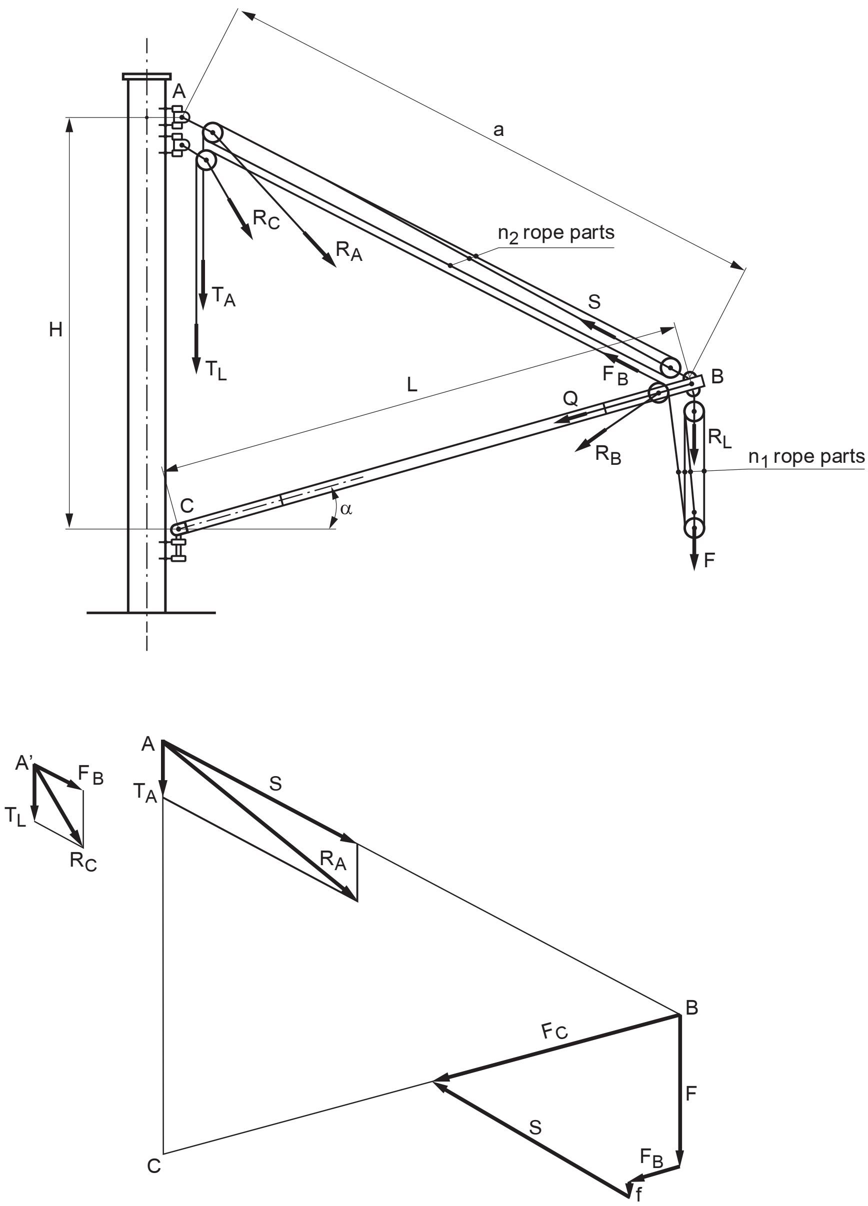
L, H	:	See Fig 5
a	:	See [6.1.5]
f	:	Dead weight (see [2.3.2])
t_n	:	Coefficient given in Ch 2, App 2, Tab 1 (when lowering) corresponding to the number of parts of rope n_1 of the cargo tackle.

6.1.7 The maximum tension T_A in the span rope is deduced from the value of S considering the coefficient t_n given in Ch 2, App 2, Tab 1 (when hoisting) corresponding to the number of parts of rope n_2 of the span tackle:

$T_A = S\ t_n$

When the topping angle cannot be altered under load, the tension T_A is equal to: S/n_2.

Figure 5 : Derrick boom for normal slewing operation with cargo runner parallel to the span tackle



6.1.8 The maximum resultant force R_A on the mast head span block is obtained considering the derrick at its lowest position. It may be determined in adding geometrically force S to the force T_A which is exerted on the span lead rope.

The force R_A may also be obtained by means of the following formula considering the coefficient t_n as per [6.1.7]:

$$R_A = S\sqrt{1 + t_n^2 + 2t_n\frac{H - L\sin\alpha}{a}}$$

When the topping angle cannot be altered under load, the coefficient t_n must be replaced by $1/n_2$ in the above formula, where n_2 is the number of parts of rope of the span tackle.

This formula is valid only if the span lead rope is vertical. If its direction is unknown, it may be assumed that:

$$R_A = S\left(1 + \frac{1}{n_2}\right)$$

6.1.9 Compression in the derrick boom is considered to be of constant value Q, whatever be the topping angle. It may be determined either by the force diagram shown on Fig 5, in this case:

$Q = 1{,}25\ F_C$

or by the following formula:

$$Q = 1,25\frac{L}{H}(F + f)$$

Note 1: In both expressions, the coefficient 1,25 takes roughly into account the additional compressive force due to the force exerted by the loaded slewing tackle. This coefficient may be taken equal to 1 provided the additional compressive force here before mentioned is estimated and taken into account.

7 Force analysis in derrick booms working with union purchase rig

7.1 General

7.1.1 The rigging principle for union purchase is defined on Ch 1, Sec 1, Fig 5.

The terms union purchase system mean handling by means of two derrick booms which remain stationary during loading and unloading: one of the derrick booms is located in way of the hatch, the other in way of the quay, the load is transferred from the one to the other only by means of two cargo runners connected together.

7.1.2 In general, in this Article, the derrick boom number 1 is the one located in way of the hatch (inboard derrick boom) and the derrick boom number 2 is the derrick boom in the outreach position, in way of the quay (outboard derrick boom).

7.1.3 As a rule, it is recommended that the SWL provided with the union purchase rig does not exceed half the SWL authorized in normal slewing operation for one of the two derrick booms (the one with the lower SWL if they are not identical).

Even if this recommendation is complied with, drawing of force diagrams or making of calculations remain necessary.

7.1.4 Attention of the designer is drawn to the necessity to compare the forces determined by force diagrams or by calculations for use in normal slewing and in union purchase in order to determine the scantlings and the SWL of each element in the most severe conditions.

7.1.5 In addition to the slewing tackles used to operate in normal slewing, a preventer guy consisting either in a steel wire rope or a chain is to be provided on each derrick boom for use in union purchase system. These preventer guys is to be given scantlings in accordance with the forces determined as per [7.6] or [7.7]. However, it is recommended not to take a value for the force G_o. in kN, used to determine scantlings for these preventer guys and their attachments, lower than $20P_o$. where P_o is the value, in t, of the SWL provided in union purchase rig.

In the case of conventional rigging of the type shown on Ch 1, Sec 1, Fig 5, only the preventer guys will be considered as being submitted to forces during working with union purchase rig. The slewing tackles are not to be in tension during handling of the load.

7.1.6 The derrick booms are to be kept together at their upper end by means of a schooner guy tackle made of steel or fibre rope. One of the inner slewing tackles may be used for this purpose.

The SWL of these schooner guy tackles is not to be below 15% of the SWL provided for working in union purchase with a minimum of 0,3 t.

7.2 Working area in an horizontal plane

7.2.1 The project is to be made considering a given working area to be specified as requested in Ch 1, Sec 2, [3.1.1], item a).

It is recommended to take into account [7.2.2] to [7.2.4], to determine this working area.

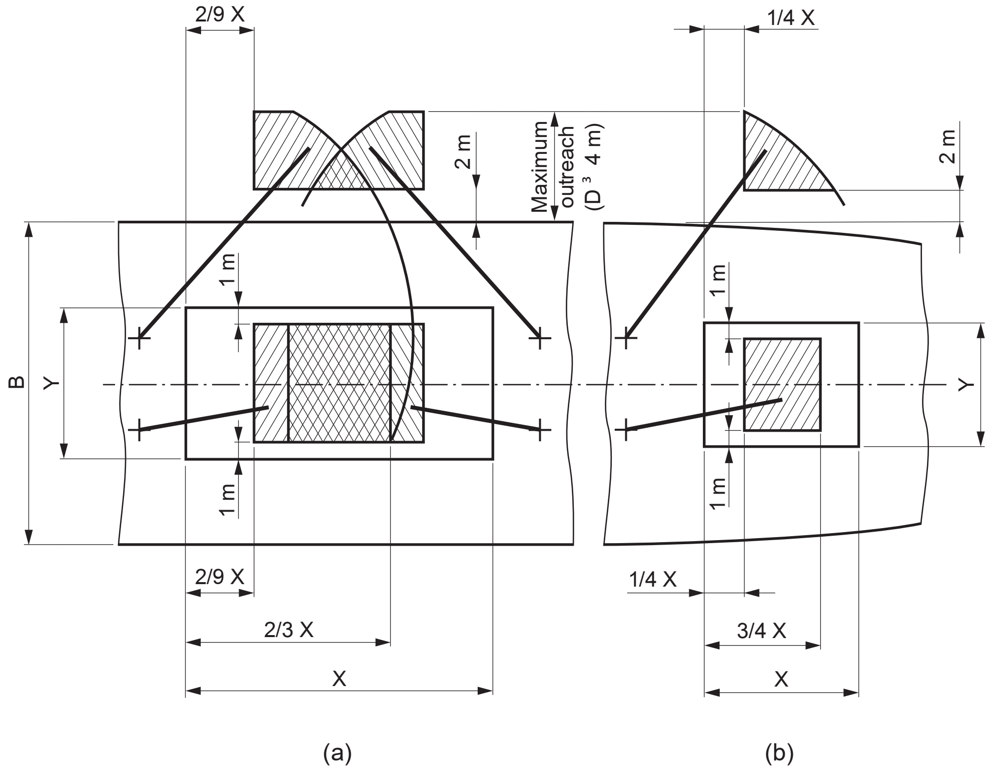
If working in union purchase is provided for a single special position of the two derrick booms, this condition is to be clearly specified in the Register of Lifting Appliances and Cargo Handling Gear.

7.2.2 The maximum outreach of the outboard derrick boom beyond the ship side as measured at the midship section is to be specified. It is not to be lower than 4 m. The outboard derrick boom is assumed not to be used for an outreach below 2 m.

7.2.3 It is recommended to provide for a minimum topping angle of 30° for working in union purchase. This angle is not to be lower than 15° in any case.

7.2.4 The plan view of the working area is to be as shown on Fig 6 (b), when the hatch is served by a single pair of derrick booms or on Fig 6 (a) when the hatch is served by two pairs of derrick booms.

Figure 6 : Working area in union purchase in the horizontal plane



7.2.5 In order to comply with the requirements as per [7.2.2] to [7.2.4], the length of the derrick booms used is to be at least equal to the greater of the two following values, when the two derrick booms have the same length:

$$L = 1,115\sqrt{\left(\frac{B}{2} + D - C\right)^2 + (E_0 + \rho X)^2}$$

$$L = 1,115\sqrt{\left(C + \frac{Y}{2} - 1\right)^2 + (E_0 + 3\rho X)^2}$$

where:

ρ : • When the hold is served by a single pair of derrick booms:
$\rho = 0,25$
• When the hold is served by two pairs of derrick booms:
$\rho = 0,222$

D : Maximum outreach contemplated ($D \geq 4$ m)

B : Ship breadth measured amidship

X , Y : Length and width of the hatch respectively

C : Transverse distance between the gooseneck and the longitudinal axis of the ship (it is assumed that $C = C_1 = C_2$)

E_0 : Longitudinal distance between the gooseneck and the nearest hatch edge.

For these notations, see also Fig 8.

Note 1: The length L, as defined here before, corresponds to a 300 minimum topping angle.

7.3 Working area in a vertical plane

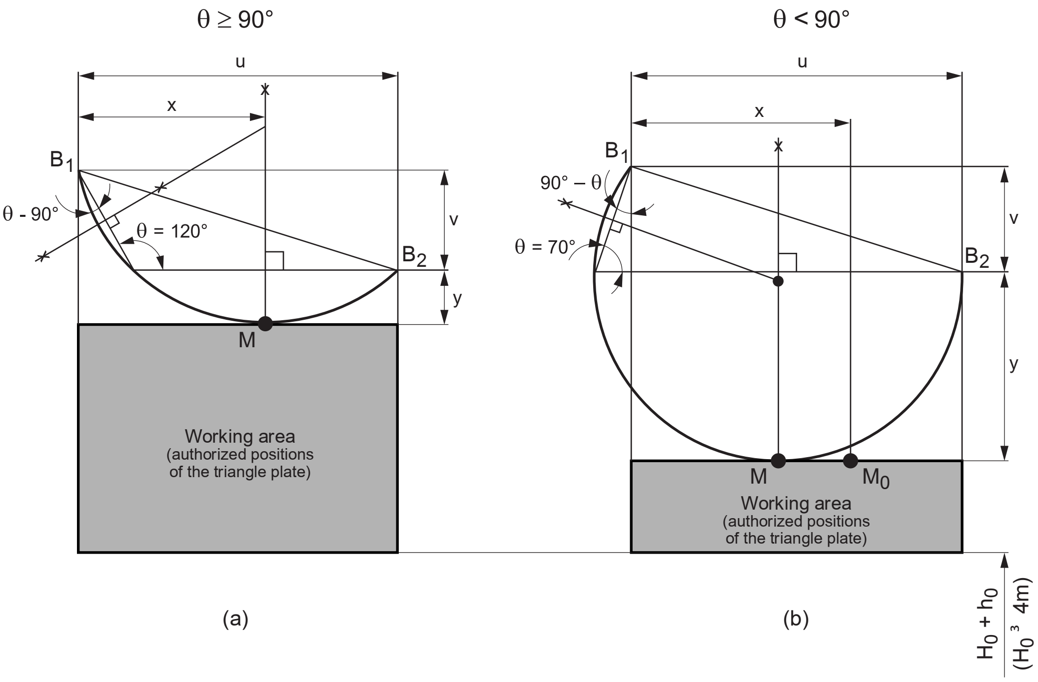
7.3.1 In general, the limit in height of the working area is determined in fixing the maximum authorized angle θ made by the two cargo runners connected to the link plate (cargo triangle plate).

Anyhow, this angle θ is not to exceed 120°. Preferably, its value is to be chosen between 90° and 120°.

7.3.2 Fig 7 (a) and (b) show how the arc of the circle through the tops B_1 and B_2 of both derrick booms and the link point M of the two cargo runners may be constructed for a given maximum angle θ.

Transfer from one derrick boom to the other is supposed to be carried out in such a way that the triangle plate does not rise above the horizontal plane tangent to the arc B_1MB_2 determined here before.

Figure 7 : Working areas in union purchase in the vertical plane



7.3.3 The free height H_o under the cargo hook is not to be lower than 4 m all over the working area.

7.3.4 In order to comply with [7.3.1] and [7.3.3], the height Z from the derrick heel pin to the deck level may be determined approximately by the following formula:

$$Z = N + H_0 + h_0 - \frac{L}{2} + \frac{1}{4}\cot\frac{\theta}{2}\sqrt{(B + Y + 2D - 2)^2 + 16\rho^2 X^2}$$

where:

N : Height of the bulwark (or of the hatch coaming if it is higher than the bulwark) above deck

H_0 : Free height under hook ($H_0 \geq 4$ m)

h_0 : Vertical distance between the triangle plate and the hook

L : Length of the derrick booms determined as per [7.2.5]

D, B, X, Y, ρ: As defined in [7.2.5]

θ : As defined in [7.3.1] (θ ≤ 120°).

The minimum topping angle is supposed to be equal to 30°.

7.4 Geometrical arrangements

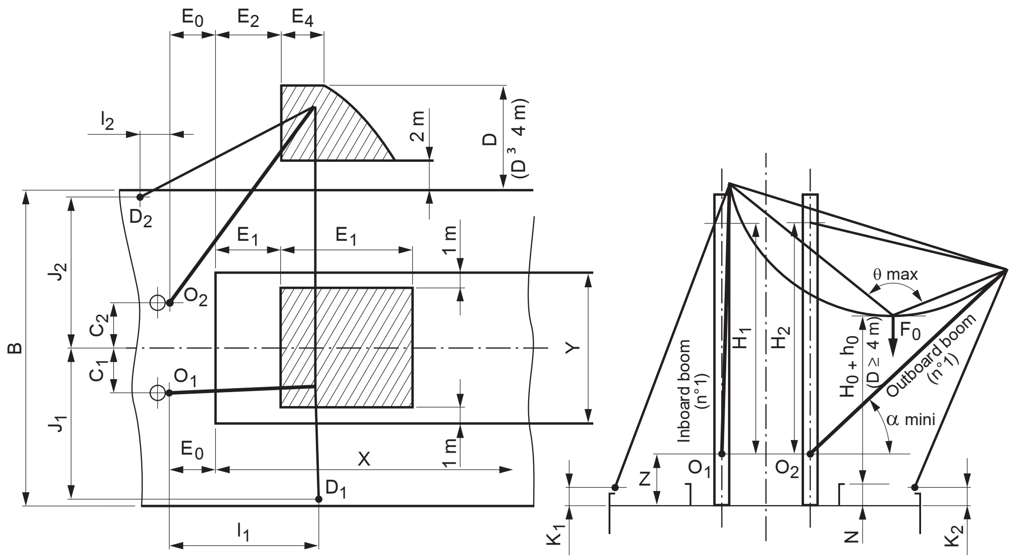
7.4.1 The position of the derrick heels, of the points of attachment of the span tackles to the mast(s) and of the fixing points of the preventer guys on the ship are to be indicated in relation to the ship.

It is recommended to show these particulars on a sketch of the type shown on Fig 8.

7.4.2 In order to avoid excess of compression in the inboard derrick boom (No. 1) and excessive tensile force in the preventer guy, it is recommended to attach this preventer guy on the ship so that the angle δ_1 formed by the projections of the derrick boom and of the preventer guy on an horizontal plane be approximately equal to 90° when the projection of the top of this derrick boom is longitudinally at a quarter of the horizontal working area measured from its nearest end of the derrick boom heels and transversely at a quarter of the hatch width measured from the hatch edge opposite the outreach side. This position is shown on Fig 8.

The ship attachment of the preventer guy of the outboard derrick boom (No. 2) is to be so positioned as to avoid risk of instability of the derrick boom in the vertical plane (“jack knifing”, i.e. improper raising up of the derrick boom). For this purpose, this attachment is not to be located too far behind the gooseneck.

Figure 8 : Geometrical arrangements (data required to determine the forces)



7.5 Position for calculation

7.5.1 General

The forces may be determined either by force diagrams or by calculation. The following requirements explain how force diagrams may be drawn and give also formulae to calculate the involved forces.

7.5.2 Position of the derrick booms

Forces are to be determined for various positions of the derrick booms in order to obtain the maximum force applied all over the working area for each element (cargo runner, preventer guy, span tackle, derrick boom).

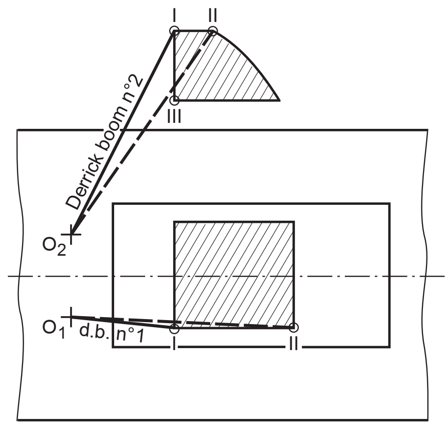
However, when the working area is determined as per [7.2] and [7.3] and when the SWL provided in union purchase complies with [7.1.3], it is usually sufficient to draw force diagrams in the positions I and II defined hereunder:

- Position I:
  - top of the derrick boom No. 1 is vertically over the corner of its working areas on the side opposite the outreach and the nearest to the derrick boom heel
  - top of the derrick boom No. 2 is vertically over the point of the maximum outreach line which is nearest to the derrick boom heel.
- Position II:
  - top of the derrick boom No. 1 is vertically over the corner of its working area on the side opposite the outreach and the farthest from the derrick boom heel
  - top of the derrick boom No. 2 is vertically over the point of the maximum outreach line which is farthest from the derrick boom heel.

When the maximum outreach is greater than 6 m, another position III of the derrick boom No. 2 is to be examined. In this case, the derrick boom No. 2 is longitudinally positioned in the same way as for the position I but is located transversely at the minimum outreach of 2 m, the derrick boom No. 1 being in position I.

The positions defined here before for calculation purpose are shown on Fig 9.

Figure 9 : Positions of the derrick booms for calculation



However, when the length and the width of the hatch are lower than or equal to 4 m, the derrick boom No. 1 may be positioned at the hatch centre.

If the positions I and II of the derrick boom No. 2 are quite near, only one position of this derrick boom may be considered too (as a rule, position I).

When several attachment points are provided on the ship for each preventer guy, the position(s) for calculation will be specially examined by the Society.

7.5.3 Position of the load

Forces will be determined considering the highest position of the load, taking into account the maximum angle θ formed by both cargo runners as per [7.3.2].

When the angle θ between both cargo runners is higher than or equal to 90° and when the difference in height of bath tops of the derrick booms is not too great ($v \leq 0,5\ u$), the load will be positioned at point M as defined in [7.3.2] and shown on Fig 7 (a).

When the above conditions are not complied with, the transverse position x of the load (see Fig 7 (b)) will be determined by means of the following formula, x is measured from the derrick boom with the highest top (in general, the top of the derrick boom No. 1):

$$x = \frac{u}{1 + \sqrt{\frac{1}{1 + \frac{v}{y}}}}$$

where:

u, v : Horizontal and vertical distances respectively between both tops of the derrick booms

y : Vertical distance between the top of the derrick boom with the lowest top (in general, the top of the derrick boom No. 2) and the triangle plate.

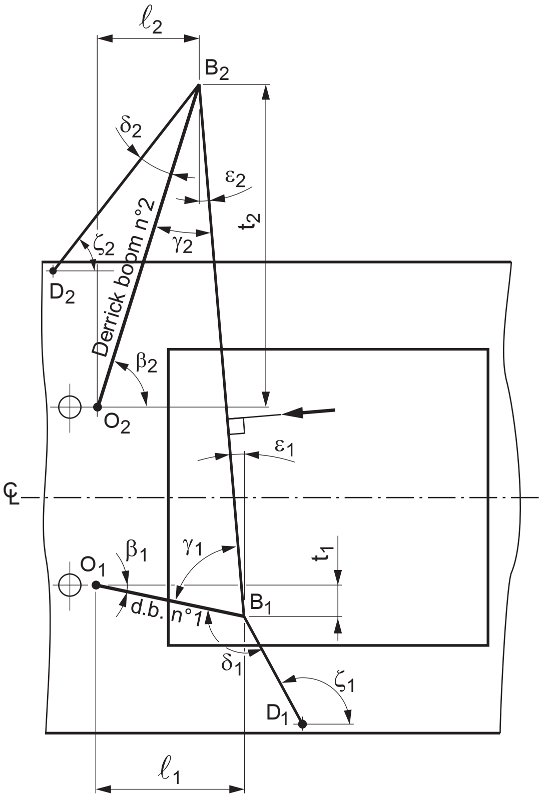
The corresponding position of the junction point of the two cargo runners is marked M_0 on Fig 7 (b).

7.6 Graphic determination of forces

7.6.1 Geometrical constructions

a) First of all, the projection of the rigging system on deck is drawn considering the position taken into account for calculation (see Fig 10).

Figure 10 : Plan view



b) The true side elevation of the vertical plane containing top B_1 and heel 0_1 of derrick boom No. 1 is obtained by rotation around the horizontal line passing through O_1. Thus the true size of the topping angle α_1 and the true lengths of the derrick boom and span tackle are obtained from this diagram. The same process is repeated for the derrick boom No. 2 (see Fig 12).

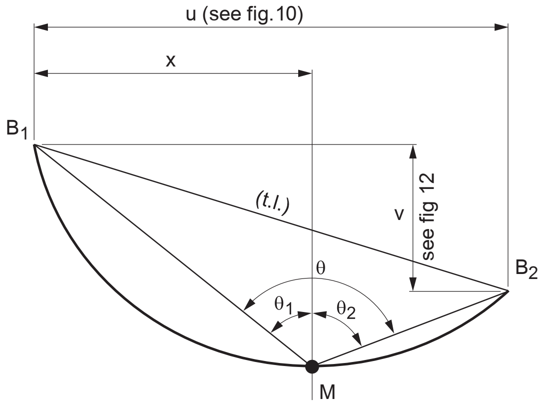
On Fig 12 and on the following ones, the abbreviation (t.l.) means that the dimension of the element concerned is shown in true length or true size.

c) Then, a view along F of the vertical plane passing through tops B_1 and B_2 of the two derrick booms is drawn (see Fig 11. The distance B_1 B_2 is, therefore, obtained in true length.

The junction point M (or M_0) of the two cargo runners is positioned on this view considering the requirements as per [7.5.3].

d) Also, a true side elevation of the vertical plane passing through top B_1 of the derrick boom No. 1 and the ship attachment point D_1 of the preventer guy D_1 B_1 enables to get the true length of this preventer guy and the true size of the angle ω_1 formed with the horizontal plane (see Fig 13). Same process is used for the derrick boom No. 2.

Figure 11 : View along F



7.6.2 Force diagram construction

a) The tensions T_i in the cargo runners at their junction point are obtained by the following diagram (Fig 14) drawn from the view along F obtained from Fig 12, depending on the lifting force F_0 corresponding to the SWL P_o provided in union purchase.

The maximum tension T_L in the cargo runner is equal to the highest of the following values:

$$T_L = \frac{T_1}{k^j}$$

$$T_L = \frac{T_2}{k^j}$$

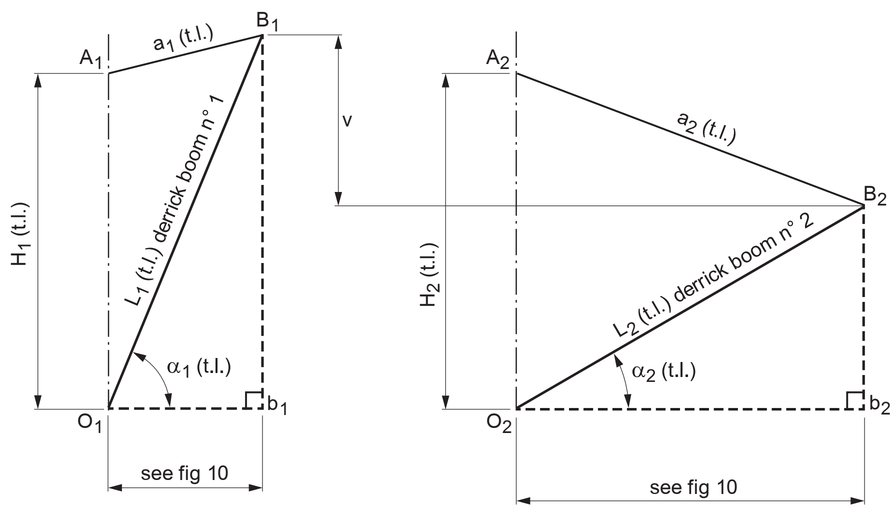
$$T_L = \frac{F_0}{k^j}$$

where:

k : Efficiency coefficient of the single cargo blocks

j : Number of single blocks on which the considered cargo runner is reeved.

Figure 12 : True side elevation of the derrick booms



b) In the horizontal plane the forces T_{ih} obtained by the previous diagram are divided between the derrick booms and the preventer guys as shown on the diagram in Fig 15 derived from Fig 10.

Figure 13 : True side elevation of the preventer guys

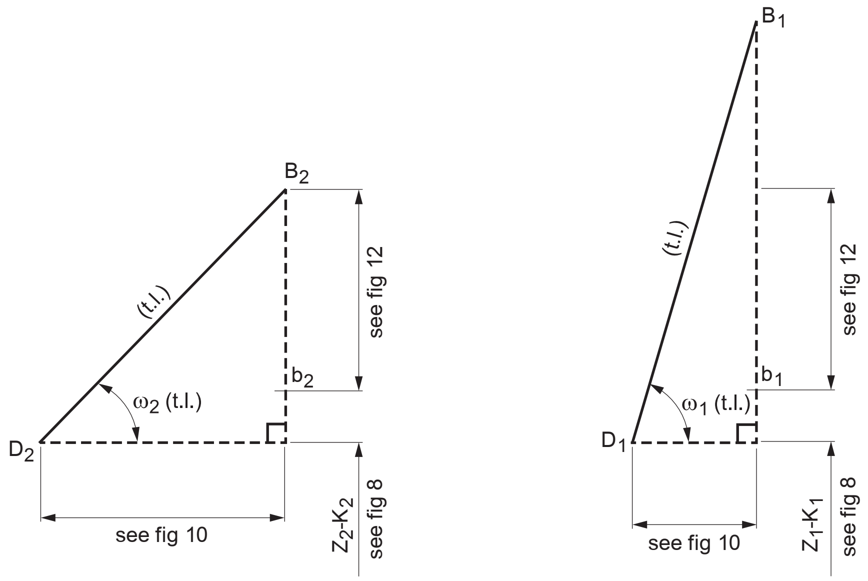


Figure 14 : Tensions in the cargo runners at the hanging point of the load

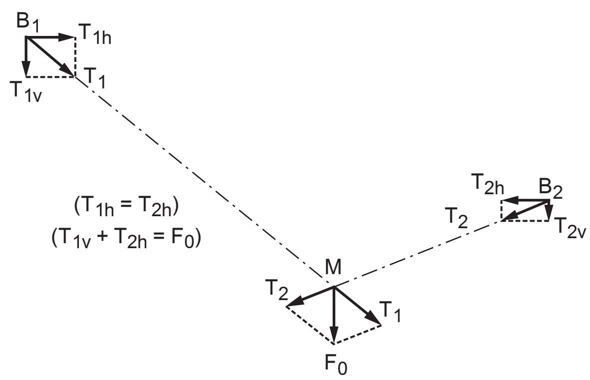
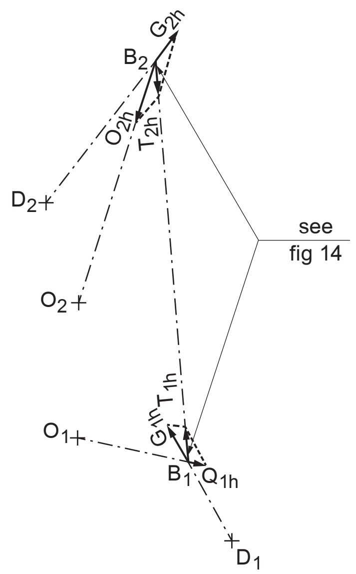
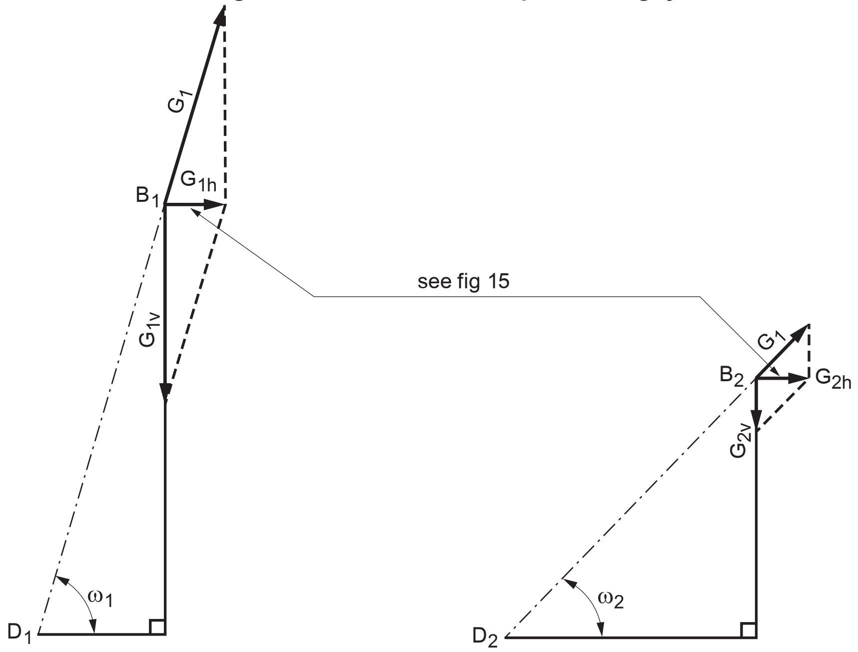


Figure 15 : Horizontal forces at derrick boom heads



c) The tensions G_i in the preventer guys are obtained from the diagram in Fig 16 derived from Fig 13, considering the horizontal components G_{ih} previously obtained.

Figure 16 : Tensions in the preventer guys



d) The forces S_i in the span tackles and Q_i in the derrick booms are obtained from the diagrams in Fig 17 derived from Fig 11, considering the forces exerted at derrick boom heads previously determined and taking into account the force exerted by the cargo runner parallel to the derrick boom, i.e.:

T_{iv} : Vertical component resulting from cargo runner

T_i' : Cargo runner parallel to the derrick boom:

$$T_i' = \frac{T_i}{k}$$

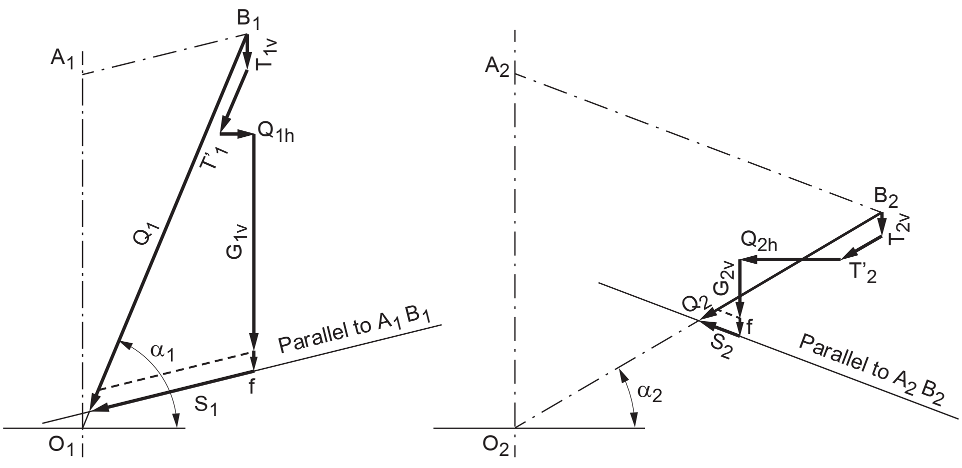
Q_{ih} : Horizontal component of the forces exerted at derrick boom head

G_{iv} : Vertical component due to the preventer guy

f : Dead weight considered at derrick boom head (see [2.3.2]).

In order to avoid risk of vertical instability (“jack knifing”) for the derrick booms, it is to be ascertained that the tensions S_i in the span tackles are positive, neglecting the dead weight f. This check is carried out in drawing a parallel to the span tackle A_iB_i from the end of force G_{iv} as shown by the reinforced dotted line (----) on Fig 17. If this line is located above the line O_iB_i. there is a risk for the derrick boom No. 1 to be in danger of jack knifing and the ship attachment point of the corresponding preventer guy must be modified accordingly.

Figure 17 : Compressions in the derrick booms and tensions in the span tackles

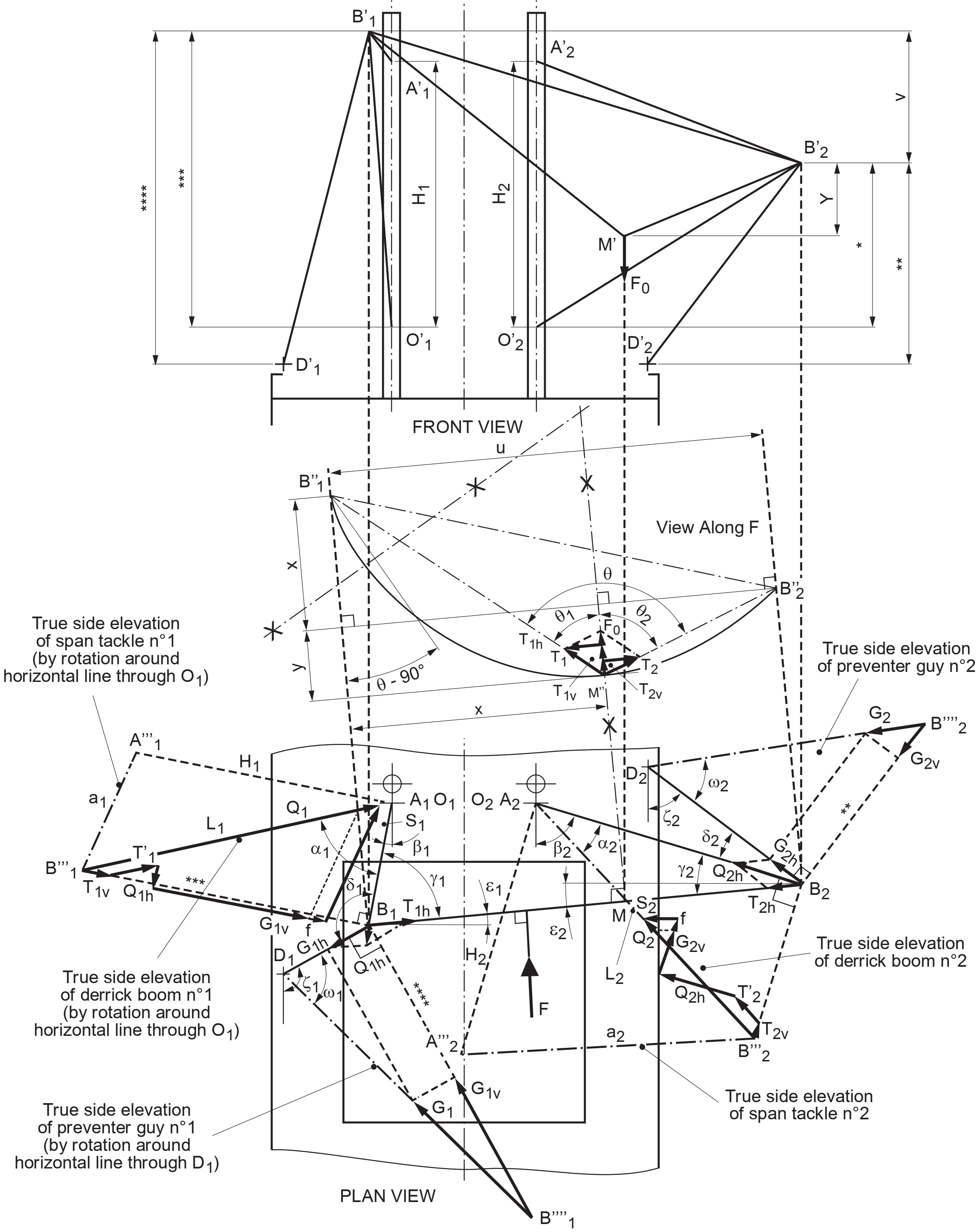


e) All the geometrical and force diagrams may by grouped on a single document as shown on Fig 18. To simplify. parallelograms of forces have been replaced by triangles of forces on Fig 18.

Note 1: For calculation purposes of derrick booms and derrick boom heel pins and fittings, the derrick boom thrust Q to be considered to meet the provisions of Article [14] (see [14.3.5], especially) will be taken as 1,25 times the value determined as indicated here-above. Coefficient 1,25 takes roughly into account:

- effects of ship list and trim
- effects of eccentricities (compared to the longitudinal axis of the derrick boom) of points of application of concentrated forces applied at derrick boom head.

Figure 18 : General force diagram in union purchase



7.7 Determination of the forces by calculation

7.7.1 The geometrical data required for calculation are defined on Fig 8.

The position of the derrick booms is determined by the coordinates ℓ_i and t_i by reference to the derrick boom heel Q_i (see Fig 10) of the projection on deck of the top of each derrick boom (t_i is to be negative when the derrick boom is swung towards the ship centre line).

a) The values ℓ_i and t_i may be calculated by the following formulae when length X and width Y of the hatch are higher than 4 m:

- derrick booms in position I (see Fig 9):
  - derrick boom No. 1

    $\ell_1 = E_0 + E_1$

    $$t_1 = \frac{Y}{2} - 1 - C_1$$

  - derrick boom No. 2

    $\ell_2 = E_0 + E_2$

    $$t_2 = \frac{B}{2} + D - C_2$$

- derrick booms in position II (see Fig 9):
  - derrick boom No. 1:

    $\ell_1 = E_0 + E_1 + E_3$

    $$t_1 = \frac{Y}{2} - 1 - C_1$$

  - derrick boom No. 2:

    $\ell_2 = E_0 + E_2 + E_4$

    $$t_2 = \frac{B}{2} + D - C_2$$

b) When the length and the width of the hatch are lower than or equal to 4 m, the values ℓ_i and t_i may be taken as equal to the following values:

- derrick boom No. 1

  $$\ell_1 = E_0 + E_1 + \frac{E_3}{2}$$

  $t_1 = -C_1$

- derrick boom No. 2

  $\ell_2 = E_0 + E_2$

  $$t_2 = \frac{B}{2} + D - C_2$$

In these formulae, the dimensions E_i, B, D, Y and C_i are defined on Fig 8.

7.7.2 The respective values α_i and β_i of the topping and slewing angles are obtained in applying the following formulae:

$$\alpha_i = \cos^{-1}\left(\frac{\sqrt{\ell_i^2 + t_i^2}}{L_i}\right)$$

$$\beta_i = \tan^{-1}\frac{t_i}{\ell_i}$$

7.7.3 The values of u, v and y (see Fig 7, (a) and (b)) are calculated by the following formulae:

$$u = \sqrt{(\ell_1 - \ell_2)^2 + (t_1 + t_2 + C_1 + C_2)^2}$$

$v = L_1 \sin \alpha_1 - L_2 \sin \alpha_2$

Note 1: v has a negative value when the top of the derrick boom No .2 is higher than the one of the derrick boom No. 1.

$$y = \frac{1}{2}(u\cot\theta - |v| + \sqrt{u^2 + v^2 1 + \cot^2\theta})$$

The value x is as per [7.5.3], whence:

$$x = \frac{1}{2}(u - v\cot\theta) \text{ when } \theta \geq 90^\circ \text{ and } |v| \leq \frac{u}{2}$$

$$x = \frac{u\sqrt{y+v}}{\sqrt{y}+\sqrt{y+v}} \quad \text{when } \theta < 90^\circ \text{ or } |v| > \frac{u}{2}$$

Note 2: When $v < 0$ the test formula is to be replaced by:

$$x = \frac{u\sqrt{y}}{\sqrt{y}+\sqrt{y+|v|}}$$

7.7.4 The following auxiliary angles are calculated (values in degrees):

$$\varepsilon_i = \tan^{-1}\left(\frac{\ell_i - \ell_k}{t + t_2 + C_1 + C_2}\right) \qquad \text{where} \qquad k \neq i$$

$$\zeta_i = \tan^{-1}\left(\frac{t_i - J_i + C_i}{\ell_i - l_i}\right) \qquad \text{if} \qquad l_F < \ell_i$$

$$\zeta_i = 90^\circ \frac{t_i - J_i + C_i}{|t_i - J_i + C_i|} \qquad \text{if} \qquad l_i = \ell_i$$

$$\zeta_i = \tan^{-1}\left(\frac{t_i - J_i + C_i}{\ell_i - l_i}\right) - 180^\circ \qquad \text{if} \qquad l_i > \ell_i$$

$$\omega_i = \tan^{-1}\left(\frac{Z - K_i + L_i \sin\alpha_i}{\sqrt{(\ell_i - l_i)^2 + (t_i - J_i + C_i)^2}}\right)$$

$\Upsilon_i = 90° - (\beta_i + \varepsilon_i)$

$\delta_i = \beta_i - \zeta_i$

Note 1: l_i is negative when the attachment point of the preventer guy is located on the opposite side of the hatch concerned by reference to the derrick boom heel (for example: $l_1 > 0$ and $l_2 < 0$ on Fig 8).

7.7.5 The following auxiliary values are calculated:

- when $v \geq 0$

$$\tan\theta_1 = \frac{x}{v+y}$$

$$\tan\theta_2 = \frac{u-x}{y}$$

- when $v < 0$

$$\tan\theta_1 = \frac{x}{y}$$

$$\tan\theta_2 = \frac{u-x}{|v|+y}$$

$$\xi = \frac{\tan\theta_1 \tan\theta_2}{\tan\theta_1 + \tan\theta_2}$$

$$\mu_i = \frac{\sin(\gamma_i + \delta_i)\tan\alpha_i}{\sin\delta_i}$$

$$\nu_i = \frac{\sin\gamma_i \tan\omega_i}{\sin\delta_i}$$

$$a_i = \sqrt{L_i^2 + H_i^2 - 2L_iH_i\sin\alpha_i}$$

7.7.6 The tensions T_i at the connecting point of the cargo runners are given by the following formula:

$$T_i = \frac{F_0\xi}{\sin\theta_i}$$

The maximum tension T_L in the cargo runners is equal to the greater of the following values:

$$T_L = \frac{T_i}{k^j}$$

$$T_L = \frac{F_0}{k^j}$$

where:

k : Efficiency coefficient of the cargo blacks

j : Number of single blacks on which the considered cargo runner is reeved.

7.7.7 The tensions G_i in the preventer guys are obtained by the following formula:

$$G_i = \frac{F_0 \xi \nu_i}{\sin \omega_i}$$

7.7.8 The tension S_i in a span tackle is given by the greater of the following values:

$$S_i = \frac{a_i}{H_i}[F_0 \xi (\cot\theta_i + \nu_i - \mu_i) + f]$$

$$S_i = \frac{a_i}{H_i}(F_0 + f)$$

In order to avoid risk of jack knifing for the derrick booms, it will be necessary to check that the tensions S_i are higher than $a_i f/H_i$

If this condition is not complied with, the position of the ship attachment point of the corresponding preventer guy is to be modified accordingly.

7.7.9 The compressive forces Q_i in the derrick booms are obtained in applying the following formula:

$$Q_i = \frac{L_i}{H_i}\left[F_0 \xi \left(\frac{H_i + kL_i \cos\theta_i}{kL_i \sin\theta} + \mu_i \frac{H_i + L_i \sin\alpha_i}{L_i \sin\alpha_i} + \nu_i\right) + f\right]$$

Note 1: For calculation purposes of derrick booms and derrick boom heel pins and fittings, the derrick boom thrust Q to be considered to meet the provisions of Article [14] [see [14.3.5] especially) will be taken as 1,25 times the value determined as indicated here-above.

Coefficient 1,25 takes roughly into account:

- effects of ship list and trim
- effects of eccentricities (compared to the longitudinal axis of the derrick boom) of points of application of concentrated forces applied at derrick boom head.

8 Masts and mast fittings hull connections

8.1 General

8.1.1 Articles [8] to [12] deal with the construction and scantlings of stayed or unstayed masts and derrick posts of steel construction intended to support derrick booms used to load and unload ships.

In these Articles, stayed masts is related to masts supported by shrouds or stays of steel wire ropes.

8.1.2 Masts and derrick posts of lattice or of peculiar design will be specially considered. In particular a full computer structural analysis may be required by the Society instead of classical manuel calculations for hyperstatic structures.

8.1.3 Where a mast is designed in such a way as shrouds are only required to lift loads exceeding a given value, the scantlings are to be checked considering the mast as unstayed for the maximum corresponding specified load and as stayed for the maximum load to be lifted.

8.1.4 The scantlings derived from [9] to [12] correspond to the correct use of the cargo gear in service in harbour, i.e. in calm water. As a rule, dynamic influence of derrick boom and lifting motions, as well as wind effects in service, need not be considered in calculations for masts of usual design. Effects of these motions are implicitly considered by allowable stress prescribed in these Articles.

8.1.5 The case of masts in stowed position subject to forces due to wind and ship motion at sea is not considered in Articles [9] to [12], as these forces are generally not significant in comparison with forces due to lifted loads.

9 Unstayed masts

9.1 Materials

9.1.1 The materials used for the construction of masts. posts and for their connections with hull are to comply with the requirements of Ch 2, Sec 1.

9.1.2 The hull steel grades to be used for the construction of masts and posts are shown in Tab 2 (see also Ch 2, Sec 1, [2.2]).

9.1.3 The allowable stresses are defined with respect to R_e, the yield stress of the steel taken into account in the calculations (design yield stress).

The value R_e is defined in Tab 3 according to the specified minimum yield stress, R_{eH}, and of the specified minimum tensile strength, R_m, of the steel used.

Table 2 : Hull steel grades for masts and posts

Plate thickness t, in mm	Hull steel grade
$t \le 20$	A or AH
$20 < t \le 25$	B or AH
$25 < t \le 40$	D or DH
$40 < t$	E or EH

Table 3 : Design yield stress

Tensile strength R_m	Design yield stress R_e
$R_m \ge 1{,}4\ R_{eH}$	$R_e = R_{eH}$
$R_m < 1{,}4\ R_{eH}$	$R_e = 0{,}417\ (R_{eH} + R_m)$

9.2 Combined stress

9.2.1 The combined stress σ_{cb} in the masts and posts is determined by the formula:

$$\sigma_{cb} = \sqrt{\sigma^2 + 3\tau^2}$$

where:

σ : Normal stress calculated considering the bending moments and the tensile and compressive forces

τ : Tangential stress calculated considering the torsional moment and the shear forces.

9.2.2 The stresses σ and τ are to be calculated at the same point of the considered cross-section.

9.3 Allowable stresses

9.3.1 Normal scantlings method

a) In service conditions, at any point, the combined stress σ_{cb} defined in [9.2] is not to exceed the allowable stress σ_a given in Tab 4 according to the SWL P of the derrick boom and the design yield stress R_e defined in [9.1.3].

The combined stress is calculated as per [9.2], taking into account the conditions of calculation defined in [8.1.4] and in Article [2].

When they are not significant, the tangential stresses which result from torsional moment or shear force may be neglected.

b) When several derrick booms are rigged on the same mast and may be used simultaneously (see [2.2.1]) the allowable stress in the structural parts which are loaded by several derrick booms depends on the derrick boom of the highest SWL.

In structural parts which are loaded by a single derrick boom, the allowable stress depends on the SWL of this derrick boom.

Table 4 : Allowable stress in masts and posts

SWL of mast P, in t	Allowable stress σ_a, in N/mm²
$P \le 20$	$0{,}57\ R_e$
$20 < P < 160$	$\dfrac{P}{1,43P + 6,5}R_e$
$P \ge 160$	$0{,}68\ R_e$

9.3.2 Special scantlings method

a) For tubular masts of circular cross-section and of SWL higher than or equal to 20 t which comply with the special requirements of [9.3.1] item b), the allowable stress σ_a, in N/mm², may be taken as equal to the following value:

- when $20\ t \le P < 160\ t$

$$\sigma_a = \frac{P}{1,3P + 6}R_e$$

- when $P \ge 160\ t$

$\sigma_a = 0{,}75\ R_e$

where:

P : SWL of the derrick, in t

R_e : Design yield stress equal to:

- $R_e = R_{eH}$ when

  $R_m \geq \frac{4}{3} R_{eH}$

- $R_e = 0,43\ (R_{eH} + R_m)$ when

  $R_m < \frac{4}{3} R_{eH}$

R_{eH} and R_m being respectively the minimum specified yield stress and the minimum specified tensile strength of the steel used.

Attention is drawn to the fact that this allowable stress is exceptional and can be accepted only with the agreement of the Society when all the requirements of [9.3.1] item b), are complied with. Under normal conditions the allowable stress is to be determined as per [9.3.1].

The structural elements the cross-section of which is not circular are to be given scantlings taking into account the allowable stress as per [9.3.1].

b) The allowable stress as mentioned in [9.3.1] item a), may be accepted for masts of circular cross-section with SWL higher than or equal to 20 t only provided that the special requirements hereunder are duly complied with:

1) precise and complete calculations are to be submitted. As a rule, structural calculations are to be carried out by computer. The Society is entitled to require additional calculations using their own computer programs. Taking into account the peculiarities of the design, when the Society considers that sufficient accuracy cannot be obtained, it is entitled to decrease the value of the allowable stress either for the whole of the proposed structure or for part of it. Especially suitable local reinforcements are to be provided where stress concentrations are expected.

2) for the calculation of the mast, the most critical positions of the derrick boom inside its working area are to be taken into account to the satisfaction of the Society.

3) the means provided to ensure that the working area will not be overstepped in service are to be specified. If these means are considered not sufficient, additional calculations are to be performed outside the working area considering the derrick boom at the minimum possible topping angle and at the maximum possible slewing angle. In such a case, the combined stress is not to exceed the allowable stress as per item a), by more than 10%.

4) the list and trim angles (see [2.5]) are to be taken into account in all cases; especially the forces due to slewing tackles are to be considered.

5) the dead-weights of the cargo tackle, of the hook, of the span tackles, and of the derrick boom, are to be taken into account in accordance with the provisions of [2.3]. The Society is entitled to require relevant justification for the weights taken into account.

6) no minustolerance will be accepted as to plate thicknesses.

7) each plate is to be ultrasonically tested.

8) the manufacturing tolerances and the construction details are to be specified and are to correspond to top-grade quality.

9) the characteristics of the steels used, their manufacturing processes and the welding procedures are to be submitted to the approval of the Society.

10) ovalization measured as the difference between two diameters of a given cross-section, is to be less than 2% of the nominal outer diameter.

11) the longitudinal seams of the various tubular sections are to be staggered by a minimum of 200 mm to each other.

12) every circumferential weld and longitudinal seams at ends (on 200 mm on both sides of a circumferential weld) are to be subject to radiographic testing. The other longitudinal welds and Tee joints are to be submitted to ultrasonic inspections. Fillet welds are to be subject to magnetic particle testing or liquid penetrant testing especially in connecting zones with mast fittings.

13) reinforced protection against corrosion is to be provided.

9.3.3 Allowable stresses as per [9.3.1] and [9.3.2], are only valid if derrick tests are carried out in accordance with the requirements of Ch 5, Sec 1, [11].

9.4 Construction

9.4.1 The following requirements apply to masts and king posts made of welded tubular structures (circular tubes or box beams).

9.4.2 The wall thickness of the mast t_{min} is to be not less than the value given in Tab 5 according to the SWL P of the mast.

Table 5 : Minimum thickness of mast plating

SWL of mast P, in t	Minimum thickness t_{min}, in mm
$P \leq 1$	6
$1 < P < 5$	$\frac{3}{8}(P + 15)$
$P \geq 5$	7,5

9.4.3 Diameter/thickness ratio for masts of circular cross-section

a) for masts of circular cross-section, D/t ratio between the external diameter D, in mm, and the thickness t, in mm, of each considered cross-section is not to exceed either 150 or the value given in Tab 6 according to the SWL P of the mast and the design yield stress R_e, in N/mm^2.

b) when the combined stress σ_{cb} calculated as per [9.2] is less than the allowable stress σ_a as per [9.3.1] or [9.3.2], as the case may be, the value of D/t ratio from Tab 6 may be increased in ratio σ_a/σ_{cb}.

c) when the allowable stress as per [9.3.2], is applicable, D/t ratio as per item a), and possibly taking into account item b), may be increased by 10%.

Table 6 : Mast of circular cross-section: D/t ratio

SWL of mast P, in t	D/t ratio
$P \leq 5$	$\frac{23500}{R_e}$
$5 < P < 160$	$\frac{47000P}{R_e(P + 5)}$
$P \geq 160$	$\frac{45600}{R_e}$

9.4.4 Width/thickness ratio and stiffening of masts with a plane face

a) for the masts the cross-section of which has a plane face, b/t ratio between the width b, in mm, of this unstiffened face (or spacing between the longitudinal stiffeners) and the thickness e, in mm, of each cross-section is to be not greater than:

$$\frac{b}{t} = \frac{720}{\sqrt{R_e}}$$

b) when the combined stress σ_{cb}, calculated as per [9.2] is lower than the allowable stress σ_a as per [9.3.1], the maximum value of b/t ratio may be taken equal to the following value:

- when $\sigma_{cb} \leq 0{,}63\ \sigma_a$

$$\frac{b}{t} = \frac{900}{\sqrt{R_e}}\sqrt{\frac{\sigma_a}{\sigma_{cb}}}$$

- when $\sigma_{cb} < 0{,}63\ \sigma_a$

$$\frac{b}{t} = \frac{1610}{\sqrt{R_e}}\sqrt{1 - 0,8\frac{\sigma_{cb}}{\sigma_a}}$$

Ratio b/t is not to exceed 100 in any case.

c) when a plane face is stiffened by longitudinal stiffeners, second moment of area with associated plate I_0, in cm^4, of each of these stiffeners is to be not less than the following value:

$$i = 3600(s + 0,01 t b_0)\left(\frac{t\ell}{b_0}\right)^2$$

where:

s : Cross sectional area, in cm^2. of the stiffener without associated plate

t : Thickness, in mm, of the mast plate

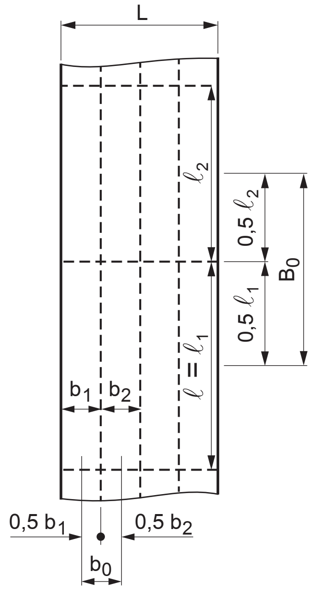
b_0 : Width, in mm, of the plate supported by the stiffener:

$b_0 = 0{,}5\ (b_1 + b_2)$

where b_1 and b_2 are the distances, in mm, between, the considered stiffener and the two nearest stiffeners, respectively

ℓ : Length, in m, of the considered stiffener (ℓ is the distance, in m, between the two stringers or transverse web plates acting as supports for the longitudinal stiffener) (see Fig 19).

Figure 19 : Stiffening of a plane face



d) the second moment of area I_0, in cm^4, with associated plate of stringers or transverse opened web plates supporting longitudinal stiffeners is to be not less than the following value:

$$I = 0,27\frac{N+2}{N+1}\left(\frac{L}{B_0}\right)^3 i_0$$

where:

L : Length, in m, of the transverse stringer (L is to be taken equal to the inner width of the plane face)

B_0 : Width, in m, of the plate supported by the transverse stringer

$B_0 = 0,5\ (\ell_1 + \ell_2)$

ℓ_1 and ℓ_2 being the distances, in m, from the concerned stringer to the nearest two stringers located on both sides of it respectively

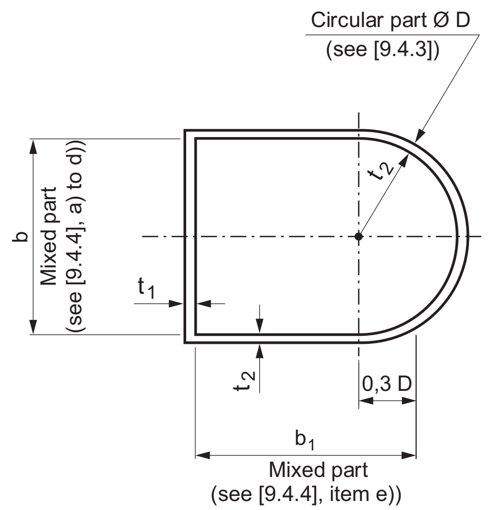
N : Number of longitudinal stiffeners supported by the considered stringer

i_0 : Actual second moment of area, in cm^4. with associated plate for each of the stiffeners assumed to be identical and equally spaced (see Fig 19).

e) when the mast walls consist in circular parts connected to flat parts on the one hand, the requirements of [9.4.3] are to be complied with for the circular part considering its external diameter D and, on the other hand, the requirements of item a) to item d) are to be complied with for the mixed part (flat portion connected to circular portion) considering a fictitious width b_1 equal to the width of the flat part increased by 0,3D (see Fig 20).

f) if the requirements as per item a) to item e), are not entirely complied with, the strength of plates and stiffeners with respect to local buckling is to be justified by calculations to the satisfaction of the Society.

Figure 20 : Mixed cross-section



9.4.5 As a rule, the masts and king posts are to be strengthened by means of additional stiffeners, transverse web plates or by increasing locally their thickness in way of all the concentrated applied forces, specially in way of their connections with the ship structure and in way of the gooseneck bearings, span bearings and other fittings.

9.4.6 As far as possible, strength continuity of the structural parts subjected to tensile stresses is to be ensured by continuous plates or by butt welding. Strength continuity of such structures by means of fillet welds on transverse plate is to be avoided. Occasionally, if this arrangement cannot be avoided, the transverse plate must be ultrasonically tested before and after welding to make sure that there is no trace of lamination and special precautions are to be taken for welding in order to limit to a maximum possible risks of lamellar tearing. Use of Z quality plate is recommended for such transverse plate.

In accordance with the above, the mast structures are to be continuous through the uppermost deck where the mast is attached unless otherwise accepted by the Society.

As a rule, the use of doubling plates is authorized only when plates are subjected to compressive forces.

9.4.7 Drain holes or other draining devices are to be provided in the structural parts where sea water or rain may stagnate.

All the structural parts are to be designed to allow inspection and are to be accessible for painting except when small dimensions make it impossible. In the latter case, closed and watertight construction is to be provided.

9.5 Strength calculation

9.5.1 Strength calculations are to be made for all masts and king posts considering the calculation assumptions as per Article [2] and the points of application of forces determined in accordance with Article [3].

In particular, reference is to be made to the following sub-articles of Article [2]:

- [2.3] for the dead-weights (as a rule, the deadweight of the mast itself may be disregarded in the calculations)
- [2.5] for the list and trim angles of the ship
- [2.6] concerning sheave and tackle efficiencies.

9.5.2 It is assumed that the worst position of the derrick boom, regarding mast scantlings, occurs when:

- the derrick boom is at its minimum topping angle, irrespective of its slewing angle, when trim and list may be ignored in the calculations (see [2.4.2], item c)
- the derrick boom is at its minimum topping angle together with its maximum slewing angle (provided that this position is part of the working area) when trim and list will have to be taken into consideration (this assumption is valid only for masts of isostatic structure and circular cross-section)
- two derrick booms are slewed together outboard at their maximum outreaches on the same mast.

The derrick boom positions for mast calculation purpose are specially considered for masts of special design or special rigging and for masts calculated in compliance with special requirements of [9.3.2].

9.5.3 Generally, stresses may be obtained from any simple method of calculation derived from the classical theory of the strength of materials in the elastic field except when very accurate calculations are deemed necessary as indicated in [8.1.2] or [9.3.2].

9.5.4 As a rule, when applicable, the calculation methods as per [9.5.5] and [9.5.6] are to be used.

9.5.5 Simplified calculation method for masts and king posts supporting derrick booms of SWL less or equal to 20 t and of circular cross-section

a) The section modulus W, in cm^3, of a circular section is calculated by means of the following formula:

$$W = 10^{-3}\frac{\pi}{32}\left[\frac{D^4-(D-2t)^4}{D}\right]$$

where D and t are, in mm, the external diameter and the thickness of the considered cross-section, respectively.

b) The section modulus W of the mast, in cm^3, at the derrick boom heel level is to be not less than:

$$w = \frac{2200M}{R_e}$$

M :
- For mast operated with a single derrick boom:

  $M = F (L \cos\alpha + c)$
- For mast used with two derrick booms simultaneously:

  $$M = \sqrt{M_1^2 + M_2^2 - 2M_1M_2\cos(\beta_1+\beta_2)}$$

Note 1: in case of masts used simultaneously with two derrick booms it is to be checked that the value of M obtained is not inferior to the one given for mast operated with a single derrick boom. Otherwise, the value of M to be considered to calculate w is the greater of:

$F_1 (L_1 \cos\alpha_1 + c_1)$ and

$F_2 (L_2 \cos\alpha_2 + c_2)$

- For masts supporting one derrick boom used in union purchase rig with a derrick boom of an other mast (the Society reserves the right to change the coefficient 2 in some cases):

  $M = 2\ F_0\ (L \cos \alpha + c)$

$M_1 = F_1\ L_1 \cos \alpha_1$ and

$M_2 = F_2\ L_2 \cos \alpha_2$

F, F_1 or F_2: SWF, in kN, corresponding to the SWL P, P_1 or P_2 of the considered derrick boom used in normal slewing (see Ch 1, Sec 1, [6.2.8])

F_o : SWF, in kN, corresponding to the SWL P_o of the considered derrick boom used in union purchase (see Ch 1, Sec 1, [6.2.17])

L, L_1 or L_2: True length, in m, of the considered derrick boom, measured from the derrick heel pin to the derrick head cargo fitting,

c : Horizontal distance, in m, between the mast axis and the derrick heel pin

α, α_1, α_2: Minimum topping angle, in degrees, of the considered derrick boom (see [2.4.1], item b))

β_1 , β_2 : Maximum slewing angle, in degrees, of the considered derrick boom which may be associated to the minimum topping angle considering the working area of the considered derrick boom (see [2.4.2], item b) and [2.4.3])

R_e : Design yield stress, in N/mm² (see [9.1.3]).

c) The scantlings of the mast may decrease gradually from the derrick boom heel level (more accurately from a cross-section located at a distance equal to half a mast diameter above the upper horizontal plate of the gooseneck bearing bracket) to the mast head span bearing bracket level where the mast diameter, as a rule, is not to be less than 0,6 the diameter in way of the derrick boom heel and where the section modulus is not to be less than 0,25 w.

   Above the derrick boom heel level the section modulus W_h in cm³, of the mast in way of a discontinuity of the mast thickness (if any) is not to be less than:

$$w_h = w\left(0,25 + 0,75\frac{H - h}{H}\right)$$

   where:

   H : Distance, in m, between the derrick boom heel pin level and the level of the attachment of the span tackle on the mast head span trunnion,

   h : Distance, in m, between the considered cross-section and the level of the derrick boom heel pin (see Fig 21).

d) If the gooseneck bearing bracket is directly attached to or effectively supported by the mast, the section modulus of the mast w determined in accordance with item b), is to be kept constant down to the level of the uppermost deck where the mast is attached.

e) If the gooseneck bearing bracket is not attached to the mast, the section modulus of the mast must increase linearly from the level of the derrick boom heel down to the level of the uppermost deck where the mast is attached.

   In this case, the section modulus W_m, in cm³. of the mast, at this deck level, is not to be less than:

$$w_m = w\frac{H_m}{H}$$

   where the distances H_m and H, in m, are as shown on Fig 21.

   The section modulus W_k, in cm³, of the king post supporting the derrick boom heel at the uppermost deck level where the king post is attached is not to be less than:

$$w_k = w\frac{H_k}{H}$$

   where:

   H : As per item c)

   H_k : Height, in m, of the derrick heel pin above the attachment deck of the king post.

   As a rule, this section modulus is kept constant over the whole height of the king post.

f) The section moduli required in item d), or item e), at the uppermost attachment deck level are normally kept constant down to the lowest deck where the mast is attached.

   However, the scantlings of the mast or king post may decrease progressively from the uppermost attachment deck (more precisely from a distance under deck equal to half the diameter of the mast) down to the lowest attachment deck where the diameter of the mast is not to be lower than 0,7 times the diameter at the uppermost attachment deck and where the bending modulus is not to be lower than 0,4 times the section modulus required at the uppermost deck.

   Between these attachment decks the section modulus W_h, in cm³, of the mast or king post in way of a discontinuity of the mast thickness (if any) is not to be less than:

$$w_h' = w'\left(0,40 + 0,60\frac{H' - h'}{H'}\right)$$

   where:

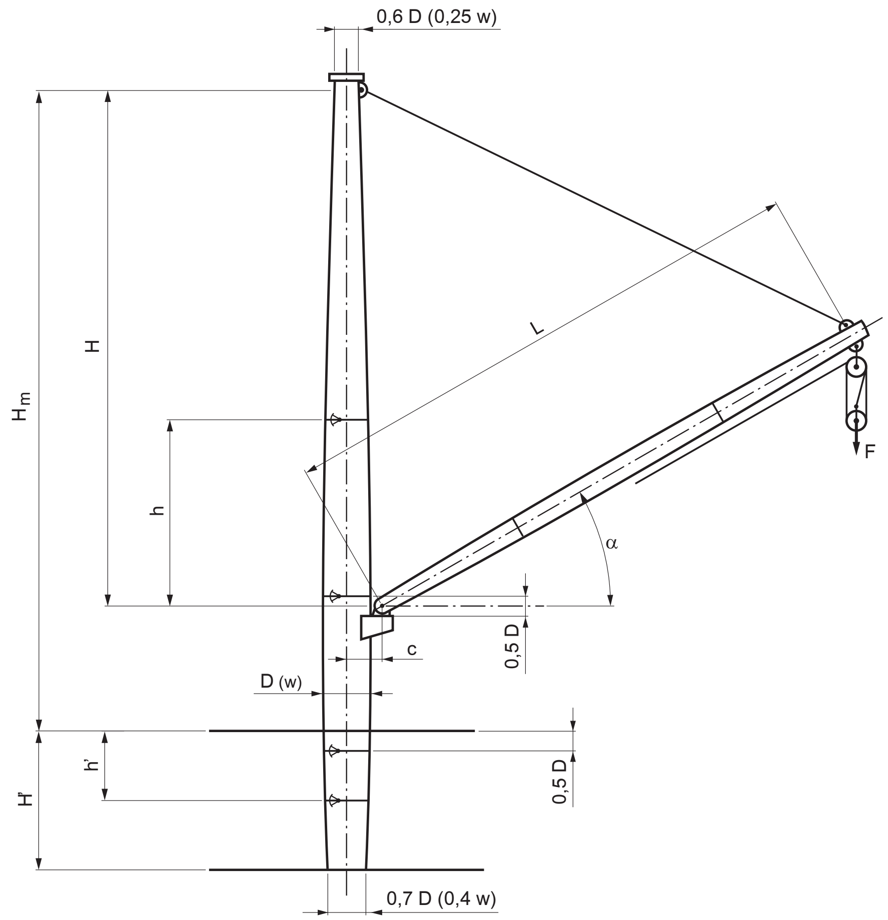
H' , h' : Distances, in m, as shown on Fig 21

w' : Equal to w, w_m or w_k, depending on the cases provided in item d), or item e).

g) Modifications in the requirements as per item c) to item f), may be accepted by the Society in some cases.

h) If the actual list of the ship is greater than 5°, the requirements as per item b) to item f), are applicable substituting cos α by cos (α – φ) in the values of M given in item b), where φ is the actual list angle to be considered in degrees.

Figure 21 : Data for unstayed mast calculations



9.5.6 Simplified calculation method for mast and king posts supporting a derrick boom of SWL less or equal to 20 t and of rectangular cross-section

a) The simplified calculation method as per [9.5.5], may be applied to masts of rectangular cross-section making sure that the following relation is complied with for each considered cross-section:

$$\frac{\sin\theta}{W_x} + \frac{\cos\theta}{W_y} \le \frac{1}{w''}$$

where:

W_x , W_y : Actual moduli along the two main axes of inertia of the considered cross-section, in cm³

$$\theta = \tan^{-1}\frac{W_y}{W_x}$$

w'' :
- when [9.5.5] item b) applies:
  $w'' = w$
- when [9.5.5] item c) applies:
  $w'' = w_h$
- as the case may be, when [9.5.5] item e) applies:
  $w'' = w_m$ or w_k
- when [9.5.5] item f) applies:
  $w'' = w'_h$

b) In the particular case of masts of square cross-section with four sides of the same thickness, the method as per item a) may be applied; however it may be simplified considering $W_x = W_y$

In this case, the following relation is to be complied with instead of the relation given in, item a)

$W_x \geq 1,4\, w''$

c) The requirements of [9.5.5] item d), [9.5.5] item g) and [9.5.5] item h) are applicable.

d) The requirements as per item a) and item b), are not applicable to masts of rectangular cross-section supporting two derrick booms which are used simultaneously.

In such a case, these requirements may be referred to, however, to check that the mast strength is sufficient when a single derrick boom is in operation.

In general, the most critical loading case with simultaneous use of two derrick booms happens approximately when one of the two derrick booms is directed in the centre line of the ship while the other is at its maximum outreach at side.

10 Stayed masts

10.1 Materials

10.1.1 As a rule, stayed masts are to be built in hull steel of normal strength (R_{eG} = 235 N/mm²).

The steel grade to be used is defined in Tab 7.

10.1.2 Staved masts made of high tensile steel will be especially examined, in particular their strength against buckling shall be justified.

Table 7 : Hull steel grade for stayed masts

Plate thickness t, in mm	Hull steel grade
$t \leq 25$	A
$25 < t \leq 30$	B
$30 < t \leq 50$	D
$50 < t$	E

10.2 Combined stress

10.2.1 The combined stress σ_{cb} in the stayed masts is determined by the formula:

$$\sigma_{cb} = \sqrt{(\omega|\sigma_c| + |\sigma_b|)^2 + 3\tau^2}$$

where:

$|\sigma_c|$: Absolute value of the normal compressive stress which results from the general compressive force taking into account the forces exerted by the shrouds

ω : Buckling coefficient as per Ch 2, Sec 3, Tab 2, for the girders of closed section (unless otherwise justified, the actual buckling length considered to calculate ω will be taken equal to the distance H_m as per [10.5.6], item b)

$|\sigma_b|$: Absolute value of the bending stress

τ : Tangential stress due to the torsional moment and the shear forces.

10.2.2 The stresses σ_c, σ_b and τ are to be calculated at the same point of the considered cross-section.

10.3 Allowable stresses

10.3.1 In working conditions, at any point, the combined stress σ_{cb} as per [10.2] is not to exceed the allowable stress σ_a given in Tab 8 in relation to the SWL P of the derrick boom and the design yield stress R_e as per [9.1.3] (as a rule R_e = 235 N/mm²).

Table 8 : Allowable stress in stayed masts

SWL of mast P, in t	Allowable stress σ_a in N/mm²
$P \leq 20$	$0,52\, R_e$
$20 < P < 160$	$\dfrac{P}{1,5P + 7} R_e$
$P \geq 160$	$0,62\, R_e$

10.4 Construction

10.4.1 Requirements as per [9.4.2], [9.4.5], [9.4.6] and [9.4.7] apply to stayed masts.

10.4.2 For stayed masts of circular cross-section, the ratio D/t between the outer mast diameter D, in mm, and the thickness t, in mm, of each considered cross section, is not to be greater than:

$$\frac{D}{t} = 75$$

When this requirement is not applicable or not complied with, the matter will be especially examined by the Society.

10.4.3 The scantlings of shrouds will have to be in compliance with the requirements of Ch 2, Sec 5. It is reminded that the constitutive strands of the rope are not to include fibre core (see [10.6]).

10.4.4 The shrouds are not to be attached to the ends of cross trees as this may affect their efficiency due, on the one hand, to the displacements of the cross trees corresponding to deflection and rotation of the mast and, on the other hand, due to self deflection of the cross trees.

10.4.5 Special attention is to be paid to the connection of shrouds to decks or bulwarks. It is to be checked that the chain plates for shrouds and the structures on which they are attached are able to withstand the forces exerted on the shrouds.

10.4.6 Strong structures or local reinforcements are to be provided under stayed masts to withstand the compressive force in the mast due to vertical reactions induced by the shrouds.

10.4.7 The arrangement of shrouds is to be such as not to hinder proper working of the derrick booms in the contemplated operating conditions.

Normally, the shrouds are symmetrically arranged in relation to the centreline longitudinal plane of the ship. In relation with the transverse plane perpendicular to it, it is recommended to arrange shrouds not only on the opposite side of the served hatch but also on the side of this hatch in order to prevent the initial tension of the shrouds from resulting in excessive bending of the mast when unused (see [10.4.8]).

10.4.8 Shrouds are to be suitably stretched to avoid slack of the wire rope. To this end apparatus to set the initial tension of the shrouds are to be fitted and provided with devices to secure them in position (for example rigging screws unlikely to be unscrewed inopportunely). Attention is drawn to the fact that initial tension of shrouds is to be moderate and not result in unacceptable initial mast deflection.

10.5 Strength calculations

10.5.1 Requirements as per [9.5.1], apply to stayed masts.

10.5.2 The masts fixed in the ship structure are to be calculated for bending considering displacement at mast top due to stiffness of mast and elasticity of support formed by the shrouds, taking into account also compressive forces due to running and standing rigging.

Unless especially justified. the modulus of elasticity of the wire ropes in relation to the net metallic cross sectional area of the rope shall be taken equal to:

- 80 000 N/mm^2 to calculate the mast
- 120 000 N/mm^2 to calculate the shrouds.

For mast calculation, and whatever be the result of the calculations, the horizontal component of the reaction force of the shrouds is not to be taken higher than (1 – 0,02 k) times the horizontal force applied at mast top by the span tackle and possibly by the cargo lead at mast top. Coefficient k is defined in [10.5.6] item b).

10.5.3 The calculations are normally to be made considering the derrick boom as parallel to the longitudinal axis of the ship and the derrick boom swung at its maximum outboard working position.

10.5.4 Heel-hinged stayed masts will be specially examined.

10.5.5 When they are applicable, the calculation methods as per [10.5.6] and [10.5.7] are to be used.

10.5.6 Simplified calculation method for stayed masts of circular cross-section fastened at heel and made of hull steel of normal strength (R_{eG} = 235 N/mm^2)

a) The section modulus W, in cm^3, and the second moment of area I, in cm^4, of a circular section are calculated by means of the following formulae:

$$W = 10^{-3}\frac{\pi}{32}\left[\frac{D^4-(D-2t)^4}{D}\right]$$

$$I = \frac{WD}{20}$$

where D and t are, in mm, the external diameter and the thickness of the considered cross-section, respectively.

b) The section modulus of the mast, W, in cm^3, at the derrick boom heel level is not to be less than the greater of the two following values:

$w_1 = \delta k M$

$w_2 = 0{,}02\ k^2 M$

where:

M : • for mast operated with a single derrick boom:

$M = F\ (L \cos\alpha + c)$

• for mast used with two derrick booms simultaneously

$$M = \sqrt{M_1^2 + M_2^2 - 2M_1M_2\cos(\beta_1 + \beta_2)}$$

$M_1 = F_1\ L_1 \cos\alpha_1$

$M_2 = F_2\ L_2 \cos\alpha_2$

Note 1: in case of masts operated with two derrick booms simultaneously the corresponding value of M is used only with value u = u_y. In addition, the mast scantlings are to be checked when operating with only one derrick boom parallel to the longitudinal centreline of the ship, using value u = u_x and value of M as the greater of:

$F_1\ (L_1 \cos\alpha_1 + c_1)$ and $F_2\ (L_2 \cos\alpha_2 + c_2)$

• for mast supporting one derrick boom used in union purchase rig with a derrick boom of another mast.

$M = 2\ F_0\ (L \cos\alpha + c)$

Note 2: The Society reserves the right, in certain cases, to change the coefficient 2

F, F_1 or F_2: SWF, in kN, corresponding to the SWL P, P_1 or P_2 of the considered derrick boom used as normal slewed derrick (see Ch 1, Sec 1, [6.2.8])

F_0 : SWF, in kN, corresponding to the SWL P_0 of the considered derrick boom used in union purchase rig (see Ch 1, Sec 1, [6.2.17])

L, L_1 or L_2: True length, in m, of the considered derrick boom measured from the derrick heel pin to the derrick head cargo fitting

c : Horizontal distance, in m, between the mast axis and the derrick heel pin

α, α_1 or α_2: Minimum topping angle, in degrees, of the considered derrick boom (see [2.4.1], item b))

β_1 or β_2 : Maximum slewing angle, in degrees, which may be associated with the minimum topping angle considering the working area of the considered derrick boom (see [2.4.2], item b) and [2.4.3]

k : • when $P \leq 20$

$k = 10$

• when $20 < P < 160$

$$k = \frac{8{,}3P + 34}{P}$$

• when $P \geq 160$

$k = 8{,}5$

P : SWL, in t, of the considered derrick boom

$\delta = \mu\ (1{,}36 - 0{,}28\ \mu)$

$$\mu = \frac{I_m}{I_m + 13H_m^3 u}$$

I_m : Second moment of area of the mast, in cm^4, at the level of the uppermost attachment deck, calculated as per item a)

H_m : Distance, in m, between the level of the uppermost attachment deck and the level of the hounds (see Fig 22)

u : Smaller of the sums:

$$u_x = \sum \frac{A}{\ell_i}\left(\frac{\ell_x}{\ell_i}\right)$$

$$u_y = \sum \frac{A}{\ell_i}\left(\frac{\ell_{yi}}{\ell_i}\right)^2$$

the individuals terms of these sums concern all the shrouds. whether they are loaded or not and are as follows:

A_i : Area of the net metallic cross sectional area, in mm^2, of the considered shroud (when precise composition of the wire rope is unknown it may be assumed that $A_i = 0{,}37d_i^2$ where d_i is the rope diameter, in mm)

ℓ_{xi} and ℓ_{yi}: Spreads, in m, of the considered shroud measured in the longitudinal and transverse directions, respectively (see Fig 22)

$$\ell_i = \sqrt{\ell_{xi} + \ell_{yi} + \ell_{zi}}$$

ℓ_{zi} : Vertical distance, in m, between the level of the fixing point of the considered shroud on the ship and the level of the hounds (see Fig 22)

c) The scantlings of the mast may decrease gradually from the derrick boom heel level (more accurately from a cross-section located at a distance of half a mast diameter above the upper horizontal plate of the gooseneck bearing bracket) to the mast head span bearing bracket level where the mast diameter, as a rule, is not to be less than 0,75 the diameter in way of the derrick boom heel and where the section modulus is not to be less than 0,55w, w being the greater of the two values w_1 and w_2 determined as per item b)

Above the derrick boom heel level the section modulus W_h, in cm³, of the mast in way of a discontinuity of the mast thickness (if any) Is not to be less than:

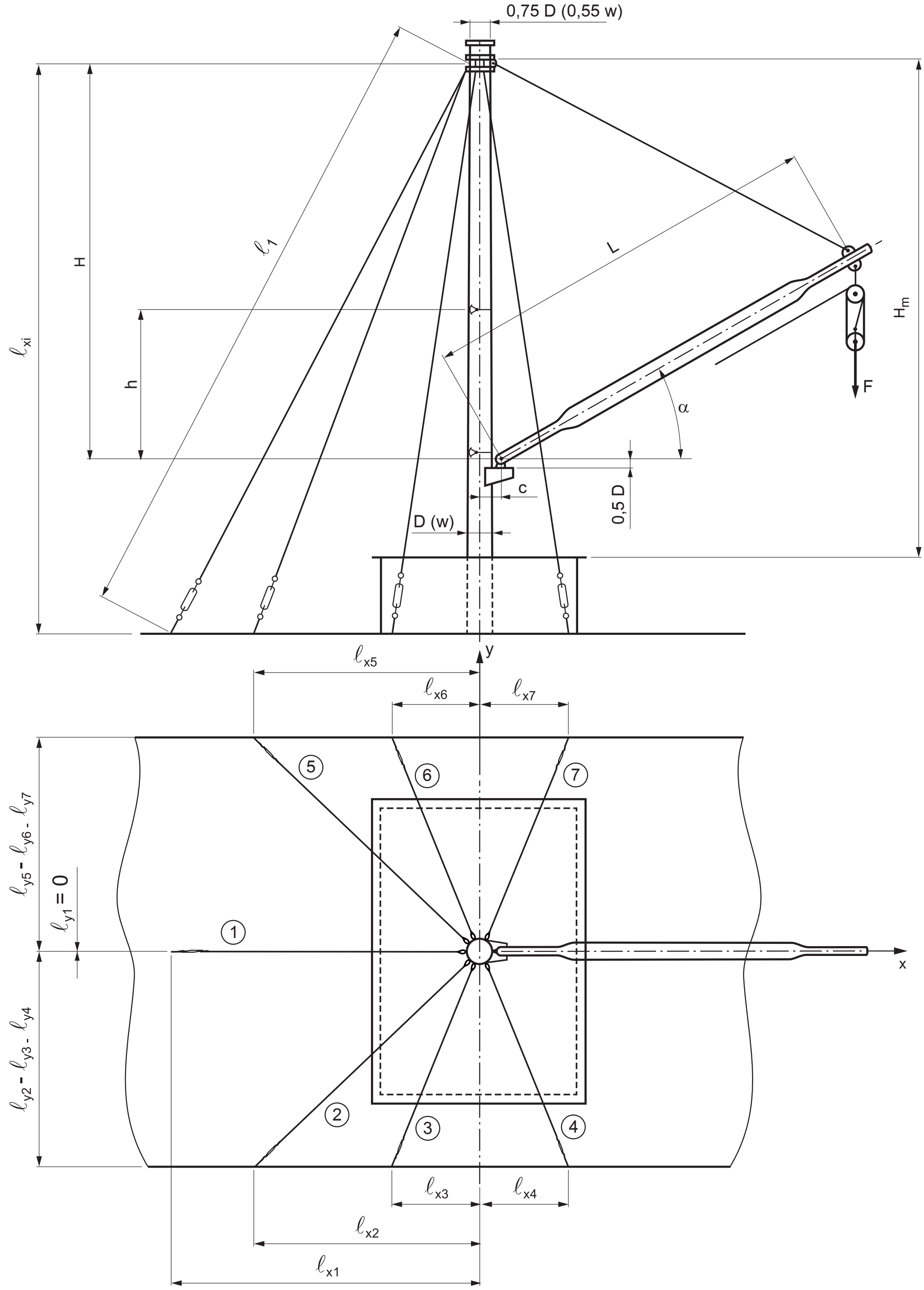
$$w_h = w\left(0,55 + 0,45\frac{H-h}{H}\right)$$

where:

H : Distance, in m, between the level of the derrick boom heel pin and the level of the attachment point of the span tackle on the mast head span trunnion

h : Distance, in m, between the considered cross-section and the level of the derrick boom heel pin (see Fig 22).

Figure 22 : Data for stayed mast calculations



d) If the gooseneck bearing bracket is directly attached to or effectively supported by the mast, the section modulus W of the mast, determined in accordance with item b), is to be kept constant down to the level of the uppermost deck where the mast is attached.

e) When the gooseneck bearing bracket is not attached to the mast, the section modulus of the mast is to increase linearly from the level of the derrick boom heel down to the level of the uppermost deck where the mast is attached.

In this case, the section modulus of the mast W_m, in cm^3, at this deck level is not to be less than:

$$w_m = w\frac{H_m}{H}$$

where the distances H_m and H, in m, are as shown on Fig 22.

The section modulus W_k, in cm^3 of the king post supporting the derrick boom heel, at the uppermost deck level where the king post is attached, is to be determined using the requirements of [9].

f) The section moduli required in item d) and item e), at the uppermost attachment deck level are normally kept constant to the lowest deck where the mast is attached.

g) Modifications in the requirements as per item c) to item f) may be accepted by the Society in some cases.

h) The tension T_{si} in kN, exerted in any shroud is determined by means of the greater of the two following formulae:

$$T_{xi} = T_x\frac{A_i\ell_{xi}}{\ell_1^2}$$

$$T_{yi} = T_y\frac{A_i\ell_{yi}}{\ell_1^2}$$

where:

$$T_x = 1,2\frac{M}{H}(1-\zeta_x)\frac{1}{v_x}$$

$$T_y = 1,2\frac{M}{H}(1-\zeta_y)\frac{1}{v_y}$$

$$\zeta_x = \frac{I_m}{I_m + 25H_m^3u_x}$$

$$\zeta_y = \frac{I_m}{I_m + 25H_m^3u_y}$$

$$v_x = \sum\frac{A}{\ell_i}\left(\frac{\ell_{xi}}{\ell_i}\right)^2$$

$$v_y = \sum\frac{A}{\ell_i}\left(\frac{\ell_{yi}}{\ell_i}\right)^2$$

the individual terms of these sums apply to loaded shrouds only, ie. to shrouds located on the opposite aide of the served hatch to calculate v_x and to shrouds located on a single side of the longitudinal symmetry plane to calculate v_y (in general $v_y = 0,5u_y$).

The values M, H, A_i, ℓ_i, ℓ_{xi}, I_m, H_m, u_x and u_y are defined in item b).

i) The actual guaranteed breaking force F_{si} of any shroud is not to be lower than:

$F_{si} = \eta T_{si}$

where η is the safety factor of the rope as per [10.6].

j) If the actual list of the ship is higher than 5°, the provisions of item b) to item i) apply, substituting cos α by cos ($\alpha - \varphi$) in the expressions of M values given in item b), where φ is the actual list angle, in degrees, to be taken into account.

k) The following procedure is given for guidance at the design stage to make easier the determination of the best scantlings of a stayed mast of circular cross-section.

1) The external diameter of the mast D_o, in mm, and its thickness t_o, in mm, at the derrick boom heel level may be determined approximately by the following formulae:

$$D_0 = 13\sqrt[3]{k^2M}$$

$$t_0 = \frac{D_0}{75}$$

where k and M are as per item b).

In the case considered in item e), the diameter D_m and thickness t_m of the mast at the uppermost deck level where the mast is attached are obtained by the following formulae:

$$D_m = D_0 \sqrt[3]{\frac{H_m}{H}}$$

$$t_m = t_0 \frac{H_m}{H}$$

where H_m and H are defined in item b).

If the thickness t_o (or t_m) is to be increased to be at least equal to the minimum thickness t_{min} required in [9.4.2], the diameter D_o (or D_m) may be multiplied, respectively, by:

$$\sqrt[3]{\frac{t_0}{t_{min}}}$$

or

$$\sqrt[3]{\frac{t_m}{t_{min}}}$$

2) When the arrangements of the shrouds has been chosen (see [10.4.7]), the minimum area A_o, in mm^2, of the net metallic cross sectional area of any shrouds (assuming that all the shrouds consist in identical ropes) may be determined approximately by the following formula:

$$A_0 = 3 \cdot 10^{-6} \frac{t}{k} \left(\frac{D}{H_m}\right)^3 (34 - k - \sqrt{1160 - 14k}) \frac{1}{s}$$

where:

s : Smaller value of the sums:

$$s_x = \sum \frac{\ell_{xi}^2}{\ell_i^3}$$

$$s_y = \sum \frac{\ell_{yi}^2}{\ell_i^3}$$

the individual terms of these sums concern all the shrouds, whether they are loaded or not

D , t : External diameter and thickness, in mm, chosen respectively for the mast at the uppermost deck level where the mast is attached, checking that D/t ratio is not greater than 75

the other notations are defined in item b).

Note 3: Attention is drawn to the fact that the choice of much greater values than the minimum values calculated here above for D and t is not beneficial; it would result in fitting shrouds of heavier cross sectional area.

3) After having selected the rope (let A be its net metallic cross-section area, in mm^2), compliance with all the requirements of items a) to item j) is to be checked considering for the calculations the values of D, t and A actually provided.

It may be necessary to increase the cross sectional area of the shrouds if the requirement of item i) is not complied with. In such a case, the calculations required in item h) and item i) are to be made again with the new value of A.

10.5.7 Simplified calculation method for stayed masts of rectangular cross-section, fastened at heel and made of hull steel of normal strength (R_{eG} = 235 N/mm²)

a) The section moduli W_x and W_y of the mast, in cm^3, calculated in way of the derrick boom heel in relation to the main inertia axes x and y shown on Fig 22 are to comply with the three following relations:

$W_x \geq w_x$

$W_x \geq w_y$

$$\frac{\sin\theta}{W_x} + \frac{\cos\theta}{W_y} \leq \frac{1}{w'}$$

where:

w_x : Greater of the two values w_1 and w_2 obtained by the method given in [10.5.6] item b), considering $u = u_y$ and substituting I_m by the second moment of area I_x of the rectangular section calculated in relation to the x axis

w_y : Greater of the two values w_1 and w_2 obtained by the method given in [10.5.6] item b), considering $u = u_x$ and substituting I_m by the second moment of area I_y of the rectangular section calculated in relation to the y axis

$$w' = \sqrt{w_x^2 \cos^2\theta + w_y^2 \sin^2\theta}$$

$$\theta = \tan^{-1}\frac{W_y}{W_x}$$

b) The formulae given in [10.5.6] item c) and [10.5.6] item e) are applicable replacing the values W_h, w_h, w, w_m by W_{hx}, W_{hx}, W_x, w_{mx} and by W_{hy}, w_{hy}, w_y, w_{my}, respectively; the index x or y gives the axis to which the section modulus is calculated.

The values w_x and w_y are as per item a).

Moreover, the following relations are to be complied with:

$$\frac{\sin\theta}{W_{hx}} + \frac{\cos\theta}{W_{hy}} \le \frac{1}{w_h'}$$

where:

$$w_h' = \sqrt{w_{hx}^2\cos^2\theta + w_{hy}^2\sin^2\theta}$$

$$\theta = \tan^{-1}\frac{W_{hy}}{W_{hx}}$$

and:

$$\frac{\sin\theta}{W_{mx}} + \frac{\cos\theta}{W_{my}} \le \frac{1}{w_m'}$$

where:

$$w_m' = \sqrt{w_{mx}^2\cos^2\theta + w_{my}^2\sin^2\theta}$$

$$\theta = \tan^{-1}\frac{W_{my}}{W_{mx}}$$

c) The formulae given in [10.5.6] item h) to calculate the tension in shrouds apply replacing l_m by l_y to determine ζ_x, and l_m by l_x to determine ζ_y.

d) The provisions of:
- [9.5.6], item d)
- [10.5.6], item d)
- [10.5.6], item f)
- [10.5.6], item g)
- [10.5.6], item i), and
- [10.5.6], item j),

are applicable.

10.6 Standing rigging

10.6.1 General

- Ropes used in standing rigging are to consist of galvanized steel wire ropes.
  Galvanizing quality A is recommended.
- Wire ropes are normally made of six strands laid over a centre core.
- Tensile grades 1370 and 1420 are recommended.
- As a rule, wire ropes of diameter inferior to 16 mm should not be used in standing rigging.

10.6.2 Safety factor

The minimum breaking force (MBF), in kN, of a wire rope used in standing rigging of a lifting appliance of SWL P is to comply with the following criteria:

$MBF \ge \eta \cdot T$

where:

η : Safety factor, function of the SWL P of the lifting appliance, defined in Tab 9

T : Maximum rope tension, in kN, induced in the wire rope by the SWL P.

When a lifting appliance has several different SWL, for example P_1 and P_2, the minimum breaking force of a wire rope used in standing rigging of this appliance is not to be lower than:

- $\eta_1 \cdot T_1$ if the wire rope is subjected to SWL P_1 only
- $\eta_2 \cdot T_2$ if the wire rope is subjected to SWL P_2 only
- $Max(\eta_1 \cdot T_1; \eta_2 \cdot T_2)$ if the wire rope may be subjected to either by SWL P_1 or SWL P_2 unsimultaneously
- $[Min(\eta_1; \eta_2)] \cdot (T_1 + T_2)$ if the rope may be subjected simultaneously to both SWL P_1 and P_2.

where:

T_1 , T_2 : Maximum rope tension induced in the wire rope by the SWL P_1 and P_2, respectively

η_1 , η_2 : Safety factors (as per Tab 9) which depend on SWL P_1 and P_2, respectively.

Table 9 : Safety factors of wire ropes (standing rigging)

P = SWL of the lifting appliance, in t	P ≤ 10	10 < P < 160	P ≥ 160
η	4	$\frac{1000}{0,8P+242}$	2,7

10.6.3 Shrouds (stayed masts)

- It is recommended to use steel wire ropes with a wire strand as centre core. The constitutive strands are not to include a fibre core.
- Use of ordinary lay ropes (regular lay ropes) made of ordinary strands of non-parallel wires of the same diameter and without yarns is recommended. The diameter of the constitutive wires should not be lower than 1 mm.
- The rope tension in shrouds is to be determined as per [10.5.6] or [10.5.7].

10.6.4 Slewing guy pendants and preventer guys

- The steel wire ropes used for the slewing guy pendants may have a fibre core.

  A steel wire core is to be provided for preventer guy pendants.
- Equal lay ropes may be used for slewing guy pendants.

  Cross lay ropes with non-parallel wires of identical diameters and without fibres are recommended for preventer guys. The diameter of the constitutive wires is not to be less than 1 mm.
- The rope tension in the slewing guy pendants is to be determined as per [4].
- The rope tension in the preventer guys is to be determined as per [7].
- Normally, the preventer guys are to be connected to the derrick boom head by shackles, however, if looped at derrick boom head, the preventer guys are to be considered as part of the running rigging. In the latter case, arrangements will be provided to avoid any contact of the loop with sharp edges of the derrick boom head fittings or of the safety catch fitted at derrick boom head.

11 Mast fittings

11.1 Materials

11.1.1 As a rule, the steels used for the construction of cross-trees of appendages to which span or cargo bearing brackets or gooseneck seatings are fixed, and of any other mast fittings, are to comply with the requirements as per [9.1], irrespective of whether the mast is stayed or not.

11.1.2 In some cases the steel grades given in Tab 2 for plates the thickness of which is above 20 mm may however not be required for small-sized or compact elements; also for elements made of rolled bars when they do not contribute to the strength, as a whole, of large-sized structures.

11.2 Cross-trees and other mast fittings

11.2.1 The requirements of [9] with respect to the design yield stress (see [9.1.3]), the calculation method for combined stress (see [9.2]), the allowable stresses (see [9.3], [9.3.2] excepted) and the constructional arrangements (see [9.4]) are applicable, irrespective of whether the mast is stayed or not.

11.2.2 The scantlings of the cross-trees and other mast fittings are to be checked considering the values and the directions of the most critical forces applied to them.

The forces are to be determined considering the requirements of Article [2] for the calculation hypotheses and of Article [3] to determine the forces.

Attention is drawn to the fact that the most critical loading cases may differ from the loading cases contemplated in the above mentioned Articles.

11.2.3 As far as possible, strength continuity of cross-trees, appendages and other fittings le to be ensured through the main structure of masts in way of their connections.

For this purpose, local reinforcements (local increase of scantlings, internal web plates, connecting brackets) may be required.

When strength continuity cannot be ensured, forces exerted by cross-trees and other similar elements are to be transmitted by large-sized connection elements considering stress concentrations due to discontinuity of shape.

11.3 Span or cargo bearing brackets

11.3.1 As a rule. the scantlings of these elements are to comply with the requirements of recognized national or international standards.

11.4 Gooseneck bearing brackets

11.4.1 As a rule. the scantlings of these elements are to comply with the requirements of recognized national or international standards.

When the derrick boom has to withstand an important torsional moment (see Article [14], and specially [14.4], item b)) special consideration is to be given to scantlings of gooseneck seating and notably to bearing surfaces of the gooseneck.

11.5 Hounds of shrouds

11.5.1 The shroud eye-plate attached to the mast is to be given scantlings in accordance with the SWF provided for the shroud concerned, the SWF being not lower than the tension determined as per [10.5.6], item h).

11.5.2 Each shroud eve-plate is to be located so that the tension in the shroud be exerted in the eve-plate plane. The whole of the hounds is to be positioned to reduce as much as possible the bending moment at the mast head due to the forces exerted by the shrouds and the span tackle.

11.5.3 The eye-plates are to be connected to the mast so as to prevent shrouds from inducing unacceptable diaphragm bending stress in the mast plate.

12 Hull connections

12.1 General

12.1.1 The ship structure is to be suitably reinforced in the area of mast attachments in order to avoid excessive local stresses or possible buckling of the ship plating.

12.1.2 Masts and king posts are normally to be attached to two decks at least or to one deck and a deckhouse. In the latter case, the deckhouse is to be of substantial construction and strongly attached to the ship structure in order to give efficient fastening to the mast in all directions.

Efficient supports are to be provided at the lower part of the masts and king posts, to withstand the vertical forces acting on them. For this purpose it is recommended to fit masts in way of a transversal or longitudinal bulkhead.

12.1.3 As indicated in [9.4.6], the structure of masts and king posts is to be continuous through the uppermost deck where they are attached.

12.2 Local scantlings of attachment decks

12.2.1 As a rule, the local thickness, in mm, of the decks on which the mast is attached is to be not less than:

$$t_1 = 1,2E\sqrt{R_{e(d)}}$$

where:

E : Local spacing of the deck stiffeners, in m

$R_{e(d)}$: Specified minimum yield stress of the deck plate steel, in N/mm²

12.2.2 In addition, for masts of circular cross-section, the local thickness of the upper and lower fastening decks is to be not less than the greater of the two values:

$$t_2 = 0,8tDa\frac{R_{e(m)}}{R_{e(d)}}$$

$T_3 = 0,5\ t$

where:

t , D : Thickness, in mm, and the outer diameter, in m, respectively of the mast at the uppermost deck level

$R_{e(m)}$, $R_{e(d)}$: Specified minimum values of the yield stress of the mast plate and of the deck plate, respectively

a :
- For the upper attachment deck when the gooseneck seating is directly attached to the mast and for the lower deck in all cases:

  $$a = \frac{1}{H'}$$

- For the uppermost attachment deck when the gooseneck seating is attached to a separate king post:

  $$a = \frac{1}{H'} + \frac{1}{H}$$

H' , H : Distances, in m, as shown on Fig 21.

The value of t_2 is given assuming that the mast is attached in the middle of a deck areas. If the mast is attached to a free edge of deck or connected to it by large brackets, the value of t_2 as obtained here-above is to be multiplied by two.

If the mast is fixed to a strip of deck of length ℓ_d, in m. both sides of which are free and at a distance d, in m, from the farthermost end of this strip of deck, the value t_2 is to be multiplied by $2d/\ell_d$ ratio.

12.2.3 In some cases, checking of the scantlings of the attachment decks by direct calculations may be required. considering the provisions of [12.3].

Especially, for the masts of rectangular cross-section, the shear stress in deck is to be lower than 0,57 σ_a where σ_a is the allowable stress calculated as per Tab 10 in accordance with the yield stress $R_{e(d)}$ of the deck and the SWL of the mast. For this, the reaction force of deck is to be considered as transmitted entirely to the mast by shear forces.

12.2.4 When the thickness of the attachment decks is not sufficient to meet the requirements given in [12.2.1] to [12.2.3], a thick plate is to be inserted in the deck plating. The dimensions of this inserted plate are not to be lower than twice the dimensions of the cross-section of the mast at the connection level.

As a rule, use of doubling plates is not permitted.

12.2.5 With respect to the longitudinal strength of the ship and to the local stress concentrations, in addition to the provisions as per [12.2.1] to [12.2.4], the Society may require local increase of deck thickness and/or fitting of a diaphragm plate inside the mast where the latter is passing through the deck.

12.3 Direct calculations

12.3.1 When direct calculations are made to check the scantlings of the local structures to which the mast is attached at any point the combined stress σ_{cb} calculated as per [9.2] is not to exceed the allowable stress σ_a given in Tab 10 in relation to the SWL P and the yield stress $R_{e(d)}$ of the local structure concerned.

12.3.2 The overturning moment M_d, in kN.m, is to be taken equal to the following value, as the case may be:

- unstayed masts and king posts of SWL ≤ 20 t:

  $M_d = 0{,}455\ w\ R_e\ 10^{-3}$

- masts and king posts of SWL > 20 t:

  M_d is obtained by direct calculation, taking into account the provisions of [9.5.1], [9.5.2] and [9.5.3].

- stayed masts:

  $M_d = 0{,}416\ w\ R_e\ 10^{-3}$

where:

w : Value required for the section modulus of the mast or king post at the level of the uppermost attachment deck, in cm^3, (see [9.5.5] d), [9.5.5] e), [10.5.6], item d) or [10.5.6], item f)

R_e : Design yield stress of the mast, in N/mm^2, (see [9.1.3]).

Table 10 : Allowable stress in local ship structures supporting masts and king posts

SWL of mast P, in t **(1)**	Allowable stress σ_a, in N/mm^2
P ≤ 20	0,5 $R_{e(d)}$
20 < P < 160	$\dfrac{P}{1,62P+7,6}R_{e(d)}$
P ≥ 160	0,6 $R_{e(d)}$
(1) When the mast supports several derrick booms, the SWL of the derrick boom of heavier capacity is to be taken into consideration.	

12.3.3 The total compression force C, in kN, exerted by the mast on the ship structure is to be taken equal to the following value:

$C = C_1 + C_2 + C_3$

where:

C_1 : Equal to the SWF of the mast increased by the self-weight of the mast and of the whole rigging equipment supported by it (when these weights are unknown, C_1 may be taken equal to 2 SWF)

C_2 : Equal to the total of the vertical components of forces exerted by the winches (reference is to be made in this respect to the applicable requirements of Articles [3] to [7]

C_3 : • For unstayed masts: $C_3 = 0$.

• For stayed masts, C_3 is equal to the greater of the two following values:

$$C_x = \sum T_{xi}\frac{\ell_{zi}}{\ell_i}$$

$$Cy = \sum T_{yi}\frac{\ell_{zi}}{\ell_i}$$

where:

- the terms of these sums apply to loaded shrouds only (see [10.5.6], item h)
- T_{xi} and T_{yi} are as per [10.5.6], item h)
- ℓ_{zi} and ℓ_i are as per [10.5.6], item b).

13 Derrick booms - general requirements, materials and constructional arrangements

13.1 General

13.1.1 Articles [13], [14] and [15] deal with the construction and scantlings of steel derrick booms of tubular structure and circular cross-section as well as with the scantlings of derrick head and heel fittings.

The derrick booms of non-circular cross-section and of special design will be especially examined by the Society on the basis of the requirements of these Articles.

13.1.2 As a rule, the construction and scantlings of the steel derrick booms are to comply with [13.3]. However and especially for the derrick booms of special design, other constructional and dimensioning methods may be accepted if they are considered satisfactory by the Society.

13.1.3 As a rule, wooden derrick booms may be used only for lifting capacities below 0,5 t. In such a case, the scantlings provided for the derrick boom and its fittings are to be justified by the Manufacturer and will be especially examined by the Society.

13.1.4 The SWL of a derrick boom is defined as equal to the SWL of the derrick i.e. the maximum load (mass) that the derrick boom is allowed to carry vertically at the point of suspension of the load and to move in service.

So the SWL P, in t, of a derrick boom is not to be mistaken for the axial thrust Q, in kN, to which it is submitted.

13.1.5 As considered in Articles [13] to [15], the length L, in m, of a derrick boom is the efficient length of the derrick boom measured from the derrick heel pin to the farthest suspension fitting of the load.

13.1.6 The strength criteria are defined in relation to the yield stress R_e taken into account in the calculations (design yield stress).

The design yield stress R_e is defined in Tab 11 according to the specified minimum yield stress R_{eH} and specified minimum tensile strength R_m.

Table 11 : Design yield stress

Tensile strength R_m	Design yield stress R_e
$R_m \geq 1,4\ R_{eH}$	$R_e = R_{eH}$
$R_m < 1,4\ R_{eH}$	$R_e = 0,417\ (R_{eH} + R_m)$

13.2 Materials

13.2.1 The materials used for the construction of derrick booms are to comply with the requirements of Ch 2, Sec 1.

13.2.2 As a rule, the steel grades used are to comply with the requirements of NR216 for normal strength hull steel grades (grades A, B, D or E) or high tensile steel grades (grades AH, DH or EH).

The hull steel grades to be used are defined in Tab 12.

13.2.3 The steel grades according to Tab 12 are not required for seamless drawn tubes or for welded tubes manufactured at works provided the grades chosen are considered suitable by the Society.

Other steel grades as per National or International Standards may be accepted if they are considered by the Society to be similar to those defined in Tab 12.

Table 12 : Hull steel grades for derrick booms

Plate thickness t, in mm	Hull steel grade
$t \le 25$	A or AH
$25 < t \le 30$	B or AH
$30 < t \le 50$	D or DH
$50 < t$	E or EH

13.3 Constructional arrangements

13.3.1 As mentioned in [13.1.1], derrick booms are supposed to be of tubular structure with circular cross-section.

They may be made of a single piece or of several cylindrical or tapered tubes joined together by welding or, in some cases, both by welding and shrink-fit.

13.3.2 In the mid length region of the derrick boom the external diameter D_m, in mm, is to be not less than 14,5L, where L is, in m, the derrick boom length as defined in [13.1.5].

It is recommended to choose a diameter D_m between 20L and 30L.

13.3.3 The minimum thickness of tubes is to be not less than 4 mm.

13.3.4 The ratio D/t between the external diameter D, in mm, and the thickness t, in mm, of any considered cross-section is not to exceed 100 or the value given in Tab 13 according to the SWL P (see [13.1.4]) and the design yield stress of the derrick boom, R_e in N/mm^2, as defined in [13.1.6].

When the scantlings of the derrick boom are heavier than the minimum scantlings to comply with the applicable strength criterion (see [14.3.1], or [14.4.1], as the case may be), the value of ratio D/t as determined from Tab 13 may be increased in ratio σ_a/σ_{cb}, where σ_a and σ_{cb} are defined in [14.3.1], or [14.4.1], as applicable.

Table 13 : Derrick booms: D/t ratio

SWL of the derrick boom P, in t	D/t ratio
$P \le 5$	$\frac{12117}{R_e}$
$5 < P < 160$	$\frac{24234P}{R_e(P+5)}$
$P \ge 160$	$\frac{23500}{R_e}$

13.3.5 The derrick boom head fittings (cargo, span. slewing fittings and possible preventer guy eye plates) should be arranged so that bending and torsional moments be minimized at derrick boom head.

Local reinforcements (by local increase in thickness and/or by local stiffening) may be required in way of the attachments of the derrick boom head fittings.

Considering the head and heel bending moments which occur generally in derrick booms, it is recommended to have them built with constant diameter and thickness over their whole length.

However when the above mentioned moments are comparatively low and the derrick boom slender, the scantlings of the derrick boom may be reduced at both ends taking into account [13.3.6], and [13.3.7].

Attention is to be paid that generally for derrick booms operated with twin span tackles, no reduction of scantlings is possible at derrick boom ends due to important bending and torsional moments at derrick boom head and heel, mainly when the derrick boom is slewed outboard at maximum topping angle. On the contrary, in some cases, the scantlings of the derrick boom are to be increased at both ends.

13.3.6 The reduction of scantlings at each end of the derrick boom may be obtained:

- either by a continuous reduction in diameter while maintaining a constant thickness over the whole length (derrick booms with tapered ends and constant thickness - recommended arrangement)
- or by a reduction of thickness, while maintaining a constant diameter (cylindrical derrick booms with reduced thickness at ends)
- or by a combination of both previous methods (derrick booms with tapered ends of reduced thickness at end.)
- either by changes in diameter in one or more steps with or without reduction of thickness (stepped derrick booms). The various types of stepped derrick booms are shown in Tab 14.

The values a of the throat thickness of fillet welds are shown in Tab 14.

Slot and plug welds shown on Tab 14 may be suppressed in the case of shrink-fits with efficient tightening.

Other construction methods may be accepted with the agreement of the Society.

13.3.7 The external diameter D_m and the thickness e_m of the derrick boom in the mid-length region are to be kept constant on a length L_m at least equal to:

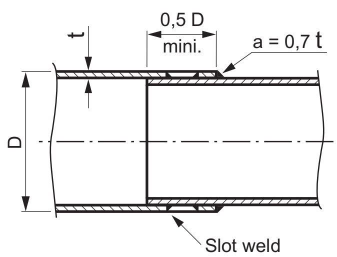
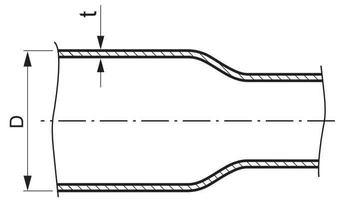
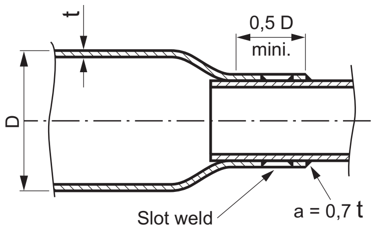
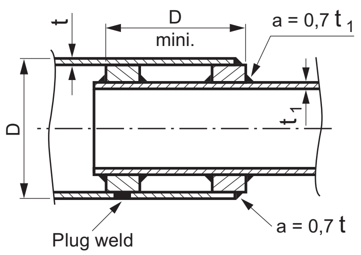
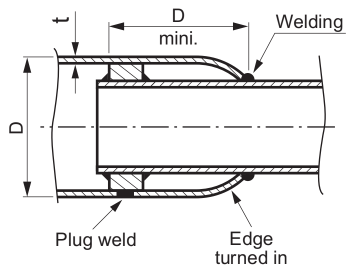
- for the tapered derrick booms with constant thickness:
  $L_m = 0,33L$
- for the cylindrical or tapered derrick booms the thickness of which la reduced at ends or for the stepped derrick booms of type I, II or III:
  $L_m = 0,40L$
- for the stepped derrick booms of type IV or V:
  $L_m = 0,60L$

Attention is drawn to the fact that in order to meet the strength criteria defined in [14.3.1], or [14.4.1], it is generally necessary to provide for a length L_m notably greater than the one defined here above especially when a reduction in thickness is provided at ends, or when stepped derrick booms are concerned.

13.3.8 The reduction of area between two adjacent cross-sections is not to exceed 20%.

The cross-sectional area of the derrick boom at ends (exclusive of the possible local reinforcements) is to be not less than 70% of the cross-sectional area in the mid-Length region.

Table 14 : Types of stepped derrick booms

Type I Lap joint  	Type II Change in diameter by forming (cressing)  	Type III Cressed end shrink fit lap joint 
Type IV Step joint with packing rings  	Type V Step joint with packing ring and edge turned in  	

14 Scantlings of derrick booms

14.1 Calculation conditions

14.1.1 The scantlings of the derrick booms are to be determined considering:

- calculation hypotheses defined in Article [2]
- forces determined in accordance with the requirements of Article [3].

14.1.2 In particular, it is to be noted that forces are to be determined considering the trim and list angles of the ship:

- when two span tackle masts or special riggings are concerned
- when the SWL of the derrick boom (see [13.1.4] is greater than or equal to 50 t)
- when the values of the list and trim angles of the ship are greater than the values given in [2.5.1]
- in the cases stated in [4.1.1], regarding the arrangement of the slewing tackles.

In the above mentioned cases, consideration is to be specially given to the forces applied by the slewing tackles and to the moments due to the eccentricities, with respect to the longitudinal axis of the derrick boom, of the points of application of forces at derrick boom head.

14.1.3 When the effect of the list and trim of the ship can be ignored in determining the forces, ie. in the cases not listed in [14.1.2], only the strength criterion as per [14.3] need be checked.

The derrick booms dealt with in the present requirement are normally submitted to insignificant torsional moment M_x and insignificant vertical bending moment M_z (see Fig 23). However for special cases, the Society may require compliance of the derrick boom scantlings with the strength criterion as per [14.4].

14.1.4 For the cases defined in [14.1.2], the scantlings of the derrick booms are to be checked applying the strength criterion as per [14.4].

14.1.5 In general, shearing stresses due to shear forces may be disregarded.

14.1.6 The value of the design factor ψ in the definition of the strength criteria as per [14.3] and [14.4] is given in Tab 15 according to the SWL P of the derrick boom.

Table 15 : Design factor ψ

SWL of the derrick boom P, in t	Design factor ψ
$P \leq 10$	1,455
$10 < P < 160$	$\frac{1,1P + 5}{1,1P}$
$P \geq 160$	1,028

14.1.7 The value of the construction factor ε in the definition of the strength criteria is given in Tab 16 according to the type of construction of the derrick boom.

Table 16 : Construction factor ε

Type of construction of the derrick boom	Construction factor ε
Cylindrical or tapered derrick booms	1,0
Stepped derrick booms (see [13.3], item f)): • type I • type II • type III • type IV and V	 1,02 1,04 1,05 1,10

14.2 Reference axes and notations

14.2.1 An orthogonal unit system of reference axes (0, x, y, z) attached to the derrick boom is defined by Fig 23.

The origin O of the system of axes is at the derrick boom head at point B (end of the effective length of the derrick boom: see [13.1.5]).

In a cross-section of abscissa x, the sign of the moments acting on the derrick boom is defined in considering the forces applied on the distance x and in applying the usual rule of the "corkscrew" (for example, under these conditions, the bending moment M_G, of y axis, due to the self weight of the derrick boom is a positive value).

Figure 23 : Reference axes system attached to the derrick boom

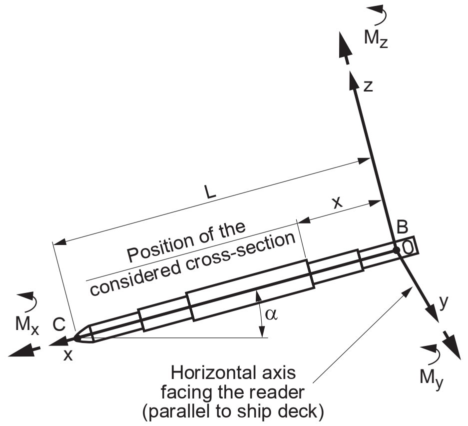


Table 17 : Derrick booms - Notations

Elements of the derrick boom		Notations	Units	Reference
Characteristics:				
	SWL	P	t	[13.1.4]
	Length	L	m	[13.1.5]
	External diameter	D	mm	see **(1) (2)**
	Thickness	t	mm	see **(1) (2)**
	Abscissa of the calculation point of the end moments at boom head	a	m	[14.3.4] [14.4.4]
	Design yield stress	R_e	N/mm²	[13.1.6]
	Minimum topping angle	α_0	degree	[14.3]
	Topping angle	α	degree	[14.4]
	Cross sectional area	$S = \pi (D - t) t$	mm²	see **(1) (2)**
	Bending modulus	$W = \frac{\pi 10^{-3}}{32D}[D^4 - (D - 2t)^4]$	cm³	see **(1) (2)**
Loads: **(1) (3)**				
	Thrust	Q	kN	[14.3.5] [14.4.5]
	Torsional moment	M_x	kN.m	[14.3.4]
	Bending moment-y axis - due to concentrated forces	M_y	kN.m	[14.3.4] [14.4.4]
	Bending moment-y axis - due to self-weight	M_G	kN.m	[14.3.3] [14.4.3]
	Bending moment-z axis	M_z	kN.m	[14.4.4]
	Resultant bending moment	M_b	kN.m	[14.3.1] [14.4.1]
Stresses:				
	Pure compression stress	$\sigma_c = 10^3 \frac{Q}{S}$	N/mm²	
	Bending stress	$\sigma_b = 10^3 \frac{M_b}{W}$	N/mm²	
	Torsional shear stress	$\tau = 10^3 \frac{M_x}{2W}$	N/mm²	
Coefficients:				
	Buckling factor	ω	-	[14.5]
	Design factor	ψ	-	[14.1.6]
	Construction factor	ε	-	[14.1.7]

(1) Index m is suffixed to figures which have a special value at mid-length of the derrick boom.
(2) Index 1 (or n when there are several steps at each end of the derrick boom) is suffixed to the geometrical characteristics of the derrick boom at ends.
(3) Index a is suffixed to end moments at derrick boom head.
Index l is suffixed to end moments at derrick boom heel.

14.2.2 The notations used to define the strength criteria are shown in Tab 17.

14.3 Scantlings of the derrick booms as per [14.1.3]

14.3.1 The following strength criterion is to be complied with for any cross-section located at a distance x lying between 0 and 0,5L from the head end:

$\sigma_{cb} \leq \sigma_a$

where:

σ_{cb} : Comparison stress, expressed in N/mm², equal to the following value:

$$\sigma_{cb} = \psi\varepsilon\left[\sigma_c + \sigma_c(\omega - 1)\sin\left(\frac{180x}{L}\right) + |\sigma_b|\right]$$

σ_a : Allowable stress, in N/mm²

$\sigma_a = 0{,}55R_e$

180x/L : Angle expressed in degrees

σ_c : Pure compression stress given in Tab 17 in relation with the boom thrust Q as per item e)

$|\sigma_b|$: Absolute value of the bending stresses shown in Tab 17 in relation with the resulting bending moment M_b equal to the following value:

$$M_b = \frac{0,9}{\psi} M_G + M_y$$

M_G : As defined in [14.3.3]

M_y : As defined in [14.3.4]

other notations are defined in Tab 17.

14.3.2 As a rule, compliance of the derrick boom scantlings with criterion as per [14.3.1], is to be verified in the following cross-sections considering the derrick boom positioned at minimum topping angle ($\alpha = \alpha_0$):

- at mid-length of the derrick boom (see [14.3.6])
- in any section with a strength discontinuity (change in diameter or in thickness)
- at head end.

Unless especially justified, the scantlings of the derrick boom are to be symmetrical with respect to mid-length of the derrick boom.

It is also to be verified, at both ends of the derrick boom, that the cross sectional area S_n, in mm², of the derrick boom complies with the following condition:

$$S_n \geq \frac{2000 Q_m \psi \varepsilon}{R_e}$$

14.3.3 The bending moment due to the self-weight of the derrick boom is to be taken equal to the following value when the actual length of the derrick boom is not significantly different from the length L as per [13.1.5]:

- at mid-length of the derrick boom:

  $M_{Gm} = 9,6\ S_m\ L^2 \cos \alpha_o\ 10^{-6}$

- at the distance x from the head end:

$$M_G = 4 M_{Gm} \frac{x(L-x)}{L^2}$$

14.3.4 Determination of bending moment M_y

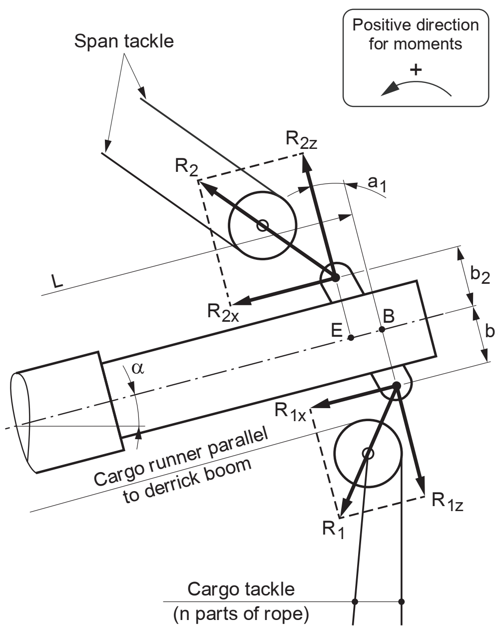
a) Bending moment at head end M_{ya} is to be calculated at point E located at a distance a of end B of derrick boom, i.e. in way of the point of application of the concentrated force which is the farthest from this end.

Fig 24 to Fig 26 show three different arrangements for derrick boom ends.

b) With the notations according to Fig 24 to Fig 26, the distances a_1, a_2, ..., b_1, b_2, ..., in m, and the forces R_1, R_2, ... in kN, the end moment M_{ya}, in kN.m, is equal to the following value:

$$M_{ya} = \sum_{i=1}^{n} (R_{ix} b_i + R_{iz} a_i)$$

Figure 24 : Calculation of end bending moment M_{ya} at derrick boom head (Case A)



Case A:

$M_{ya} = - R_{1x}\, b_1 + R_{2x}\, b_2 - R_{1z}\, a_1$

with:

$R_{1x} = F\,(\sin\alpha + 1/n)$

$R_{2x} = (F+f)\,(L/H - \sin\alpha)$

$R_{1z} = F\cos\alpha$

where $a_n = 0$ and where forces R_{ix} and R_{iz} may be obtained from the forces S, R_B and R_L determined as per the requirements of [5.1] or [6.1] as applicable and where each product $R_{ix}b_i$ or $R_{iz}a_i$ is to be considered with its appropriate sign taking into account the positive direction chosen for the moments.

The value of M_{ya} (at point e) peculiar to each case concerned is shown on Fig 24 to Fig 26.

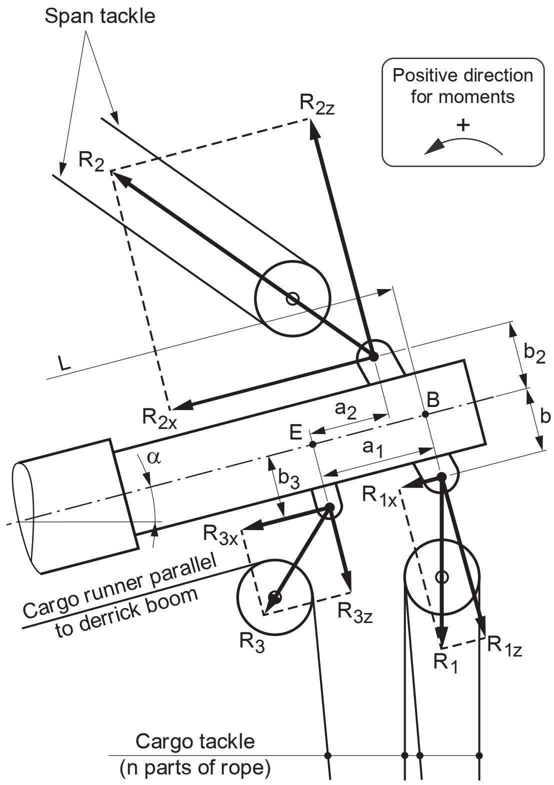
c) The moment M_y in a cross-section located at a distance x between a and 0,5L from the head end is equal to the following value:

$$M_y = M_{ya}\frac{L - x}{L - a}$$

The moment M_y in a cross-section located at a distance x between 0 and a from the head end and located in way of the point of application of a concentrated force has the two values, obtained by means of the following relation:

$$M_y = \sum_i (R_{ix}b_i + R_{iz}a_i)$$

Figure 25 : Calculation of end bending moment M_{ya} at derrick boom head (Case B)



Case B:

$M_{ya} = - R_{1x}\, b_1 + R_{2x}\, b_2 - R_{3x}\, b_3 - R_{1z}\, a_1 + R_{2z}\, a_2$

with:

$R_{1x} = (F / n)\,(n - 1)\sin\alpha$

$R_{2x} = (F + f)\,(L/H - \sin\alpha)$

$R_{3x} = (F / n)\,(\sin\alpha + 1)$

$R_{1z} = (F / n)\,(n - 1)\cos\alpha$

$R_{2z} = (F + f)\cos\alpha$

where the sum is extended:

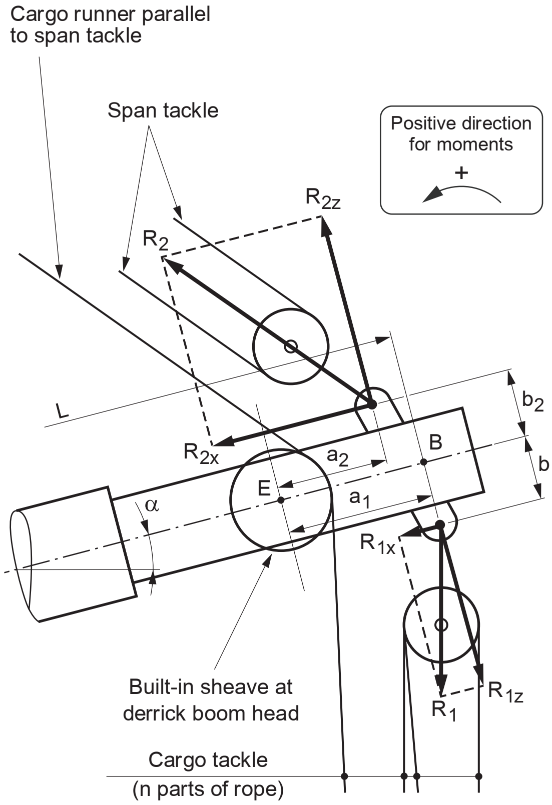
1) on the one hand, to all the forces R_{ix} and R_{iz} applied between the boom end b and the cross-section concerned, inclusive of the forces applied in way of this section

2) on the other hand, to the forces defined in a) here above, exclusive of the forces applied in way of the section concerned.

The forces R_{ix} and R_{iz}, as well as the distances a_i and b_i are defined in item b), and on Fig 24 to Fig 26.

14.3.5 In any cross-section located at a distance x between a and 0,5L from head end B, the derrick boom thrust is assumed to have a constant value Q_m equal to the value determined in accordance with the requirements of [5.1.9], [6.1.9], [7.6.2] item d) or [7.7.9] as applicable.

Figure 26 : Calculation of end bending moment M_{ya} at derrick boom head (Case C)



Case C:

$M_{ya} = -R_{1x}\, b_1 + R_{2x}\, b_2 - R_{3x}\, b_3 - R_{1z}\, a_1$

with:

$R_{1x} = (F / n)\,(n - 1) \sin\alpha$

$$R_{2x} = K\left[F + f - \frac{F}{n\sqrt{K^2 + (\cos\alpha)^2}}\right]$$

$K = (L / H) - \sin\alpha$

$R_{1z} = (F / n)\,(n - 1) \cos\alpha$

In any cross-section located at a distance x between 0 and a from the head end and located in way of the point of application of a concentrated force, the boom-thrust Q has the two values obtained by means of the following relation:

$$Q = \sum_i R_{ix}$$

where the sum is extended:

a) on the one hand to all the forces R_{ix} (see Fig 24 to Fig 26) applied between the boom end B and the cross-section concerned, inclusive of the force applied in way of this section

b) on the other hand, to the forces defined in item a), here-above, exclusive of the forces applied in way of the section concerned.

To check the strength criterion defined in [14.3.1], the value of Q determined in item a) (or in item b)) is to be associated with value M_y determined in accordance with [14.3.4] item c), 1) (or [14.3.4] item c), 2)).

14.3.6 The strength criterion defined in [14.3.1], is applicable to the mid-length of the derrick boom however instead of applying this criterion, it may be checked that the boom thrust Q is lower than or equal to the following maximum allowable thrust Q_{max}, in kN:

$$Q_{max} = \frac{t_m D_m R_e - |\Delta|\varepsilon}{590\omega\psi\varepsilon D_m}$$

where |Δ| is the absolute value of the expression:

$\Delta = 65 t_m\, D_m\, L^2 \cos\ \alpha_0 + 1{,}23\ \psi\ M_{ya}$

The calculated value of Q_{max} is to be positive. If it is not (exceptional case where the moment M_{ya} is very significant), the scantlings of the derrick boom are to be increased.

14.4 Scantlings of the derrick booms as per in [14.1.4]

14.4.1 The following strength criterion is to be complied with for any cross-section located at a distance x from head end:

$\sigma_{cb} \le \sigma_a$

where:

σ_{cb} : Comparison stress, expressed in N/mm², equal to the following value:

$$\sigma_{cb} = \psi\varepsilon\sqrt{\left[\sigma_c + \sigma_c(\omega - 1)\sin\left(\frac{180x}{L}\right) + \sigma_b\right]^2 + 3\tau^2}$$

σ_a : Allowable stress, in N/mm²

$\sigma_a = 0{,}60\ R_e$

180x/L : Positive angle in degrees

σ_c : Pure compression stress as per Tab 17 in relation with the boom thrust Q as per [14.4.5]

σ_b : Bending stress as per Tab 17 according to the resultant bending moment M_b equal to the following value:

$$M_b = \sqrt{\left(\frac{0,9}{\psi}M_G + M_y\right)^2 + M_z^2}$$

M_G : As defined in [14.4.3]

M_y , M_Z : As defined in [14.4.4]

τ : Torsional shear stress as per Tab 17 according to the torsional moment M_x as per [14.4.4]

the other notations are defined Tab 17.

14.4.2 For checking criterion as per [14.4.1]relevant calculations are to be made:

- at mid-length of the derrick boom (see [14.4.6])
- at any cross-section with a strength discontinuity (change in diameter or in thickness)
- at head and heel ends.

The calculations are to be made in the mast unfavourable loading conditions to the satisfaction of the Society.

As a rule, calculations are to be made in each of the following positions of the derrick boom, considering the most unfavourable conditions of list and trim for the ship:

- at minimum topping angle α_o associated with nil slewing angle and maximum slewing angle
- at maximum topping angle α_{max} associated with the above mentioned slewing angles.

14.4.3 The bending moment due to the self-weight of the derrick boom may be calculated by means of the following formulae when the self-weight of the derrick boom may be considered as evenly distributed and when the actual length of the derrick boom is not significantly different from the length L defined in [13.1.5]

- at mid-length of the derrick boom:

  $M_{Gm} = 9{,}6\ S_m\ L^2 \cos\alpha\ 10^{-6}$

- at a distance x from the head end:

$$M_G = 4M_{Gm}\frac{x(L-x)}{L^2}$$

In accordance with the system of reference axes defined in [14.2.1], the bending moment mentioned above is a y-axis moment when ship is under neither trim nor list condition.

When list and trim angles are not nil, in general, the z component of this moment may be disregarded and the y component may be taken equal to the above mentioned M_G value.

14.4.4 Determination of bending moments M_y and M_z and of torsional moment M_x

a) The end moments at derrick boom head are to be calculated at point E located at the distance a from the boom end B, i.e., in way of the point of application of the concentrated force which is the farthest from this end.

   The end moments M_x, M_{ya} and M_{za} must be calculated considering the concentrated forces applied on the distance BE = a, taking into account the considered position of the derrick boom (topping and slewing). the list and trim conditions of the ship and the geometrical eccentricities of the points of application of the forces with respect to the longitudinal axis of the derrick boom.

b) To calculate the resultant moment M_b in any cross-section of the derrick boom, degrees of freedom of the connection system between mast and boom are to be taken into account.

   In the usual case (i.e. when the derrick heel is free to rotate around y-axis and when the gooseneck is free to rotate around vertical axis) the derrick boom is submitted, at the heel, to a bending moment M_{zL} such as:

   $M_{zL} = M_x \tan\alpha$

   The bending moment M_{yL} is nil at derrick heel.

The gooseneck gives a reaction moment M_R such as:

$$M_R = -\frac{M_x}{\cos\alpha}$$

Diagram of the moments applied to the derrick boom is shown on Fig 27.

c) The torsional moment is constant along L – a whence:

$M_{xa} = M_{xL} = M_x$

The bending moments M_y and M_z vary linearly between point E and point C. They are equal to the following values, respectively, in a cross-section located at a distance x from the end:

$$M_y = M_{ya}\frac{L-x}{L-a}$$

$$M_z = M_{za} + (M_x\tan\alpha - M_{za})\frac{x-a}{L-a}$$

14.4.5 The boom thrust Q in a cross-section is to be determined with respect to the contemplated loading case.

In any cross-section located at a distance x lying between a and 0,5L from the head end B, it is generally admitted that the boom thrust has a constant value Q equal to the value determined at mid-length of the derrick boom.

In a cross-section located at a distance x between 0 and a from the head end B, the value of the boom thrust Q is to be determined as indicated in [14.3.5].

14.4.6 At mid-Length of the derrick boom, the strength criterion as per [14.4.1], is applicable; however instead of applying this criterion, it may be checked that the boom thrust Q is lower or equal to the following maximum allowable thrust Q_{max}, in kN.

$$Q_{max} = \frac{S_m}{\omega}\left[\sqrt{0,36\left(\frac{R_e}{\psi\varepsilon}\right)^2 - 3\tau_m^2} - \sigma_{bm}\right]$$

where:

$$\tau_m = \frac{10^{-3}M_x}{2W_m}$$

$$\sigma_{bm} = \frac{10^{-3}M_{bm}}{W_m}$$

with:

$$M_{bm} = \sqrt{\left(M_{ym} + \frac{0,9}{\psi}M_{Gm}\right)^2 + M_{zm}^2}$$

$M_{Gm} = 9{,}6\ S_m\ L^2\ \cos\alpha 10^{-6}$

$$M_{ym} = 0,5M_{ya}\frac{L}{L-a}$$

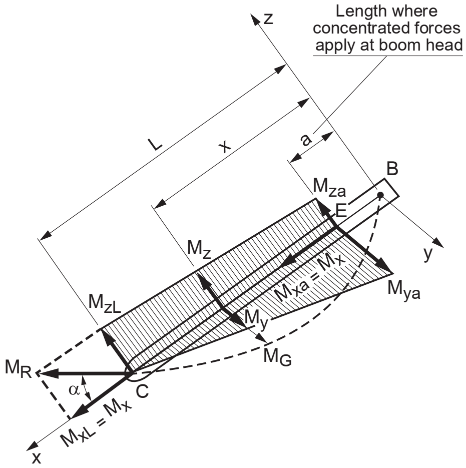
$$M_{zm} = M_{za} + 0,5(M_x\tan\alpha - M_{za})\frac{L-2a}{L-a}$$

The other notations are defined in Tab 17.

The moments M_x, M_{ya} and M_{za} are calculated at point E as per [14.4.4] item a).

The calculated value of Q_{max} is to be positive. If it is not so, the scantlings of the derrick boom are to be increased.

Figure 27 : Distribution of bending and torsional moments in a derrick boom



14.5 Determination of the buckling factor

14.5.1 Derrick booms with constant moment of inertia

a) The buckling factor ω of cylindrical derrick booms with circular cross-section and constant thickness is given by the following formula:

$$\omega = V + \sqrt{V^2 - 4U^2}$$

where:

U = 0,01533 ρ

with:

$$\rho = 10^3 \frac{L}{D}\sqrt{\frac{R_e}{235}}$$

V = 2 U (U + 0,1) + 0,48

R_e : Design yield stress, in N/mm2 as per [13.1.6]

L : Effective length, in m, of the derrick boom (see [13.1.5])

D : External diameter, in mm, of the derrick boom.

For convenience, the values for ω are listed in Tab 18 in relation to the ratio:

$$\rho = 10^3 \frac{L}{D}\sqrt{\frac{R_e}{235}}$$

b) In the exceptional cases of derrick booms of non-circular cross-section, the buckling factor ω may be determined according to Ch 2, Sec 3, Tab 2 and Ch 2, Sec 3, Tab 3, considering that the buckling length is equal to the length L of the derrick boom.

c) For ω determination, derrick booms having strengthened scantlings at ends will be considered as having constant scantlings equal to those of the mid-section.

14.5.2 Derrick booms of variable moment of inertia

a) When the second moment of area moment of the derrick boom is not constant, the buckling factor ω as per [14.5.1] item a), is to be determined using a fictitious diameter D_f calculated as mentioned hereunder:

$D_f = \xi D_m$

where:

1) for derrick booms with tapered ends and when the thickness of the derrick boom is constant over its full length (see Tab 19)

$\xi = \xi_a = \mu^q$ with $q = 0,3(1 - \nu)^{2,2}$

with:

$$\mu = \frac{D_1}{D_m} \quad \text{and} \quad \nu = \frac{L_m}{L}$$

2) for stepped derrick booms with only one change of diameter at each end (see Tab 20)

$$\xi = \xi_b = \frac{\mu}{\sqrt[3]{1 + (\mu^3 - 1)[\nu + 0,318\sin(180\nu)]}}$$

with:

$$\mu = \frac{D_1}{D_m}\sqrt[3]{\frac{t_1}{t_m}} \quad \text{and} \quad \nu = \frac{L_m}{L}$$

D_m , t_m : Respectively the external diameter and the thickness of the derrick boom in the mid-portion of length L_m, in mm,

D_1 , t_1 : Respectively the external diameter and the thickness of the derrick boom at ends, in mm, without taking Into account the possible local reinforcements in way of the heel and head fittings. As a rule, when both ends have dissimilar scantlings the smaller will be considered.

For both contemplated cases the relevant numerical values of ξ are shown in Tab 19 or Tab 20.

b) The formula given in item a), 2) is applicable to cylindrical derrick booms with reduction in thickness at ends ($t_1 < t_m$).

In such a case:

$$\mu = \sqrt[3]{\frac{t_1}{t_m}}$$

c) For derrick booms both tapered and reduced in thickness at ends ($t_1 < t_m$) the coefficient ξ is to be taken equal to:

$\xi = \xi_a \; \xi_b$

where:

ξ_a : Determined as per item a), 2), using diameters D_m and D_1

ξ_b : Determined as per, item a), 2), using the coefficient:

$$\mu = \sqrt[3]{\frac{t_1}{t_m}}$$

d) For stepped derrick booms with more than one change of diameter at each end (see Fig 28) the coefficient ξ will be the product of the coefficients ξ_i for each considered change of diameter:

$$\xi = \prod_{i=1}^{i=n} \xi_i$$

n : Number of changes of diameter at each end of derrick boom

ξ_i : Depends on μ_i and ν_i and is obtained applying the formula given in item a), 2), with:

- $\mu_i = \dfrac{D_i}{D_m} \sqrt[3]{t_1/t_m} \times \dfrac{1}{\prod_{j=0}^{j=i-1} \xi_j}$

  considering $\xi_0 = 1$

  and,

- $\nu_i = (L_i - 1) / L$ considering $L_0 = L_m$

Fig 28 shows an example of a derrick boom with 3 changes of diameter (steps) at each end (n = 3).

Figure 28 : Derrick boom with three steps at each end

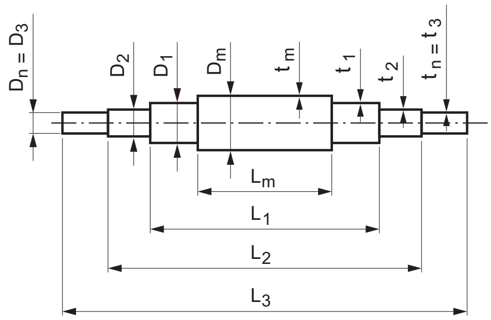


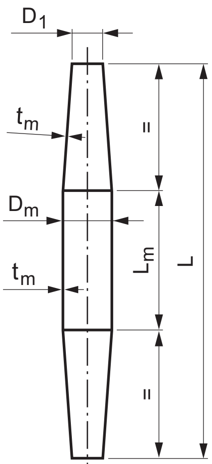
Table 18 : Values of the buckling factor ω for derrick booms

P	P + 0,0	P + 0,2	P + 0,4	P + 0,6	P + 0,8	P + 1,0	P + 1,2	P + 1,4	P + 1,6	P + 1,8
16	1,075	1,077	1,079	1,081	1,083	1,086	1,088	1,090	1,093	1,095
18	1,097	1,100	1,102	1,105	1,108	1,110	1,113	1,116	1,118	1,121
20	1,124	1,127	1,130	1,133	1,136	1,140	1,143	1,146	1,149	1,153
22	1,156	1,160	1,164	1,167	1,171	1,175	1,179	1,183	1,187	1,192
24	1,196	1,200	1,205	1,209	1,214	1,219	1,224	1,229	1,234	1,239
26	1,244	1,250	1,255	1,261	1,266	1,272	1,278	1,284	1,290	1,297
28	1,303	1,310	1,316	1,323	1,330	1,337	1,344	1,352	1,359	1,367
30	1,374	1,382	1,390	1,398	1,407	1,415	1,424	1,432	1,441	1,450
32	1,459	1,468	1,478	1,487	1,497	1,507	1,516	1,527	1,537	1,547
34	1,557	1,568	1,579	1,590	1,601	1,612	1,623	1,634	1,646	1,657
36	1,669	1,681	1,693	1,705	1,717	1,730	1,742	1,755	1,768	1,781
38	1,794	1,807	1,820	1,833	1,847	1,860	1,874	1,888	1,902	1,916
40	1,930	1,944	1,959	1,973	1,988	2,002	2,017	2,032	2,047	2,062
42	2,078	2,093	2,108	2,124	2,140	2,155	2,171	2,187	2,203	2,219
44	2,236	2,252	2,269	2,285	2,302	2,318	2,335	2,352	2,369	2,386
46	2,404	2,421	2,438	2,456	2,473	2,491	2,509	2,527	2,545	2,563
48	2,581	2,599	2,618	2,636	2,655	2,673	2,692	2,711	2,730	2,748
50	2,768	2,787	2,806	2,825	2,845	2,864	2,884	2,903	2,923	2,943
52	2,963	2,983	3,003	3,023	3,043	3,064	3,084	3,105	3,125	3,146
Note 1: The intermediate values may be obtained by linear interpolation.										

P	P + 0,0	P + 0,2	P + 0,4	P + 0,6	P + 0,8	P + 1,0	P + 1,2	P + 1,4	P + 1,6	P + 1,8
54	3,167	3,187	3,208	3,229	3,251	3,272	3,293	3,314	3,336	3,357
56	3,379	3,401	3,422	3,444	3,466	3,488	3,510	3,532	3,555	3,577
58	3,599	3,622	3,644	3,667	3,690	3,713	3,736	3,759	3,782	3,805
60	3,828	3,851	3,875	3,898	3,922	3,945	3,969	3,993	4,017	4,041
62	4,065	4,089	4,113	4,137	4,162	4,186	4,211	4,235	4,260	4,285
64	4,309	4,334	4,359	4,384	4,409	4,435	4,460	4,485	4,511	4,536
66	4,562	4,588	4,613	4,639	4,665	4,691	4,717	4,743	4,770	4,796
68	4,822	4,849	4,875	4,902	4,929	4,955	4,982	5,009	5,036	5,063
70	5,091	5,118	5,145	5,173	5,200	5,228	5,255	5,283	5,311	5,339
72	5,367	5,395	5,423	5,451	5,479	5,508	5,536	5,564	5,593	5,622
74	5,650	5,679	5,708	5,737	5,766	5,797	5,824	5,854	5,883	5,912
76	5,942	5,971	6,001	6,031	6,061	6,091	6,120	6,151	6,181	6,211
78	6,241	6,271	6,302	6,332	6,363	6,394	6,424	6,455	6,496	6,517
80	6,548	6,579	6,610	6,642	6,673	7,704	6,736	6,767	6,799	6,831
82	6,863	6,894	6,926	6,958	6,991	7,023	7,055	7,087	7,120	7,152
84	7,185	7,217	7,250	7,283	7,316	7,349	7,382	7,415	7,448	7,481
86	7,515	7,548	7,582	7,615	7,649	7,682	7,716	7,750	7,784	7,818

Note 1: The intermediate values may be obtained by linear interpolation.

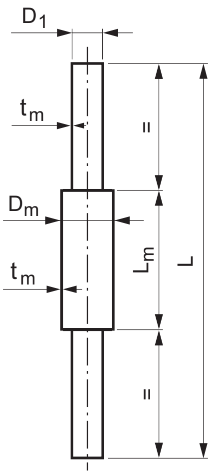
Table 19 : Derrick booms with variable moment of inertia - Tapered derrick booms with constant thickness - Coefficient ξ_a



(a)

Values of μ	Values of ν							
	0,3	0,4	0,5	0,6	0,7	0,8	0,9	1,0
0,70	0,952	0,966	0,977	0,986	0,992	0,997	0,999	1,0
0,75	0,961	0,972	0,981	0,989	0,994	0,998	0,999	1,0
0,80	0,970	0,978	0,986	0,991	0,995	0,998	1,0	1,0
0,85	0,978	0,984	0,989	0,994	0,997	0,999	1,0	1,0
0,90	0,986	0,990	0,993	0,996	0,998	0,999	1,0	1,0
0,95	0,993	0,995	0,997	0,998	0,999	1,0	1,0	1,0
1,00	1,0	1,0	1,0	1,0	1,0	1,0	1,0	1,0

Table 20 : Derrick booms with variable moment of inertia - Stepped derrick booms - Coefficient ξ_b



(b)

Values of μ	Values of ν							
	0,4	0,45	0,5	0,6	0,7	0,8	0,9	1,0
0,70	0,860	0,883	0,905	0,944	0,974	0,992	0,999	1,0
0,75	0,892	0,911	0,928	0,959	0,981	0,994	0,999	1,0
0,80	0,920	0,935	0,948	0,971	0,987	0,996	0,999	1,0
0,85	0,944	0,955	0,965	0,980	0,991	0,997	1,0	1,0
0,90	0,966	0,972	0,978	0,988	0,995	0,998	1,0	1,0
0,95	0,984	0,987	0,990	0,995	0,998	0,999	1,0	1,0
1,00	1,0	1,0	1,0	1,0	1,0	1,0	1,0	1,0

15 Derrick booms - end fittings

15.1 General

15.1.1 As a rule, the materials used for the construction of the derrick boom end fittings are to satisfy [13.2].

When the steel grades used do not comply with those provided in Tab 12, it is to be ascertained that the steels used are of weldable quality, except for the derrick heel pin.

15.1.2 Attention is drawn to the fact that the reductions of scantlings accepted in this section when high tensile steels are used may generate high bearing pressures inconsistent with lubricating conditions provided and with the nature of the materiels in contact.

In this respect it is the responsibility of the Manufacturer to choose the steel grade (satisfactory operation is to be demonstrated upon testing prior to putting into service and confirmed upon periodical inspections).

15.2 Derrick boom head fittings

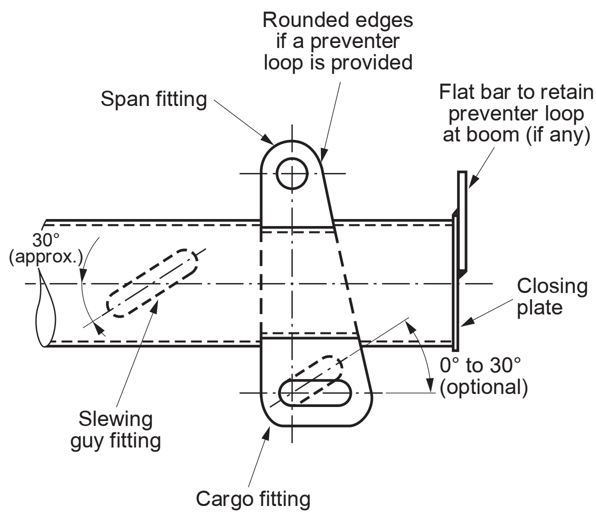
15.2.1 As a rule, the scantlings of the derrick boom head fittings are to comply with international or national standards, taking into account the forces determined in accordance with the requirements of Article [3].

15.2.2 As mentioned in [13.3.5], the cargo, span, slewing and possibly preventer guy fittings are to be arranged in such a way as to reduce to a minimum the bending and torsional moments at the derrick boom.

For this purpose, the cargo and span fittings are to be made of a single solid or welded piece passing through the derrick boom (see Fig 29). This requirement can be applicable to both slewing fittings.

15.2.3 In the case of union purchase rig with preventer guys looped around the derrick boom head, a device is to be fitted to retain the preventer loop at derrick boom head; this device consists usually in a welded flat bar (see Fig 29).

Figure 29 : Typical arrangement of derrick boom head fittings



15.3 Derrick heel pin and fittings

15.3.1 The dimensions of the derrick heel pins and fittings are defined in [15.3.3] and [15.3.4] according to the derrick boom thrust Q determined as indicated in [14.3.5] or [14.4.5], as applicable.

The scantlings thus defined are suitable for the derrick booms defined in [14.1.3]. As an alternative, the derrick heel pins and fittings complying with international or national standards will generally be accepted for these derrick booms.

For the derrick booms defined in [14.1.4], reference is to be made to [15.3.2], the provisions of which are also applicable to the derrick heel pins and fittings designed in compliance with international or national standards.

Heel fittings of a design different from the one defined in Fig 30 are to be of an equivalent strength.

15.3.2 For the derrick booms defined in [14.1.4] (derrick booms generally submitted to important torsional moment), the scantlings given in Tab 21 and Fig 30 are considered to be satisfactory if the reaction moment M_R exerted by the gooseneck (see [14.4.4], item b)) does not exceed the following value, in kN.m:

$M_{R0} = 0{,}003\ Q^{3/2}$

where Q is the value of the derrick boom thrust, in kN, exerted on the derrick heel pin.

If the reaction moment MR is greater than the value M_{Ro}, the scantlings of the derrick heel pin and fittings may be determined in considering a fictitious boom thrust Q' defined by the following formula:

$$Q' = Q\left(0,6 + 0,4\frac{M_R}{M_{R0}}\right)$$

15.3.3 The diameter d, in mm, of the derrick heel pin is defined in Tab 21 depending on the derrick boom thrust Q (or Q').

The scantlings defined in Tab 21 correspond to the use of steel with design yield stress (see [13.1.6]) at least equal to 235 N/mm^2.

In the case of use of steel with design yield stress R_e higher than 235 N/mm^2 and for the derrick booms defined in [14.1.4], the diameter of the derrick heel pin may be reduced in the proportion $(235/R_e)^{1/3}$ without taking for this ratio a value lower than 0,87 (see [15.1.2]). As a rule, for the derrick booms defined in [14.1.4], no reduction of this type will be accepted.

The derrick heel pin is recommended to consist in a suitably tightened bolt with a crown nut secured by a split pin as shawn in Fig 30.

15.3.4 The dimensions, in mm, of derrick heel fittings are shown in Fig 30 depending on the diameter d, in mm, of the derrick heel pin determined as indicated in Tab 21. No consideration is to be given to possible reduction of scantlings due to the steel used for the pin, except for the diameter d_1 to be suited to the diameter of the derrick heel pin.

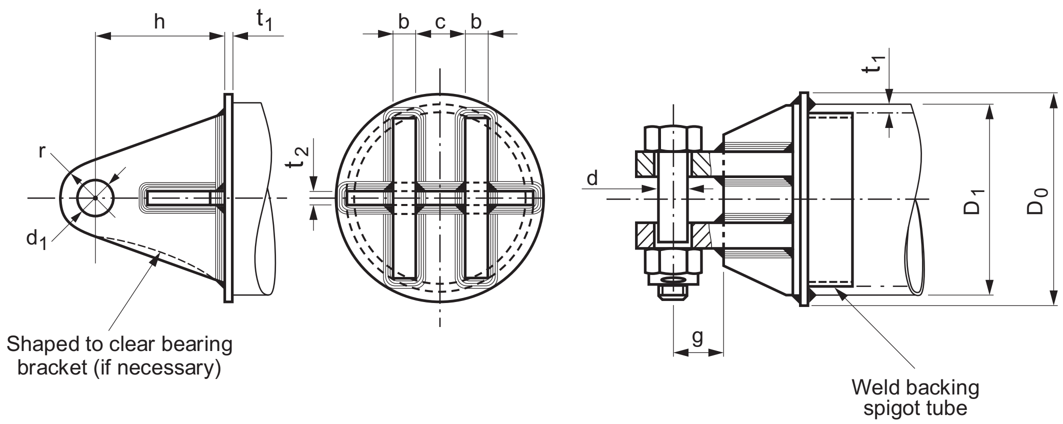
The dimensions shown in Fig 30 apply to derrick heel fittings made of steel with design yield stress (see [13.1.6]) at least equal to 235 N/mm^2.

If steel with design yield stress R_e higher than 235 N/mm^2 is used, the dimensions b, $(r – 0,5d_1)$, t_1 and t_2 may be reduced in the proportion $(235/R_e)^{1/3}$ without taking for this ratio a value lower than 0,87.

Table 21 : Derrick heel pin

Derrick boom thrust Q, in kN	Diameter d of the derrick heel pin, in mm
$Q \leq 400$	$4,4\sqrt{Q} + 2$
$400 < Q < 1000$	$4,5\sqrt{0,08Q} + 80$
$Q \geq 1000$	$4,25\sqrt{Q}$

Figure 30 : Derrick heel fittings



Dimensions, in mm, according to diameter d of derrick heel pin as defined in Tab 21:

$d_1 = d + j$

$b = 0,75\ d$

$c = 1,2\ d + j$ (see Note 1)

$h = 2,2\ d + 20\ j$ (see Note 2)

$g = 1,1\ d + 4\ j$

$r = d$

$t_1 = 0,22\ d + 3$

$t_2 = 0,45\ d + 3$

$D_0 = D_1 + 3j$ (see Note 2)

where:

$j = 2$ when $d \leq 50$

$j = 3$ when $50 < d \leq 100$

$j = 4$ when $100 < d \leq 200$

$j = 5$ when $d > 200$

Note 1: Dimension c to suit gooseneck with normally equal to 1,2 d.

Note 2: Dimensions h and D_0 to suit outside diameter D_1 and thickness t_1 of derrick boom end.

CHAPTER 4
LIFTING PLATFORMS

Section 1 General

1 General

1.1 Application

1.1.1 The present Chapter provides requirements for the certification of lifting platforms, as defined in [1.3.3], installed onboard ships or offshore units and used for lifting cargoes or provisions.

1.1.2 Lifting platforms that may be operated with personnel on the lifting platform are subject to additional requirements as described in Sec 6.

1.1.3 When application is requested, considered as possible and reasonable, the requirements of this Chapter may be used wholly or partly by the Society upon special request of the Owner or Manufacturer for appliances not explicitly covered by the definition of lifting platform (see [1.3.3]).

1.1.4 Lifting platforms installed onboard naval ships may be subject to specific requirements from the Naval Authority. In such cases, the specific requirements (e.g. test loads, safety requirements, etc.) are to be agreed with the Society on a case-by-case basis at the beginning of the design review process.

1.1.5 Items not covered by this Chapter are to comply with applicable requirements of Chapter 2.

1.2 Documentation to be submitted

1.2.1 The documentation to be submitted for the certification of lifting platforms is listed in [1.2.2] and [1.2.3].

1.2.2 Documentation to be submitted for information

- General arrangement drawings indicating the positions of cargoes, vehicles or aircraft on the platform and their types
- Descriptions of self-weights and centres of gravity of the movable components of the lifting platform structure
- Description of the lifting operations and operating conditions
- Definition of the loadable area of the platform
- Specification of loads to be carried and their types as well as their possible positions and centres of gravity, distributions and combinations
- Characteristics of the wheeled load (tyre prints area, axle loads, axle distributions, etc.), if applicable
- Description of system operation and equipment design (including mechanical, electrical, hydraulic systems, locking and supporting devices, etc.)
- Operating manuals including procedures for any manual operating mode of the lifting platform
- Design calculations
- Design description
- Other data relevant to the design assessment, as requested by the Society
- Information about watertightness or weathertightness, if applicable
- Additional requirements specified by the Flag Administration, where applicable.

1.2.3 Documentation to be submitted for approval

- Description of the electrical installations and hydraulic systems
- Description of hoists, hydraulic actuating units, braking systems and safety devices and systems as well as related drawings
- Scantling and construction drawings, including supporting devices and locking devices
- Test plans and procedures, including definition of test loads.

1.3 Definitions

1.3.1 Hoisting machinery

The hoisting machinery is the equipment which acts upon suspension elements or directly upon the lifting platform in order to raise, lower or stop the platform. This equipment includes motors, brakes, drums, cylinders, pumps, pump motors, gears, shafts, sheaves, sprockets, control valves, etc.

1.3.2 Hoisting system

The hoisting system is the set of hoisting machinery and suspension elements.

1.3.3 Lifting platform

Lifting platform is a lifting appliance constituted by a horizontal deck suspended by ropes/chains or screw-type systems or supported by hydraulic cylinders and used to transport cargoes vertically between two levels in general.

1.3.4 Locking devices

Locking devices are the mechanisms that keep the lifting platform fixed in position relative to an adjacent deck. When engaged they resist the weight of the lifting platform and any loads applied to it, taking into account ship motion effects.

1.3.5 Non-operating conditions

The non-operating conditions are the conditions in which the lifting platform is in a stowed position with locking devices engaged, either with load or without load on the platform.

1.3.6 Normal conditions

Normal conditions include operating conditions and non-operating conditions, but do not take into account test conditions or flooding conditions.

1.3.7 Operating conditions

The operating conditions are the conditions in which the lifting platform is hoisted or lowered with cargo.

1.3.8 Positive drive

Positive drive is a hoisting action where suspension elements are driven directly by turning of the hoist drum (in case of wire rope suspension elements) or by turning of sprockets (in case of chain type suspension elements).

1.3.9 Safe Working Load (SWL)

For the purpose of this Chapter, the Safe Working Load (SWL) of a lifting platform is the maximum mass, in tons, which may be transported vertically by the lifting platform.

Note 1: This mass includes the mass of any cargo handling equipment (e.g. a forklift) which is on the platform during hoisting or lowering operations. In such case, the own mass of the cargo handling equipment is to be deducted from the SWL in order to obtain the maximum mass which may be transported on the platform.

2 System operation and use

2.1 Design description

2.1.1 The lifting platform system and its use are to be described with at least the following detailed information:

- Description of the system, sub-systems and components, including their function
- The SWL of the lifting platform
- Types of loads carried (individually or in combination) and their possible distributions
- Definition of the self-weight of the lifting platform and moving parts
- Description of the lifting operations that may be conducted
- Description of system operation in powered and manual modes
- Description of system operation in the emergency operating mode(s), including use of necessary overrides
- Description of safety devices and their functions, including, where applicable, overrides and means of test
- Operating conditions for lifting operations and system functions
- Identification of lifting platforms that are required to carry load under non-operating conditions and description of these loads (for example aircraft parked on aircraft elevators when the system is not in operation)
- Indication of lifting operations where personnel may be carried on the lifting platform
- Performance requirements relevant to testing (e.g. speed or time of lifting operation, duty cycle, etc.)
- Relevant design assumptions

These data are to be taken into account for definition of the design loading cases.

2.2 Operating conditions

2.2.1 The ship or offshore unit motions and accelerations resulting from the most severe operating conditions are not to be less severe than those taken into account in the design (see Sec 2, [1.6]).

2.2.2 Lifting platform are not to be operated under conditions that exceed the operating conditions taken into account in the design assessment.

2.3 Specific operating modes

2.3.1 Emergency operation

In case of malfunction, failure of power supply, failure of control system, or similar situations, a means for emergency operation is to be available.

2.3.2 Manual operation

The procedures for any manual operating mode of the lifting platform are to be clearly described, along with all necessary controls and precautions necessary to maintain safe operation. This information is to be made available in the operating manual.

2.4 Safety arrangements

2.4.1 Ship/offshore unit deck

Handrails are to be provided at the edges of the ship/offshore unit deck abreast the platform opening. A foot plate not less than 150 mm in height is to be fitted.

Handrails are to be arranged and constructed as follows. Alternative design and arrangement may be accepted if found in compliance with appropriate standard recognised by the Society.

a) Handrails are to be of 1,0 m in height as a minimum, measured above platform. Where this height would interfere with the normal operation of the lifting platform, a lesser height may be accepted by the Society on a case-by-case basis.

b) Handrails are to have at least two courses. Handrails fitted on lifting platforms intended for use in offshore conditions are to have at least three courses.

c) The size of openings, below the lowest course of handrails and the deck is to be a maximum of 230 mm. The distance between other courses is not to be greater than 380 mm.

d) Stanchions of handrails are to comply with the following requirements:
   - fixed, removable or hinged stanchions are to be fitted approximately 1,5 m apart
   - at least every third stanchion is to be supported by a bracket or stay (other alternatives may be accepted by the Society on a case-by-case basis)
   - removable or hinged stanchions are to be capable of being locked in the upright position.

e) Handrails are to resist to a horizontal load of 75 kg at mid span.

f) Wire ropes may be accepted, in lieu of guard rails, only in special circumstances and then only in limited lengths. In such cases, they are to be made taut by means of turnbuckles.

g) Chains may be accepted, in lieu of guard rails, only where they are fitted between two fixed stanchions.
   If the opening is wide, the chains are to be fitted with vertical courses to prevent the horizontal courses from spreading apart.

2.4.2 Lifting platform

The lifting platform is to be provided with all necessary safety fittings such as barriers and other suitable safety way guidance systems.

a) Safety guidance systems are to take the form of colour markings, lighting or photo-luminescent indicators and warning signs.

b) Platform is to be fitted with adequate anti-slip system.

3 Communication system

3.1 General

3.1.1 All lifting platform control stations and areas accessible to the personnel are to be connected to a permanently installed communication system.

Section 2 Design Loads and Loading Cases

1 Design loads

1.1 General

1.1.1 Strength calculations of the various components of lifting platforms are to be made under operating conditions, non-operating conditions and testing condition taking into account the loads due to:

- Self-weight as defined in [1.3.1]
- Safe Working Load as defined in [1.4.1]
- Dynamic loads due to lifting platform motion as defined in [1.5]
- Dynamic loads due to ship/offshore unit motions as defined in [1.6]
- Static inclination angles of the ship/offshore unit as defined in [1.7.1]
- Green sea loads and wave impact loads, if applicable, as defined in [1.8]
- Testing loads as defined in [1.9]
- Flooding loads, if applicable, as defined in [1.10.1].

1.1.2 No loads induced by the hull deformation are to be transferred to the lifting platform in its stowed position. If this can not be ensured, the induced loads are to be considered on a case-by-case basis.

1.1.3 Operating conditions are to take into account the duty category depending on kind and rate of service contemplated.

1.2 Duty category

1.2.1 General

The nature and the intensity of intended lifting platform duty are taken into account by increasing the design loads considered in calculations and also by providing minimum sheaves diameter.

Depending on the nature of their duty and the rate of operation, the lifting platforms are divided into three duty categories:

- Category I: lifting platforms very seldom used at their SWL
- Category II: lifting platforms regularly operated at less than 75% of their SWL
- Category III: lifting platforms extensively operated for loads approaching their SWL.

1.2.2 Duty coefficients for harbour conditions

The duty coefficients Ψ_0 associated to the duty categories for harbour conditions are given in Ch 2, Sec 2, Tab 1.

1.2.3 Duty coefficients for seagoing conditions

The duty coefficients Ψ_0 associated to the duty category for seagoing conditions are given in Ch 2, Sec 2, Tab 2.

1.3 Self-weight

1.3.1 The self-weight, Pp, in kN, is the load acting on the hoisting mechanism due to the weight of the permanent components of the lifting platform and its machinery.

1.3.2 For loading cases considering the self-weight as a uniformly distributed load, the corresponding pressure p_P, in kN/m², is to be taken as follows:

$$p_P = \frac{P_P}{A_p}$$

where:

P_p : Self-weight, in kN, as defined in [1.3.1]

A_p : Loadable area of the platform, in m².

1.4 Safe Working Load

1.4.1 Mobile devices

The SWL, as defined in Sec 1, [1.3], is, in general, to include the mobile devices used for handling the cargoes.

Where the added weight of mobile lifting and handling equipment may load the platform with more than the SWL during loading operations (e.g. by using a forklift), this is to be indicated by the Designer and the static test load is to be adjusted accordingly.

1.4.2 For loading cases considering the SWL as a uniformly distributed load, the corresponding pressure p_{SWL}, in kN/m², is to be taken as follows:

$$p_{SWL} = \frac{SWL}{A_p} g$$

where:

SWL : Safe Working Load, in t

A_p : Loadable area of the platform, in m²

g : Gravity acceleration taken equal to 9,81 m/s².

1.4.3 For loading cases considering the SWL as concentrated forces due to a unit cargo, the static force F_Z, in kN, is calculated as follows:

$$F_Z = Mg$$

where

M : Total mass, in t, of the unit cargo considered

g : Gravity acceleration taken equal to 9,81 m/s².

1.4.4 For loading cases considering the SWL as concentrated forces due to a wheeled load, the static force F_W, in kN, is calculated as follows:

$$F_W = Mg$$

where

M : Mass, in t, applied by one wheel and calculated as follows:

$$M = \frac{Q_A}{n_W}$$

with

Q_A : Axe load, in t

n_W : Number of individual wheels for the axle considered:

g : Gravity acceleration taken equal to 9,81 m/s².

1.5 Dynamic loads due to lifting platform motion

1.5.1 The dynamic load due to the lifting platform motion is considered by multiplying the self-weight and the SWL by a factor Ψ_{CZ}.

1.5.2 Ψ_{CZ} may be evaluated as follows:

$$\Psi_{CZ} = 1 + 0,3\ V$$

where

V : Maximum hoisting speed, in m/s

For calculation purposes, the hoisting speed is not to be taken less than 0,5m/s, nor greater than 1,0m/s.

1.6 Dynamic loads due to ship/offshore motions

1.6.1 General

The dynamic loads due to ship motions are considered by multiplying the self-weight and the SWL by the factors α_{cx}, α_{cy} and α_{cz}, as specified in Article [2], obtained with the following formulas:

$$\alpha_{cx} = \frac{a_x}{g}$$

$$\alpha_{cy} = \frac{a_y}{g}$$

$$\alpha_{cz} = 1 + \frac{a_z}{g}$$

where:

a_x, a_y, a_z : Accelerations of the ship in x, y and z direction respectively, in m/s²

g : Gravity acceleration taken equal to 9,81 m/s².

The accelerations of the ship/offshore unit are to be considered separately for the evaluation of the lifting platform in operating and stowed conditions according to [1.6.2] and [1.6.3].

1.6.2 Lifting platforms operated in seagoing condition

For lifting platforms intended to be operated in seagoing condition, limited to a defined sea state, accelerations a_x, a_y and a_z may be obtained according to App 1, [2.2].

Accelerations are to be evaluated, at least, at the lowest and highest positions during operations.

1.6.3 Lifting platforms stowed in seagoing condition

For lifting platforms stowed in seagoing condition, accelerations a_x, a_y and a_z may be obtained according to App 1, [2.3].

Accelerations are to be evaluated at each level where the lifting platform can be stowed during navigation.

1.7 Operation at harbour

1.7.1 Static inclination of the ship

In operating conditions at harbour, the angles of trim θ, and list ℓ, to be considered are to be specified by the Designer and agreed with the Society. The angles are not to be less than the values defined in Ch 2, Sec 2, [3.2.1].

The static inclination angles of the ship are taken into account by means of the factors α_{cx} and α_{cy} that can be obtained using the following formulae:

$\alpha_{cx} = \sin\theta$

$\alpha_{cy} = \sin\ell$

1.7.2 Vertical amplification factor

In operating conditions at harbour, the vertical acceleration of the ship is taken into account by means of the factor α_{cz}, that can be taken as:

$\alpha_{cz} = 1{,}1$

1.8 Sea pressures

1.8.1 Green sea loads

When the platform in non-operating condition is stowed at a weather deck level, the external pressure p_d, in kN/m², due to green sea is to be considered. The external pressure p_d is to be calculated according to applicable Rules. For offshore units, calculation of p_d is to be agreed with the Society.

1.8.2 Wave impact pressure

When the platform may be subject to wave impact pressure on its underside, this pressure will be defined on a case-by-case basis.

1.9 Testing loads

1.9.1 Testing loads are defined in Ch 5, Sec 1, [12.4].

1.10 Internal pressures

1.10.1 Flooding loads

When the platform in non-operating condition is stowed at a watertight deck level, the internal pressure p_{Fl}, in kN/m², due to flooding is to be considered. The internal pressure p_{Fl} is to be calculated according to applicable Rules. For offshore units, calculation of p_{Fl} is to be agreed with the Society.

2 Loading cases

2.1 Description of loading cases

2.1.1 Loading cases for lifting platforms are to be defined for all components, including description of:

- Applicable loads and their combinations. Combination of loads for each loading case is described in [2.2] to [2.5]
- Conditions under which the loads will be applied (operating, non-operating or testing conditions) as well as the configuration, position or mode of components (e.g. platform in upper position with locking devices engaged). As a guidance, reference may be made to Tab 1.
- Self-motion coefficients and ship motion effects under applicable conditions. As a guidance, reference may be made to Tab 2
- Other relevant data or assumptions.

2.1.2 Load cases not specified in these Rules are to be specified by the Designer and assessed to the satisfaction of the Society.

Table 1 : Assessment of lifting platforms components

Component	Position / Mode	Conditions		
		Operating	Non-operating	Testing
Lifting platform	Upper position	X	In stowed position **(1)**	X
	Lower position	X		X
Locking devices **(2)**	Engaged	X	X	X
	Disengaged	X		X
Suspension elements	Under tension **(3)**	X		X
Guide rails **(4)**	–	X **(5)**	X	X **(5)**

(1) When the lifting platform can be stowed in several different positions, every possible stowing position is to be assessed
(2) Engaged and disengaged modes are to be considered, at least, with the lifting platform in both upper and lower positions
(3) If any system function relies upon controlled tensioning of suspension elements when the locking devices are engaged, such loading cases are to be taken into account and the design loads are to be specified by the Designer
(4) If fitted to restrict horizontal movements
(5) Lifting platform at intermediate position between two rail supports.

Table 2 : Applicable conditions for self-motion coefficients and ship motion effects

Load effect	Type	Conditions		
		Operating	Non-operating	Testing
Dynamic amplification	Ship motion	X	X	
	Self-motion	X		X

Note 1: Under testing conditions the influence of self-motion is to be considered for overload and operational tests.

2.2 Operating loading cases

2.2.1 Lifting platforms operating at harbour

For lifting platform which operates only at harbour or still water conditions, the loads to be applied in each direction for each loading case are specified in Tab 3.

2.2.2 Lifting platforms operating in seagoing condition

For lifting platform which is intended to operate in seagoing condition, the loads to be applied in each direction for each loading case are specified in Tab 4.

2.2.3 Definition of loading cases

The nomenclature of loading cases defined in Tab 3 and Tab 4 is as follows:

- Loading Case I for SWL uniformly distributed on the platform
- Loading Case II for concentrated forces due to unit cargo, if applicable
- Loading Case III for forces due to wheeled loads, if applicable.

Additionally, loading cases defined in Tab 4 for seagoing condition are completed by a subindex a, b and c which correspond to head sea, beam sea and oblique sea respectively.

Table 3 : Loading cases for lifting platforms operating at harbour

Load case	Design loads		
	x direction **(2)**	y direction **(2)**	z direction **(2)**
I **(1)**	$\psi_0\ (p_{swl} + p_p)\ \alpha_{cx}$	$\psi_0\ (p_{swl} + p_p)\ \alpha_{cy}$	$\psi_0\ (p_{swl} + p_p)\ \alpha_{cz}\psi_{cz}$
II	$\psi_0\ (p_p + \Sigma^n_{i=1}\ F_{z,i})\ \alpha_{cx}$	$\psi_0\ (p_p + \Sigma^n_{i=1}\ F_{z,i})\ \alpha_{cy}$	$\psi_0\ (p_p + \Sigma^n_{i=1}\ F_{z,i})\ \alpha_{cz}\psi_{cz}$
III	$\psi_0\ (p_p + \Sigma^n_{i=1}\ F_{w,i})\ \alpha_{cx}$	$\psi_0\ (p_p + \Sigma^n_{i=1}\ F_{w,i})\ \alpha_{cy}$	$\psi_0\ (p_p + \Sigma^n_{i=1}\ F_{w,i})\ \alpha_{cz}\psi_{cz}$

Note 1:
p_{swl} : Uniformly distributed SWL, in kN/m² as defined in [1.4.2]
p_p : Uniformly distributed self-weight, in kN/m², as defined in [1.3.2]
$\Sigma^n_{i=1}\ F_{z,i}$: Distribution of unit cargoes as indicated by the Designer (see [1.4.3])
$\Sigma^n_{i=1}\ F_{w,i}$: Distribution of wheeled loads as indicated by the Designer (see [1.4.4])
α_{cx}, α_{cy}, α_{cz}: Factors due to static inclination of the ship and to vertical acceleration in harbour conditions, as defined in [1.7.1] and [1.7.2] respectively
ψ_0 : Duty coefficient at harbour conditions, as defined in [1.2.3]
ψ_{cz} : Dynamic factor due to lifting platform motion as defined in [1.5]
(1) Loading case to be considered regardless of the nature of the lifted load.
(2) With respect to ship reference co-ordinate defined in App 1, [1.2]

Table 4 : Loading cases for lifting platforms operating in seagoing condition

Load case	Design loads		
	x direction **(2)**	y direction **(2)**	z direction **(2)**
I_a **(1)**	$\psi_0 (p_{swl} + p_p) \alpha_{cx}$	0	$\psi_0 (p_{swl} + p_p) \alpha_{cz}\psi_{cz}$
I_b **(1)**	0	$\psi_0 (p_{swl} + p_p) \alpha_{cy}$	
I_c **(1)**	$0,6\ \psi_0 (p_{swl} + p_p) \alpha_{cx}$	$0,6\ \psi_0 (p_{swl} + p_p) \alpha_{cy}$	
II_a	$\psi_0 (p_p + \Sigma^n_{i=1} F_{z,i}) \alpha_{cx}$	0	$\psi_0 (p_p + \Sigma^n_{i=1} F_{z,i}) \alpha_{cz}\psi_{cz}$
II_b	0	$\psi_0 (p_p + \Sigma^n_{i=1} F_{z,i}) \alpha_{cy}$	
II_c	$0,6\ \psi_0 (p_p + \Sigma^n_{i=1} F_{z,i}) \alpha_{cx}$	$0,6\ \psi_0 (p_p + \Sigma^n_{i=1} F_{z,i}) \alpha_{cy}$	
III_a	$\psi_0 (p_p + \Sigma^n_{i=1} F_{w,i}) \alpha_{cx}$	0	$\psi_0 (p_p + \eta\ \Sigma^n_{i=1} F_{w,i}) \alpha_{cz}\psi_{cz}$
III_b	0	$\psi_0 (p_p + \Sigma^n_{i=1} F_{w,i}) \alpha_{cy}$	
III_c	$0,6\ \psi_0 (p_p + \Sigma^n_{i=1} F_{w,i}) \alpha_{cx}$	$0,6\ \psi_0 (p_p + \Sigma^n_{i=1} F_{w,i}) \alpha_{cy}$	

Note 1:
p_{swl} : Uniformly distributed SWL, in kN/m² as defined in [1.4.2]
p_p : Uniformly distributed self-weight, in kN/m², as defined in [1.3.2]
$\Sigma^n_{i=1} F_{z,i}$: Distribution of unit cargoes as indicated by the Designer (see [1.4.3])
$\Sigma^n_{i=1} F_{w,i}$: Distribution of wheeled loads as indicated by the Designer (see [1.4.4])
α_{cx}, α_{cy}, α_{cz}: Factors due to ship motions in seagoing conditions, as defined in [1.6]
ψ_0 : Duty coefficient at seagoing conditions, as defined in [1.2.3]
ψ_{cz} : Dynamic factor due to lifting platform motion as defined in [1.5]
η : Coefficient taken equal to:
- 0,5 if shock absorbers are fitted
- 1,0 for landing gears of trailers or other rigid supports

(1) Loading case to be considered regardless the nature of the load transported on the lifting platform.
(2) With respect to ship reference co-ordinate defined in App 1, [1.2].

2.3 Non-operating loading case

2.3.1 Lifting platforms stowed without cargo at a weather deck level in seagoing condition

For lifting platform which is stowed at a weather deck level in seagoing condition, the loads to be applied are specified in Tab 5.

When the lifting platform may be subject to wave impact loads, the platform structure and its locking devices are to be examined taking into account the applicable wave impact loads as defined in [1.8.2].

2.3.2 Lifting platforms with cargo in seagoing condition

For lifting platform which is stowed with cargo in seagoing condition, the static and dynamic loads to be applied are specified in Tab 4, considering ψ_{cz} as 1,0 and α_{cx}, α_{cy} and α_{cz} as defined in [1.6].

Table 5 : Applicable loads for lifting platforms stowed at weather deck level in seagoing condition

Direction	Load
x	$p_p\ \alpha_{cx}$
y	$p_p\ \alpha_{cy}$
z	$p_p\ \alpha_{cz} + p_d$

Note 1:
p_p : Self-weight uniformly distributed, in kN/m², as defined in [1.3.2]
p_d : Green sea load, in kN/m², if applicable as defined in [1.8.1]
α_{cx}, α_{cy}, α_{cz}: Dynamic factors due to ship motion as defined in [1.6].

2.4 Testing loading case

2.4.1 For testing loading case, the overload testing load, as defined in Ch 5, Sec 1, [12.4], is to be applied.

2.5 Flooding loading case

2.5.1 When the lifting platform in its stowed position forms the boundary of a watertight deck, the platform structure and its locking devices are to be examined taking into account the applicable flooding loads as defined in [1.10.1].

Section 3 Structural Scantling

1 General

1.1 Application

1.1.1 This Section specifies the requirements that the scantlings of the lifting platform are to comply with, considering the loading cases defined in Sec 2, [2], as applicable.

1.1.2 Scantling approach

The scantlings of the plating and ordinary stiffeners determined according to [2] are expressed in terms of net thickness, i.e. they do not include the corrosion addition.

The scantlings of all other elements (primary supporting members, rails, locking devices...) are directly determined in terms of gross scantlings, i.e. they already include additions for corrosion.

The corrosion addition is to be taken into account according to NR467, Pt B, Ch 4, Sec 3.

1.1.3 Scantling compliance

The platform is to be built at least with the gross scantlings.

1.2 Strength criteria

1.2.1 Allowable stress

Unless otherwise specified, stresses are to be obtained by means of direct calculations. It is to be checked that stresses are in compliance with the following criteria:

$\sigma_{VM} \leq \eta R_e$

$\sigma \leq \eta R_e$

$\tau \leq 0{,}5 \eta R_e$

where:

σ_{VM} : Combined Von Mises stress, in N/mm²

$$\sigma_{VM} = \sqrt{\sigma^2 + 3\tau^2}$$

σ : Normal stress, in N/mm²

τ : Shear stress, in N/mm²

η : Safety factor as defined in Tab 1

R_e : Design yield stress, in N/mm², as defined in Ch 2, Sec 3, [2.3.3].

Table 1 : Safety factor

Loading case	η
Operating loading cases	0,67
Non-operating loading case	0,67
Testing loading case	0,90
Flooding loading case	**(1)**

(1) The allowable stress for flooding loading case is to be calculated according to the Rules applicable to the ship or unit where the lifting platform is installed.

1.3 Buckling analysis

1.3.1 The buckling check of plating, stiffeners and primary supporting members made of steel is to be performed according to the applicable requirements of NR615, considering net scantlings of members and taking into account, in addition, the requirements set out in [1.3.2] and [1.3.3].

Other verification methods in compliance with recognized standards or codes may be accepted.

1.3.2 Allowable buckling utilisation factor

The allowable buckling utilisation factor η_{all} is defined in Tab 2.

1.3.3 Slenderness requirements

The slenderness requirements defined in NR615, Sec 2 are to be applied to all structural members including plating, web and face plate, if any, of stiffeners and tripping brackets, web plating and flange of primary supporting members.

When the buckling capacity of a plate element is assessed according to NR615, Sec 5, its associated slenderness requirement may be disregarded.

Table 2 : Allowable buckling utilisation factor η_{all}

Condition	η_{all}
Harbour	0,80
Seagoing	1,00
Testing / Flooding	1,00

2 Platform structure

2.1 General

2.1.1 Arrangement

The platform is to be constructed of steel complying with Ch 2, Sec 1, [2].

Other equivalent materials are considered by the Society on a case-by-case basis.

2.1.2 Allowable deflection

The deflection of the platform structure calculated considering the net scantlings of the structural items, is not to exceed 5 mm/m.

2.2 Scantlings

2.2.1 Plating

The required net thickness of the platform deck plating is to be not less than the value obtained from:

- NR467, Pt B, Ch 7, Sec 4, [1], for plating subject to lateral pressure
- NR467, Pt B, Ch 7, Sec 4, [3], for plating supporting wheeled loads

for the loading cases described in Sec 2, [2] and acceptance criteria given in Tab 3.

2.2.2 Ordinary stiffeners

The required net section modulus and shear area of the ordinary stiffeners of the platform deck are to be not less than the value obtained from:

- NR467, Pt B, Ch 7, Sec 5, [1.1], for ordinary stiffeners subject to lateral pressure
- NR467, Pt B, Ch 7, Sec 5, [1.2], for ordinary stiffeners supporting wheeled loads

for the loading cases described in Sec 2, [2] and acceptance criteria given in Tab 3.

The maximum normal bending stress σ and shear stress τ in a stiffener using net properties with reduced end fixity, variable load or being part of grillage are to be determined by direct calculations and are to comply with the strength criteria defined NR467, Pt B, Ch 7, Sec 5, [1.7.2].

2.2.3 Primary supporting members

The primary supporting members of the platform deck are to be verified through direct calculations, for the loading cases described in Sec 2, [2] and considering the allowable stresses defined in [1.2.1].

Table 3 : Acceptance criteria

Ship/offshore unit condition	Acceptance criteria
Harbour condition	AC-1
Seagoing condition	AC-2
Testing condition	AC-3
Flooding condition	

3 Guide rails

3.1 General

3.1.1 Arrangement

Horizontal movements are to be restricted by means of guide rails or other equivalent means.

3.1.2 Materials

The guide rails are to be constructed of steel.

3.2 Strength assessment

3.2.1 Strength criteria

The allowable stresses of guide rails, when subjected to load cases defined in Sec 2, [2], are defined in [1.2.1].

3.2.2 Allowable deflection

The deflection of the guide rails is not to exceed 6 mm under operating load cases.

4 Locking devices and supports

4.1 General

4.1.1 Arrangement

Lifting platforms are to be fitted with mechanical supports and locking devices, to secure them in the stowed position or when they are not operated during navigation.

For hydraulic locking mechanisms, the locking cylinder is to be certified.

4.1.2 Strength criteria

It is to be checked that stresses in mechanical supports and locking devices are in accordance with the criteria defined in [1.2.1] for non-operating and testing conditions.

4.1.3 Structural axles and hinges

The design of structural axles and hinges is to be checked in accordance with Ch 2, Sec 3, [3.5], for the loading cases described in Sec 2, [2].

5 Weathertightness and watertightness

5.1 Weathertightness

5.1.1 General

When the lifting platform is stowed at a weather deck level, the weathertightness is to be ensured according to the applicable requirements of NR467, Pt B, Ch 11, Sec 9, [8].

5.2 Watertightness

5.2.1 General

When the lifting platform is stowed at a watertight deck level, the watertightness is to be ensured and it is to be assessed on a case by case basis.

The deformation of the deck due to hull girder loads is to be taken into account to assess the watertightness of the lifting platform.

5.2.2 Locking devices and supports

The arrangement of locking devices and supports is to be designed with redundancy so that, in the event of failure of any single locking device or support, the remaining devices are capable of withstanding the reaction forces without exceeding by more than 20% the allowable stresses defined in [1.2.1].

Section 4 Hoisting System and Machinery

1 General

1.1 General

1.1.1 Application

The requirements of this Section apply generally to the hoisting system and machinery. See Sec 1, [1.3.1] and Sec 1, [1.3.2] for definitions.

Positive drive (defined in Sec 1, [1.3.8]) hoisting systems are also to comply with the requirements given in Article [4].

Hydraulic type lifting systems are also to comply with the requirements given in Article [5].

Screw-type hoisting systems will be considered on a case-by-case basis.

1.1.2 Design of components

Components are to be designed such that inadvertent loosening of screws, nuts and other components used for adjusting alignment, tension, length, etc. is prevented.

Hoisting machinery and similar components are to be designed considering the loads defined in Sec 2, [2].

1.1.3 Lifting accessories

The design, testing and marking of the lifting accessories items are to be in accordance with Ch 2, Sec 4.

1.1.4 Efficiency of sheaves

The efficiency of sheaves is to be taken into account as per Ch 2, App 2.

2 Electrical and hydraulic systems

2.1 General

2.1.1 Electrical installations and hydraulic systems of lifting platforms are to comply with Ch 2, Sec 7, except that:

a) References made to NR467 Rules for Steel Ships are to be replaced by references to the corresponding sections of Rules applicable to the ship or unit where the lifting platform is installed.

b) Hydraulic installations for hydraulic type systems are to take into account the requirements in [5].

3 Suspension elements and sheaves

3.1 Suspension elements

3.1.1 The suspension elements are the wire ropes or chains by which the lifting platform is suspended and which are acted to raise and lower the platform. The use of other suspension elements is to be agreed with the Society.

Materials and manufacture of suspension elements are to be in accordance with the requirements of NR216.

3.1.2 The nominal rope diameter is to be not less than 8 mm.

3.1.3 Wire rope terminations are to be in accordance with Ch 2, Sec 5, [5].

3.1.4 Safety factor for suspension elements

- The safety factor for wire ropes is to comply with Ch 2, Sec 5, [2], without being taken less than 4.
- The minimum safety factor for chains is to be $3\alpha_{CZ}$, without being taken less than 4.

3.2 Sheaves

3.2.1 Constructional arrangement

The constructional arrangement of sheaves is to be in accordance with Ch 2, Sec 4, [3.1.2].

4 Positive drive hoisting systems

4.1 General

4.1.1 As a rule, the vertical dynamic factor α_{CZ} is to be taken into account in the specified Rated line Pull of the winch.

4.1.2 The stall load of the winch is to be sufficient with respect to the platform testing load.

4.1.3 Winches are to comply with the requirements of Ch 2, Sec 6.

4.2 Main hoist brakes

4.2.1 In case of failure of power supply or failure of supply to control circuits, main hoist brakes are to automatically prevent platform movement and be capable of holding the platform in place.

A means of safely moving the lifting platform to a safe deck is to be provided if main power is unavailable.

4.2.2 The brake system is to be activated when the hoist motor is deactivated.

4.2.3 A manual means of disengaging the hoist brakes whilst ensuring safety is to be provided. The main hoist brakes are to automatically reset upon this manual disengagement.

4.2.4 Main hoist brakes are to be capable of stopping the movement of the lifting platform under the dynamic load generated when the platform is travelling downward at rated speed (see Note 1) in any load case defined in Sec 2, [2], including the overload testing as defined in Ch 5, Sec 1, [12.4].

The braking process is to complete within the stopping distance specified in the design specification, as a rule not exceeding 1 metre.

Note 1: The rated speed is the speed at which the lifting platform is designed to travel.

4.2.5 Main hoist brakes are to be capable of holding the lifting platform during the overload testing, as defined in Ch 5, Sec 1, [12.4].

5 Hydraulic lifting systems

5.1 General

5.1.1 The system is to be designed so as to prevent tipping or racking of the lifting platform.

In systems with multiple hydraulic cylinders, these are to be connected in parallel to ensure the same pressure in each cylinder during lifting.

5.1.2 The hydraulic system is to be in accordance with the requirements of Ch 2, Sec 7, [3.1].

5.1.3 Design pressure

The design pressure is not to be less than the pressure occurring in the hydraulic system under the following conditions:

- operating loading conditions defined in Sec 2
- platform testing condition defined in Ch 5, Sec 1.

5.1.4 Down direction valves

Each down direction valve is to close under the action of hydraulic pressure with the assistance of a compression spring and is to open electrically.

5.1.5 Up direction valves

Where bypass valves control the stopping of upwards motion they are to close electrically and open under the action of hydraulic pressure with the assistance of a compression spring.

5.1.6 Lifting platform movement is to be automatically stopped and the platform held in place when supply pressure is inadequate.

5.1.7 A means of safely lowering the lifting platform under gravity and raising it by manual action is to be provided if main power is unavailable.

5.2 Hydraulic cylinders

5.2.1 Hydraulic cylinders are to fulfill the requirements of Ch 2, Sec 7, [3.2].

5.2.2 For directly acting systems, the cylinder or cylinders are to be flexibly connected to the lifting platform.

5.2.3 For indirectly acting systems, bending forces acting on the cylinder are to be prevented. The cylinders are to be guided unless pulling arrangement prevents bending forces on the cylinder.

5.2.4 Over-travel of the cylinder is to be prevented either by shock absorbing stops or by an interlock that shuts off the hydraulic supply.

6 Other lifting mechanisms

6.1 Design load of rack and pinion mechanisms or endless screw mechanisms

6.1.1 The design load is not to be less than the pressure occurring in the hydraulic system under the following conditions:

- operating loading conditions defined in Sec 2
- platform testing condition defined in Ch 5, Sec 1.

Section 5 Control and Safety Devices

1 General

1.1 General

1.1.1 Control and safety devices are to comply with the requirements of Ch 2, Sec 8.

1.2 Locking and re-levelling

1.2.1 Unintended movement of the lifting platform when at decks serviced is to be prevented by locking devices that keep the lifting platform fixed in position relative to the adjacent deck.

1.2.2 Upon engagement of the locking devices, the supply of power used for their disengagement is to be interrupted.

1.2.3 Re-levelling (see Note 1) is to be conducted in order to avoid any change in the level or position of the lifting platform when disengaging the locking device mechanisms, regardless of any load change that may have occurred on the platform when locking devices were engaged.

Note 1: Re-levelling is the process of aligning the lifting platform with the adjacent deck when the platform is already stopped.

1.3 Protection against overtravel and failure to stop

1.3.1 If the normal control system fails to prevent upwards or downwards overtravel, a device is to automatically deactivate power to the lifting platform hoisting machinery and control system and the platform is to be held in place.

1.3.2 If the normal control system fails to sufficiently slow the lifting platform when approaching the uppermost or lowermost level or a closed hatch above, a device is to automatically deactivate power to the lifting platform hoisting machinery and control system and the platform is to be held in place.

Section 6 Lifting Platforms Accompanied by Personnel

1 General

1.1 Application

1.1.1 This Section provides additional requirements for the certification of lifting platforms that are operated with personnel on them.

1.1.2 This Section does not apply to lifting platforms exclusively intended to lift personnel.

2 Safety principles

2.1 Communication

2.1.1 An effective fix means of communication is to be provided between the lifting platform operator and the personnel to be lifted, unless the operator can remain in continuous direct communication with the personnel on the platform.

2.2 Handrails

2.2.1 In addition to the provisions of Sec 1, [2.4], handrails complying with Sec 1, [2.4.1] are to be provided at the boundaries the platform.

2.3 Environmental conditions

2.3.1 Unless otherwise stated in the operating manual, for lifting platforms intended to be operated in seagoing conditions, the lifting operations with personnel on the platform are to be normally restricted to sea conditions where the significant wave height does not exceed 2,0 m.

3 Design loads

3.1 Safety factors

3.1.1 Platform structural components

Platform structural components are to be designed considering a design load equal to γ x SWL, in loading cases defined in Sec 2, [2], where the load factor γ is given in Tab 1.

3.1.2 Mechanical elements of the hoisting system

Mechanical elements which are part of the hoisting system, or which are directly connected to any component of the hoisting system and suspension elements, are to be designed considering a design load equal to twice the SWL, in loading cases defined in Sec 2, [2].

This includes, for example, fixation points and pad eyes, elements along the reeving path such as sheaves, their axles and supports, fixation of winches and cylinders.

3.1.3 Any exception is to be agreed with the Society.

Table 1 : Platform structural components - Load factor γ

Structural component		Load factor γ
Plating and ordinary stiffeners		1,0
Primary supporting members	$SWL \leq 10$	2,0
	$10 < SWL \leq 67$	$10^4/(29SWL + 4708)$
	$SWL > 67$	1,5
Note 1: SWL in t		

3.2 Duty category

3.2.1 For lifting operations with personnel on the platform, the duty category as defined in Sec 2, [1.2] is to be ranked to next following category.

4 Structural assessment

4.1 Strength criteria

4.1.1 The assessment of structural elements is to be performed according to Sec 3, taking into account additional requirements set down in [3.1] and [3.2].

5 Equipment and machinery

5.1 Hoisting arrangement

5.1.1 Two independent hoisting cylinders are to be fitted, and each cylinder is to be independently capable of holding the SWL.

Alternatively, a single hydraulic cylinder may be used, provided that no single point hydraulic failure will cause the lifting platform to be out of control under the SWL.

5.1.2 Wire ropes and chains

The safety factor for wire ropes and chains is to be taken as twice the safety factor as defined in Sec 4, [3.1.4].

When there is a redundancy of suspension elements (duplicated wire ropes or chains at each attachment point to the platform), the above safety factor can be multiplied by 0,75 for each suspension element.

5.2 Winch brakes

5.2.1 Winch is to be equipped with a mechanically and operationally independent secondary/redundant brake, with separate control system, compliant with the requirements of Ch 3, Sec 3, [4.3].

Each brake is to be tested independently dynamically and statically.

5.3 Lifting accessories

5.3.1 Lifting accessories are to be designed, tested and marked considering a design load equal to twice the SWL.

6 Control and safety systems

6.1 General

6.1.1 There is to be only one active control location of the lifting platform.

6.1.2 Both normal and secondary/redundant brakes are to be automatically activated when controls are in neutral position, or in case of the emergency stop is activated, or in case of any failure in the control or power system.

6.1.3 A procedure including instructions for the safety of personnel on the platform is to be provided. This procedure is to be available in the control location.

7 Testing

7.1 Free fall preventer

7.1.1 When a free fall preventer system is installed, its correct functioning is to be demonstrated during testing.

Appendix 1 Ship Accelerations

1 General

1.1 Application

1.1.1 The requirements of this Appendix apply to the calculation of the accelerations induced by the ship motions.

For offshore units, the calculation methodology for operations at site is to be agreed with the Society.

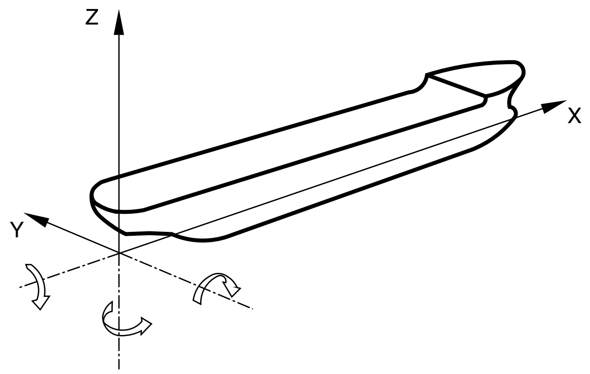
1.2 Definitions

1.2.1 The ship's geometry, motions and accelerations are defined with respect to the following right-hand co-ordinate system (see Fig 1):

- Origin: at the intersection among the longitudinal plane of symmetry of ship, the aft end (AE) of the ship rule length and the baseline
- X axis: longitudinal axis, positive forwards
- Y axis: transverse axis, positive towards portside
- Z axis: vertical axis, positive upwards.

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

Figure 1 : Reference co-ordinate system



2 Accelerations

2.1 General principle

2.1.1 The accelerations for the calculation of dynamic loads due to ship motions are to be determined for full load and ballast loading conditions in:

- normal environmental conditions (operating conditions)
- extreme environmental conditions.

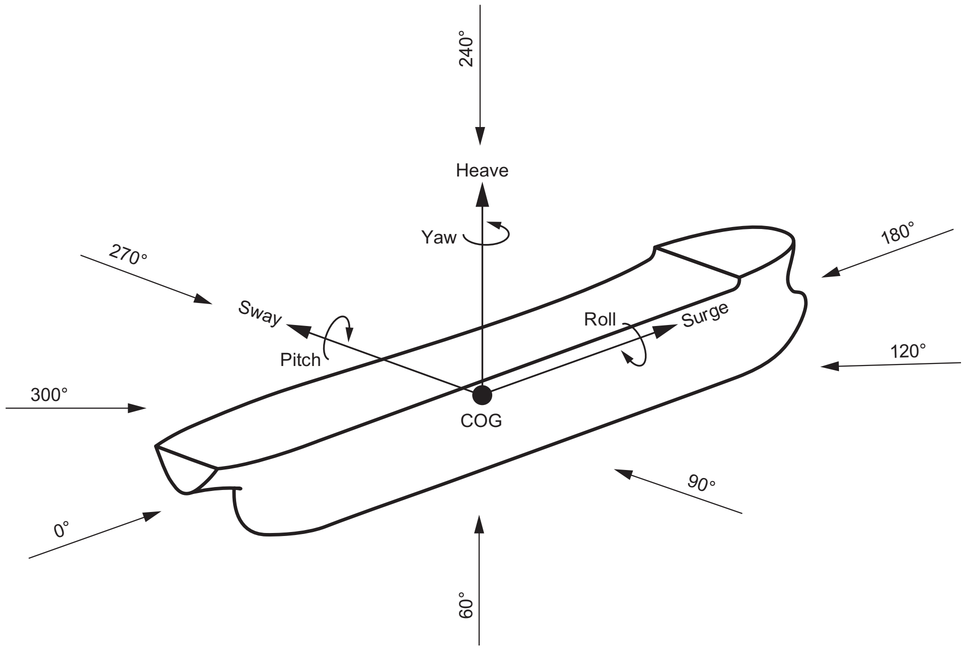
2.1.2 The wave angles of incidence, as shown in Fig 2, are to be selected from the following wave incidences:

- Head sea and following sea: angle of incidence equal to 0° or 180°
- Beam sea: angle of incidence equal to 90° or 270°
- Forward oblique sea conditions: angle of incidence equal to 120° or 240°
- Following oblique sea conditions: angle of incidence equal to 60° or 300°.

2.1.3 As a rule, a minimum of three wave angle incidence cases are to be selected as follow:

- 1st case: maximum value of the longitudinal acceleration, selected from the incidences listed in [2.1.2], with the transversal and vertical accelerations of the case considered
- 2nd case: maximum value of the vertical acceleration, selected from the incidences listed in [2.1.2], with the transversal and longitudinal accelerations of the case considered
- 3rd case: maximum value of the transversal acceleration, selected from the incidences listed in [2.1.2], with the vertical and longitudinal accelerations of the case considered.

Figure 2 : Wave angle incidences



2.2 Accelerations in normal environmental conditions

2.2.1 In normal environmental conditions limited by a maximum significant wave height, H_s, defined by the Designer in accordance with the operating manual, the accelerations considered at any position of the lifting platform are to be submitted and documented by the Designer.

When the values of the accelerations are not available from the Designer, the calculation approach defined in [2.3.1] can be considered as a guideline for seagoing monohull displacement ships of conventional shape, speed and proportions.

In this case, the wave parameter coefficients defined in Tab 2 in relation to the H_s considered are to be taken into account to determine the ship accelerations.

2.3 Accelerations in extreme environmental conditions

2.3.1 The accelerations in extreme environmental conditions used at any position of the lifting appliance are defined in NR467, Pt B, Ch 5, Sec 3 [3.2].

These accelerations are based on the:

- ship motions as defined in NR467, Pt B, Ch 5, Sec 3 [2.1]: using the wave parameter calculated with the coefficients defined in Tab 1, the metacentric height and roll radius giration of the ship for the considered loading condition

Note 1: The metacentric height GM and roll radius of giration k_r are to be deduced from the actual loading conditions considered. When GM and K_r are unknown, these values may be taken as defined in NR467.

- accelerations of the ship at the centre of gravity as defined in NR467, Pt B, Ch 5, Sec 3 [2.2]
- position of the centre of the gravity of the considered components of the lifting platform system
- load combination factors to be applied to the accelerations as defined in NR467, Pt B, Ch 5, Sec 2 [2] based on the Equivalent Design Wave (EDW) concept.

Note 2: The EDW concept applies a consistent set of dynamic loads to the ship such that a specified dominant load response is equivalent to the required long term response value.

Table 1 : Wave parameter coefficients

A_0	A_1	e_1	A_2	e_2	L_c
0,90	1,30	1,80	0,90	1,80	552

Table 2 : Wave parameter coefficients when sea state conditions are limited by H_s

H_s **(1)**	A_0	A_1	e_1	A_2	e_2	L_c
≤ 1,0 m	0,07	1,66	2,29	0,16	1,29	107
≤ 1,5 m	0,11	1,65	2,28	0,16	1,37	116
≤ 2,0 m	0,16	1,65	2,28	0,17	1,44	127,3
≤ 2,5 m	0,21	1,64	2,26	0,17	1,50	140,6

H_s **(1)**	A_0	A_1	e_1	A_2	e_2	L_c
≤ 3,0 m	0,25	1,63	2,25	0,18	1,55	155,4
≤ 3,5 m	0,30	1,61	2,23	0,20	1,59	171,6
≤ 4,0 m	0,35	1,60	2,21	0,21	1,62	188,8
≤ 4,5 m	0,39	1,59	2,19	0,24	1,64	206,8
≤ 5,0 m	0,43	1,57	2,16	0,26	1,67	225,3
≤ 5,5 m	0,47	1,55	2,13	0,29	1,69	241,1
≤ 6,0 m	0,51	1,54	2,10	0,32	1,70	263,1
≤ 6,5 m	0,55	1,52	2,07	0,35	1,72	281,9
≤ 7,0 m	0,58	1,50	2,04	0,39	1,73	300,6
≤ 7,5 m	0,61	1,48	2,01	0,43	1,74	318,8
≤ 8,0 m	0,64	1,47	1,98	0,47	1,75	336,6
≤ 8,5 m	0,67	1,45	1,95	0,51	1,75	353,7
≤ 9,0 m	0,69	1,44	1,93	0,55	1,76	370,2
≤ 9,5 m	0,71	1,42	1,91	0,60	1,76	385,9
≤ 10,0 m	0,73	1,41	1,89	0,64	1,77	400,7

(1) H_s : Maximum significant wave height, in m, associated to the operating condition as defined by the Designer.

CHAPTER 5
CONSTRUCTION, TESTING AND SURVEYS

Section 1 Construction, Survey, Testing and Marking

1 General provisions

1.1 Application

1.1.1 This Section deals with:

- inspection at works of materials and welding
- construction survey at the shipyard or at the premise of the manufacturer of the lifting appliances, their accessories and their foundations
- final inspection and tests at works prior to fitting onboard
- testing and inspection of loose gear prior to fitting onboard
- survey of fitting onboard
- survey of overall tests onboard and inspection after testing prior to putting into service
- marking of equipment and accessories after inspection and tests mentioned here above.

1.1.2 The certification process for materials and components intended to be part of the lifting appliances is to be in compliance with App 2.

1.1.3 It is the responsibility of the Manufacturer or the Yard to inform the local representatives of the Society in due time to enable them to perform the interventions as per [1.1.1]. In particular, the yard is to ascertain that the Society's certificates are specified in the orders for materials placed with suppliers.

1.1.4 Materials, workmanship, structures and welded connections are to be subjected before, during and after construction, to inspections by the Manufacturer or Shipyard in order to ensure compliance with the applicable requirements, approved plans and applicable standards. Irrespective of the interventions of Surveyors, the Manufacturer of Shipyard is entirely and solely responsible for compliance of the lifting appliances with the stipulated requirements.

1.1.5 Construction survey, final inspection, testing and marking may be carried out simultaneously.

2 Fabrication by welding

2.1 General

2.1.1 Welding of load carrying structures, fittings and items of loose gear of lifting appliances is to comply with the requirements of NR467, Pt B, Ch 13, Sec 1, NR467, Pt B, Ch 13, Sec 2, NR467, Pt B, Ch 13, Sec 3 and NR467, Pt B, Ch 13, Sec 4, unless otherwise stipulated in this Section.

2.1.2 The manufacturer is responsible for ensuring that the operating conditions, welding procedures and work schedule are in accordance with the applicable requirements, approved plans and recognized good welding practice.

2.1.3 The elements for which the materials are required to be inspected by the Society (see Ch 2, Sec 1, [2.1.2] and Ch 2, Sec 1, [2.1.4]) are to be welded according to agreed welding procedures and by welders qualified by the Society in compliance with NR476 Approval testing of Welders.

The welding consumable used are to comply with the requirements of NR216, Chapter 11.

2.1.4 As a rule, only basic coated electrodes are to be used for manual welding.

2.1.5 All welds of load carrying structural elements are to be continuous and without end crater. They are to pass round the edge of the plates without interruption.

2.1.6 Connections by means of plug-welds or slot-welds are to be avoided; they may be accepted on exceptional cases only.

As a rule, overlapping welds (lap-joints) are forbidden. They may be accepted in special cases only.

2.1.7 The included bevel angle of butt welds and of half penetration or full penetration fillet welds is to be sufficient to allow sound welding at weld root. This angle is not to be lower than 40°.

Moreover, a sufficient edge preparation root gap is to be provided to ensure adequate penetration at weld root.

2.1.8 Repair by welding of broken, cracked, worn or corroded elements cannot be contemplated without the consent of the Surveyor of the Society who may require the approval of the Society. In any cases, such repairs are to be made under the Surveyor's supervision.

2.1.9 In general, type, dimensions and possibly edge preparations for welds are to be mentioned on the construction drawings submitted for approval.

2.2 Butt welds

2.2.1 Butt welds are to include the whole thickness of the thinnest plate. Half-penetration welds are not accepted.

2.2.2 Butt welds are to be in accordance with NR467 Pt B, Ch 13, Sec 3.

2.3 Fillet welds and angle welds

2.3.1 All the fillet welds of load carrying structures, fittings and items of loose gear of lifting appliances are to be continuous. They may be with partial penetration or full penetration.

2.3.2 The dimension a of the throat thickness of the weld fillet is measured as shown on Fig 1 (a) and Fig 1 (b) for the fillet welds without bevels and half-penetrated welds with bevels.

2.3.3 Full penetration welds normally of the K or V-type may be required for heavily stressed elements, specially if the thickness of the abutting plate is above 15 mm (see Fig 2) or when access to one side of the plate is either difficult or impossible (see Fig 3 and Fig 4).

Figure 1 : Definition of the throat thickness

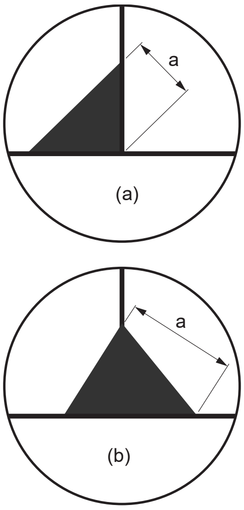


Figure 2 : k-type weld

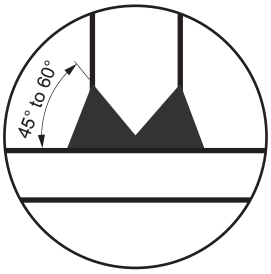


Figure 3 : V-type weld

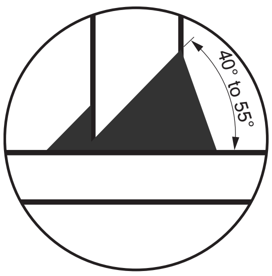
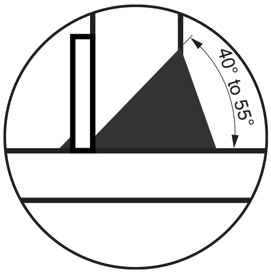


Figure 4 : V-type weld with backing flat bar



2.3.4 Half-penetration welds may sometimes be accepted instead of full penetration welds. In such a case, the throat thickness a of the weld, measured as shown on Fig 1 (b), is not to be less than 0,5 times the thickness of the abutting plate.

2.3.5 In general, the throat thicknesses of the double fillet welds is to be neither lower than 3,5 mm nor higher than 0,7 times the thickness of the thinnest plate of the assembly. Normally, it is unnecessary to provide for throat thicknesses greater than 0,5 times the thickness of the plate included between the two fillet welds except for special cases either when the throat thickness is reinforced against corrosion or when the two weld fillets are unsymmetrical.

When slot-welds or overlap welds are authorized, as a rule, the throat thickness is to be equal to 0,7 times the thickness of the edge welded plate.

2.3.6 Considering the requirements of [2.3.5] the throat thickness a of the double symmetrical fillet welds is to be, as a rule, equal to the following value which varies with the thickness e of the thinnest plate of the assembly considered:

- a = 0,45 t for welds of heavily stressed elements when full penetration weld is not required (for example, for elements under tension the strength continuity of which is to be ensured or for elements heavily stressed in shear such as webs of girders of small depth or attachments of fittings)
- a = 0,40 t for welds of brackets or of faceplates of girders with single web (I beams)
- a = 0,35 t for welds of webs of box-girders or for welds of stiffeners.

The Society retains the right to modify these requirements according to the nature or level of the stresses in the element concerned.

2.3.7 When the two fillet welds are asymmetrical, in general, the throat thicknesses a_1 and a_2 may be dimensioned so that $a_1 + a_2 = 2a$ (where a is as per [2.3.6]) provided that a_1 and a_2 comply with the requirements of [2.3.5].

2.4 Post-weld Heat treatment

2.4.1 As a rule, compact parts such as goosenecks or trunnions, when they are of welded construction, are to be stress relieved after welding.

2.4.2 In some cases, the Society may require stress-relieving of important joints of welded structures.

3 Inspection and checks

3.1 Materials

3.1.1 The materials used to manufacture the elements considered as part of the ship structure i.e. the elements as per Ch 1, Sec 1, [1.1.3] which are within the scope of the ship classification are to be tested and certified by the Society in compliance with the provisions of NR216.

3.1.2 The materials used to manufacture:

- load carrying structural elements of the lifting appliances
- fittings and items of loose gear not submitted to individual tests as per Ch 2, Sec 4, [3.5] (exclusive of built-in block sheaves)
- crane slewing rings
- locking devices required for stability of the lifting appliances
- cylinders of load carrying hydraulic cylinders
- pressure pipes of class I
- winch shafts
- elements the functions of which are essential or similar to those of the above mentioned elements

are to be:

- tested and certified by the Society in compliance with the requirements of NR216 when the additional class notations **ALP** or **ALM** are to be assigned to the ship or offshore unit, and for items of loose gear of SWL above 100t
- tested by the manufacturer with a work's certificate provided to the Surveyor showing chemical and mechanical properties and the results of the tests performed for certification/inscription on the Register of Lifting Appliances and Cargo Handling Gear.

3.1.3 For the elements as per Ch 2, Sec 1, [2.1.4], the Society may require inspection of the materials by its Surveyors.

3.1.4 In any case, the Supplier is to specify the steel quality grade used to manufacture loose gear, in accordance with the provisions of Ch 2, Sec 4, [1.2.1].

3.1.5 In case of doubt concerning identification of the material, check tests may be required at the Surveyor's discretion.

3.1.6 Notwithstanding the previous provisions, the Society reserves the right to require particular inspections or tests of the materials used for the manufacture of lifting appliances and their accessories.

3.2 Dimensional checking and visual inspection

3.2.1 After completion of the welding operations and inspection by the Manufacturer, the structure is to be presented to the Surveyor for a general visual examination, at a suitable stage of fabrication.

3.2.2 The dimensional checks and verification of compliance with approved drawings are the responsibility of the Manufacturer. Some checks are to be made in the presence of the Surveyor, as deemed necessary, solely for those parts subject to approval

3.3 Non-destructive examinations

3.3.1 The extent and the nature of the non-destructive examinations are to be agreed with the Society taking into account [3.3.3] to [3.3.7]. For this purpose, the locations to be examined and the nature of the examinations are to be mentioned on drawings or documents submitted to the Society.

During drawing review, non-destructive examination of particular locations may be required by the Society without relieving the Manufacturer of the requirement to carry out the normal examinations on other structural parts.

3.3.2 All welds over their full length are to be subject to visual examination by personnel designated by the Manufacturer.

3.3.3 The methods and acceptance criteria for radiographic and ultrasonic testing are to comply with the requirements of NR467 Rules for the Classification of Steel ships.

3.3.4 For butt welding of transverse sections of isostatic (non-redundant connections) structures or parts, mainly stressed under tension, bending or torsion, the following extent of the whole welded length are at least to be submitted to non-destructive examinations at random locations:

- 10% by radiographic testing
- 40% by ultrasonic testing
- 20% by magnetic particle or liquid penetrant testing.

For cranes with SWL higher than 25 t, radiographic testing may be replaced by ultrasonic testing after agreement with the Surveyor; however, in the latter case, the ultrasonic testing are to cover of each transverse joint.

When longitudinal welds end on (or cross with) a transverse weld, the corresponding joints are to be included among those to be examined.

3.3.5 When cross welded joints are accepted instead of butt welds as per [2.2.1], i.e. when one of the plates is tensile stressed in the through thickness direction, as well as in the case of restrained joints, internal examinations by non-destructive methods are to be carried out on of the weld and of the heat affected zone in order to reduce the risk of lamellar tearing. Moreover, systematic crack detection is to be carried out by liquid penetrant testing and/or by magnetic particle testing.

Note 1: Important: plates which are stressed in the through thickness direction are to be submitted to ultrasonic testing prior to welding all along the contemplated welding line in order to ascertain that no lamination defect exists (see also Ch 2, Sec 1, [2.2.7]).

3.3.6 Welds of large cross section, especially those executed on steel castings, steel forgings, heavily stressed welded joints, connecting welds for fittings as well as the welds carried out in critical conditions (for example, overhead welds) are to be submitted to suitable examinations after agreement with the Surveyor.

3.3.7 In some special cases, the Surveyor or the Society may require non destructive testing after completion of the load tests as per [10].

3.4 Repair of defects and final decision

3.4.1 The Surveyor is to be informed of every defect detected upon examinations.

Unacceptable defects are to be eliminated and, if their number is too important, the weld is to be entirely re-executed, taking the usual precautions.

After repair, new examinations are to be carried out.

3.4.2 Important repairs are to be carried out in agreement with the Surveyor.

3.4.3 The repairs decided by the Manufacturer are to be communicated to the Surveyor. Results of the original examination and of the examination after repair are to be submitted to him.

3.4.4 When numerous or repeated defects are detected, the examinations are to be extended to the Surveyor's satisfaction.

3.4.5 The final decision as to extent of defects to be eliminated, repairs to be made and final acceptance of the repaired welds is subject to the agreement of the Surveyor.

4 Construction survey

4.1 Construction survey of the fixed parts of the lifting appliances

4.1.1 The construction of fixed parts of the lifting appliances as per Ch 1, Sec 1, [1.1.3] (crane pedestals, winch foundations, etc.) and the elements which connect them with the ship/offshore unit structure is subject to surveys by the Society within the scope of ship/offshore unit classification.

4.1.2 The yard is to provide the Surveyor with adequate identification and inspection and testing documentation of material, in accordance with the provisions of Articles [2] and [3].

4.2 Construction survey of the lifting appliances and of their accessories

4.2.1 When the supporting ship/offshore unit is to be assigned the notation **ALM** or **ALP**, the construction survey of the lifting appliances and their accessories is required for the following elements:

- main load carrying structures of lifting appliances
- fittings and accessories not submitted to separate tests
- loose gear with SWL greater than or equal to 100 t
- lifting beams, lifting frames and equivalent lifting aids
- hydraulic cylinders of the luffing and slewing devices of the crane jibs
- locking devices required for stability of the lifting appliances
- winches (prototypes)
- other elements, the functions of which are essential or similar to those of the elements listed above.

4.2.2 When required, the construction survey is carried out at the manufacturer's works according to the procedure as per [4.1].

4.2.3 In some cases, for example if mass production elements are concerned, the construction survey required in [4.2.1] may be replaced by a final inspection as per the requirements of Article [6].

5 Inspection and testing of ropes

5.1 Steel wire ropes

5.1.1 Steel wire ropes used in running rigging or standing rigging are to be in accordance with NR216, Ch 10, Sec 5.

5.1.2 Precautions are to be taken upon paying out the wire ropes from reels or coils in order to avoid the making of kinks which would result in refusing the rope.

The unwound wire rope is neither to ripple nor twist when it is not in tension.

5.2 Fibre ropes

5.2.1 All synthetic fibre ropes are to be inspected at the manufacturer's works.

5.2.2 An inspection is to be carried out for each continuous length submitted to the Surveyor, according to NR216, Ch 10, Sec 6.

6 Final inspection and testing prior to fitting onboard

6.1 Final inspection prior to fitting onboard

6.1.1 Prior to fitting onboard, a final inspection is to be carried out at the Manufacturer's works, for the following elements:

- elements listed in [4.2.1] with all their fittings and main equipment (for example equipped cranes)
- all loose gear and other movable accessories
- wire ropes and fibre ropes
- all winches with their motors and reduction gear
- electrical motors and equipment
- pumps, hydraulic motors and equipment
- other elements of primary importance or similar to those listed above.

6.1.2 The Manufacturer is to provide the Surveyor with the certificates or attestations relating to materials in accordance with the provisions of [3.1].

6.1.3 The manufacturer has to demonstrate to the Surveyor that efficient arrangements are provided to prevent the swivels or the suspending devices of the accessories from being accidentally unscrewed and that the various pins are locked in translation.

If deemed necessary, the Surveyor may ask to improve the corresponding arrangements.

6.1.4 When tests are required (see [7.2]) the Surveyor witness testing and check that the concerned elements have not undergone visible damage or permanent deformation.

6.1.5 When the results of the inspections as per [7.1] and of the tests as per [7.2] are satisfactory, the concerned elements may be marked as per Article [13] and an inspection certificate may be delivered by the Surveyor.

6.2 Tests prior to fitting onboard

6.2.1 The requirements from [6.3] to [6.6] provide the test procedures to be followed for the elements to be tested within the scope of the final inspection prior to fitting onboard.

6.3 Loose gear

6.3.1 Every item of loose gear defined in Ch 1, Sec 1, [6.2.5] is to be submitted to an overload test prior to fitting onboard under the conditions as per Article [7].

6.3.2 When they are integral part of the lifting appliance or when the items are designed for very heavy loads (as a rule for SWL ≥ 160 t) and when it is practically impossible to carry out an individual test, exceptional waiving of individual tests before fitting onboard may be accepted by the Society but additional checks or non-destructive tests may be required.

In such a case, these items are to be tested on the lifting appliance when overall proof testing is carried out as per [11.3.1].

6.3.3 The SWL allowed to each item under these conditions is not to be higher than the static load applied upon overall proof testing less the test overload.

6.3.4 The items fixed or incorporated permanently in the structure of the lifting appliance (such as built-in sheaves, trunnions, goosenecks and derrick heel cargo lead block bearings, jib heel pins) are not regarded as part of loose gear.

6.4 Locking devices

6.4.1 In some cases, the Society may require testing of the main parts of the locking devices designed to ensure stability of the lifting appliance; as a rule, the proof load is to be in conformity with that required for loose gear and/or a part is to be submitted to a destructive test under loading conditions as near as possible to the working load conditions.

6.5 Cylinders and hydraulic equipment

6.5.1 The hydraulic cylinders, the functions of which are the lifting, luffing or slewing of the crane jibs are to be submitted to an hydraulic test under a pressure at least equal to 1,5 times the design pressure.

6.5.2 The pumps are to be submitted to a hydraulic test under the conditions as per NR467, Pt C, Ch 1 Sec 10, i.e. at a test pressure P_H , in MPa, equal to the following value:

$P_H = 1,5\ P$ when $P \le 4$

$P_H = 1,4\ P + 0,4$ when $4 < P \le 25$

$P_H = P + 10,4$ when $P > 25$

where P is the design pressure, in MPa.

6.5.3 Pipings, welded joints and accessories (shut-off valves, block-valves, etc.) are to be submitted to a hydraulic test at a pressure equal to 1,5 times the design pressure. This test may however be carried out after fitting onboard.

6.6 Other equipment

6.6.1 The electrical equipment are to be submitted to inspections and tests as per Ch 2, Sec 7.

6.6.2 Winches and their equipment are to be submitted to inspections and tests as per Ch 2, Sec 6, [6].

7 Testing and inspection of loose gear prior to fitting onboard

7.1 General

7.1.1 The loose gear concerned in this Article is defined in Ch 1, Sec 1, [6.2.5]. It includes the following items:

- blocks
- hooks
- shackles
- swivels
- chains
- rings
- rigging screws
- slings
- lifting beams
- hand-operated tackles used with pitched chains, rings, hooks, shackles and swivels permanently attached to
- other loose gear fulfilling similar functions to those listed above.

7.1.2 Each item of loose gear defined in [7.1.1] is to be granted an individual SWL and is to be submitted to an overload test, prior to being fitted onboard.

These tests are normally to be performed before painting, in the presence of a Society's Surveyor.

7.1.3 Test may be carried out by applying certified weights; their values are to be justified to the Surveyor's satisfaction.

Tensile testing machines of a type approved by the Society and calibrated every year may also be used.

The guaranteed accuracy of these machines is to be ± 2%.

A difference of ± 2% is acceptable in the value required for the proof load.

7.1.4 When a weight is applied for testing, its value, in t, (proof load = PL) is defined in [7.2].

7.1.5 When a force is applied for testing, the value, in kN, of the test force TF is deduced from the provisions of [7.2] in considering TF = 10 PL.

7.1.6 Several items of loose gear attached together may be tested simultaneously provided that the arrangements ensure that during testing each of them is actually submitted to a load (or a force) equal to the proof load (or test force) required according to its SWL.

Attention is drawn to the fact that sometimes this condition is not complied with for the shackle connecting the rope with the becket of a block: in such cases, this shackle must be tested separately.

7.2 Proof loads

7.2.1 When a load is applied for testing, the proof load, in t, for each item of loose gear is defined in Tab 1 according to its own SWL.

7.2.2 Loose gears intended for offshore lifting should be tested considering the vertical dynamic amplification factor as defined in [11.3.1].

7.3 Blocks

7.3.1 For definition of SWL of blocks, reference is to be made to Ch 2, Sec 4. The special definition of SWL for single sheave blocks with and without becket is to be noted. The proof loads for every block are the loads to be applied to their head fitting during testing.

7.3.2 In general, it is unnecessary to give a separate SWL to the head fitting of the block since this element is an integral part of the block.

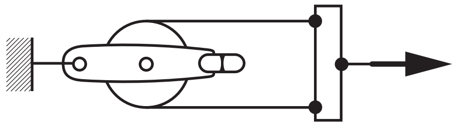
7.3.3 When there is a becket, a separate SWL is to be granted to it, as stated in Ch 2, Sec 4.

7.3.4 In general, blocks with beckets are to be tested in two phases, as shown on Fig 5 and Fig 6.

7.3.5 The shackles of the blocks and those used to fasten the ropes on the becket are to be considered as special items of loose gear (see [7.1.6]).

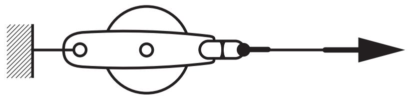
Note 1: When the recommendation of Ch 2, Sec 4, [2.2.3] is complied with (i.e. when SWL of the block is determined considering that all parts of rope are parallel) it can be accepted that the block and the becket are tested in one single operation under the proof load as per Tab 1 (a) for single sheave blocks or Tab 1 (b) for multiple sheave blocks.

Figure 5 : Testing of blocks head fitting and block pin



Proof load as per Tab 1 (a) or (b), as the case may be

Figure 6 : Testing of becket



Proof load as per Tab 1 (e)

7.4 Chains

7.4.1 The whole length of the chains with short and long links is to be submitted to a proof load in accordance with the requirements of Tab 1.

7.4.2 Moreover, it is to be checked on a sample including at least three links that the chain can withstand a load equal to 4 times its SWL without being broken. As a rule, continuance of the test until breaking is not required, but the tested sample are to be discarded.

Table 1 : Proof loads of loose gear

Elements / SWL, in t		Proof load / PL, in t	
a) Single sheave blocks **(1) (2)**		4 SWL	
b) Multiple sheave blocks **(2)**	SWL ≤ 25	2 SWL	
	25 < SWL < 160	0,933 SWL + 27	as per ILO 152
		0,993 SWL + 27	as per MSC.1/Circ.1663
	SWL ≥ 160	1,1 SWL	
c) Hand operated tackles used with pitched chains and rings, hooks, shackles and swivels permanently attached to		1,5 SWL	
d) Lifting beams, lifting frames, spreaders and similar lifting aids	SWL ≤ 10	2 SWL	
	10 < SWL < 160	1,04 SWL + 9,6	
	SWL ≥ 160	1,1 SWL	
e) Other items of loose gear: hooks, shackles, swivels, chains, rings, rigging screws, slings, etc.	SWL ≤ 25	2 SWL	
	SWL > 25	1,22 SWL + 20	

(1) SWL of single sheave block, with or without becket, is equal to half the maximum load that the block is allowed to carry by means of its head fitting (see Ch 2, Sec 4, [2.2]).

(2) Sheave blocks that are permanently attached to, or are integral with the hook, are called hook blocks. Hook blocks are to be tested with the load for multiple sheave blocks. The hook of the hook block is to be tested with the loads for hooks.

Note 1: Loose gears intended for offshore use are to be tested as per [7.2.2].

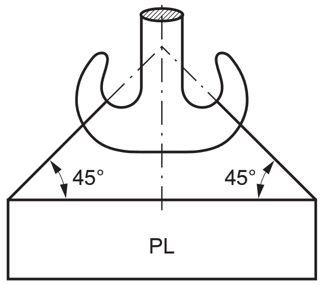
7.5 Ramshorn hooks

7.5.1 Ramshorn hooks may be tested in one operation if the proof load (PL) as per Tab 1 is suspended as shown on Fig 7.

If this arrangement is not adopted, the test are to be carried out in two phases (see Fig 8):

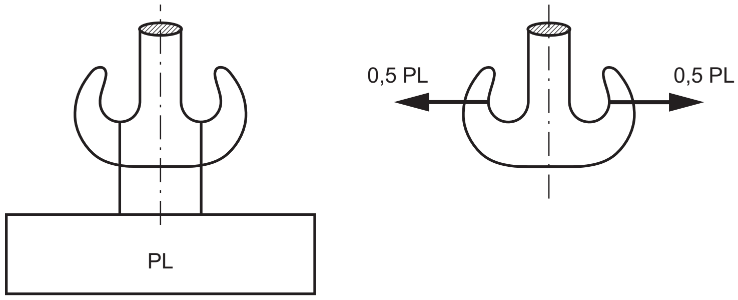
- on the one hand in applying the proof load PL vertically, and
- on the other hand, in applying horizontally a force corresponding to half the proof load.

Figure 7 : Ramshorn hooks - one operation testing



Single phase testing

Figure 8 : Ramshorn hooks - two phases testing



Testing in first phase

Testing in second phase

7.6 Thorough examination after testing

7.6.1 After testing, every item of loose gear is to be thoroughly examined by a Society's Surveyor.

7.6.2 Thorough examination aims at checking that the item has not been damaged or permanently deformed by testing and that there is no apparent defect likely to impair its reliability in service.

7.6.3 Thorough examination consists of a visual inspection completed by other means, if need be, such as dismantling or various non-destructive tests which may be required by the Surveyor.

7.6.4 The pins and sheaves of blocks must be dismantled for inspection. However, in the case of a batch of identical blocks, only dismantling of one or several of these blocks taken at random from the batch may be required by the Surveyor.

7.6.5 The items which include mobile parts are to operate freely. Especially, it is to be ascertained that the sheaves of the blocks as well as the swivels rotate freely around their axle.

7.6.6 When damages such as cracks are detected after testing of an item of loose gear, as a rule, this item are to be discarded. Moreover, if this item is a part of a batch of identical elements the other elements of this batch are to be examined very carefully to the Surveyor’s satisfaction either by dye penetrant test or by magnetic particle test if cracks end at the surface or near to the surface or by ultrasonic or radiographic tests if the damages result from internal defects.

Repairs may be contemplated only in agreement with the Surveyor who may possibly refer to the Society in this respect. Any element the strength of which may have been affected by repair are to be re-tested.

7.6.7 When the result of the examination is satisfactory, the Surveyor has the item marked for identification in accordance with the provisions of Article [13].

A certificate will be issued subsequently as per Ch 1, Sec 1, [2].

8 Additional inspection and testing for lifting appliances used in offshore conditions

8.1 Motion compensation systems

8.1.1 When fitted on the lifting appliance, motion compensation systems are to be tested at works in accordance with an agreed program.

8.1.2 A test of the motion compensation with a moving support and under safe working load is to be performed. The test is to last 30 min.

This test is to be conducted up to the maximum motion amplitude of the system.

Note 1: As an alternative, the moving support may be replaced by a software simulation.

8.2 Additional safety features

8.2.1 When additional safety features according to Ch 3, Sec 1, [5] are fitted, the following inspections and testing are to be carried out:

- specific indicators and alarms
- limiting devices
- overload protection systems
- emergency operation system
- both normal and independent/redundant brakes of winch.

9 Testing and inspection of personnel lifting appliances

9.1 General

9.1.1 Overall testing with proof load, as defined in Ch 3, Sec 3, [4], is to be performed before putting the lifting appliance into service.

The simulation of power failure is to be carried out during this test.

9.1.2 All specific features of personnel lifting appliances are to be tested, including:

- switch to personnel lifting mode
- emergency lowering system
- both normal and independent/redundant brakes of winch.

10 Survey of fittings onboard

10.1 General

10.1.1 Fittings onboard of cranes, gantry-cranes, winches and associated accessories are to be surveyed by the Surveyors of the Society.

Survey of the fitting aboard of the fixed parts of the lifting appliances (see [4.1]) is carried out within the scope of ship/offshore unit classification.

10.1.2 It is the responsibility of the yard to inform the local office of the Society of the beginning of installation works onboard and to acquaint it with the scheduled programme in this respect.

10.1.3 Intervention of the Society is limited to survey of satisfactory carrying out of the connections of the lifting appliances with the ship structure, to checking of correct rigging of the accessories and of good working of the driving equipment. It does not concern handling or scaffolding required to set up the lifting appliances.

10.1.4 The Surveyor checks that the materials, the loose gear and the various equipment used have been duly submitted to the inspections and tests required in this Section and ascertains that they are suitably identified by their marks. The relevant certificates are to be made available for the Surveyor.

10.1.5 It is also checked that the loose gear is located in accordance with the lay-out drawing of the rigging elements and that the wire and fibre ropes are suitably rigged.

Precautions are to be taken to avoid kinks when reels of ropes are uncoiled.

The ropes, hinges, bearings, roller or ball bearings, swivels and various pins are to be suitably greased with the lubricants recommended by the suppliers.

10.1.6 The hydraulic systems are to be submitted to a test pressure equal to 1,5 times the design pressure.

However if a hydraulic test of the piping and its accessories has been performed prior to fitting onboard as per [6.5.1], the whole of the hydraulic system may be tested after fitting aboard at a pressure equal to:

- 1,25 times the design pressure when welded joints have been executed onboard
- at the set pressure of the safety valves or other protecting devices against over pressures if no welded joint has been executed onboard or if all the welded joints executed onboard have been subjected to non-destructive tests to the satisfaction of the Surveyor of the Society.

10.1.7 As a rule, the no-load tests and preliminary checking as per [11.2] are carried out within the scope of the survey of the fitting onboard.

11 Overall testing for cranes and derrick systems

11.1 General

11.1.1 Cranes and derrick systems are to be tested in the presence of a Society's Surveyor.

11.1.2 A detailed test programme taking into account the requirements of this section is to be drawn up and submitted to the Surveyor.

For intricate cases, the Surveyor may require submitting of the test programme to the approval of the Society to take into account the most critical loading cases as determined by calculation.

11.1.3 Prior to testing, the test programme is to be agreed by the captain or the person responsible for the ship (or for the support of the lifting appliance) by the Manufacturer and by the Society's Surveyor.

11.1.4 Prior to any load test, the Master or the person responsible for the ship/offshore unit is to confirm that ship/offshore unit stability will not be impaired by testing and that strength of the structures intended to support the proof loads is sufficient.

If special ballast conditions or special devices (for example, support legs or removable stays) are provided either to limit the list of the support or to ensure stability of the lifting appliance, the person responsible for the ship is to ascertained that these conditions are complied with and that these devices are fitted before and during the load tests.

If ballast conditions are to be modified depending on the outreach of the proof load, working of the ballast system are to be tested prior to carrying out load tests.

11.1.5 During the overload tests and the load manoeuvring tests, the person responsible for the ship is to check that the list and trim conditions remain within the limits taken into account for calculation (see Ch 2, Sec 2, [3.2]).

If ballast capabilities do not allow compliance with these limits, as a rule, the tests are to be stopped and another study is to be submitted for approval with modified trim and list conditions.

In a few cases, carrying out of load tests in the maximum trim and list conditions taken into account in the study may be required. If the person responsible for the ship/offshore unit is against placing the ship/offshore unit in these conditions since he considers that there is a risk of instability, the maximum list and trim angles finally authorized are to be reduced to the values deemed acceptable by the aforesaid person.

11.1.6 The load tests are to be carried out by applying certified weights the value of which are to be justified to the Surveyor's satisfaction with an accuracy of ± 2%.

11.1.7 The tests include:

- preliminary no-load tests (if these tests have not been carried out within the scope of survey of fitting onboard)
- overload test intended to test the strength of the appliance and its support
- manoeuvring tests of the appliance at maximum capacity in conditions as near as possible to actual working conditions.

11.1.8 When a lifting appliance is designed to handle loads in several different conditions, the overload test and the manoeuvring tests at maximum service capacity are to be carried out for each of these conditions.

However, if the overload test corresponding to a special working condition does not result in submitting an appliance, its connections, its support and any of its constituents (except for the loose gear which have been tested separately) to stresses higher than those supported during other tests, the overload test may possibly be omitted for this special working condition, subject to agreement of the Surveyor or of the Society. The manoeuvring test at maximum working capacity corresponding to this condition are however to be carried out.

11.2 No-load testing and preliminary checking

11.2.1 The whole lifting appliance is to be tested under no-load in order to check that every motion may be carried out within the contemplated working area.

11.2.2 During this test, correct operation of the driving and control devices of the motors, winches and brakes is to be checked.

11.2.3 It is to be ascertained that the ropes do not rub on metal parts and that there is no risk of them coming out of the block grooves.

It is also to be checked that the lengths of the ropes are sufficient and comply with the requirements of Ch 2, Sec 6, [3.1.2].

11.2.4 The end limit switches are to be set.

11.3 Overload testing

11.3.1 The proof load is specified in Tab 2 according to the SWL of the lifting appliance, describing maximum capacity of the appliance.

For lifting appliance used in offshore conditions, the SWL referred in Tab 2 is to be taken as the greater of:

- 0,75 α_{CZ} SWL
- SWL.

With α_{CZ} as defined in Ch 3, Sec 1.

Table 2 : Proof loads of the lifting appliances

SWL of the lifting appliance, in t	Proof load, in t
SWL ≤ 20	1,25 SWL
20 < SWL < 50	SWL + 5
SWL ≥ 50	1,1 SWL

11.3.2 When the SWL of the lifting appliances is constant over their whole working area they are to be tested at their maximum radius i.e. at the minimum topping angle taken into account in the calculations.

11.3.3 The lifting appliances the SWL of which varies continuously over their working area must be tested at maximum and minimum topping angles. A test in an intermediate position to be determined in agreement with the Surveyor or the Society may be required.

If the SWL does not vary continuously over the working area but remains constant between two different values of the topping angle, the test are to be carried out at the maximum radius corresponding to each different SWL.

11.3.4 The various motions allowed by the lifting appliance are to be carried out at slow speed with the proof load.

a) Lifting motion: the proof load is to be lifted at low speed, the crane jib being located in the longitudinal plane of the ship. It is unnecessary to lift the proof load up to the maximum possible height, however, as a minimum, the cargo winch drum are to be entirely rotated.

b) Luffing motion: the crane jibs are to be raised to their maximum luffing angle then lowered to their minimum luffing angle.

c) Translation: the various translating motions of the overhead travelling cranes, underhung trolleys, travelling gantries and travelling cranes are to be performed all along their tracks.

11.3.5 Stationary position of the proof load in case of failure of the power-source feeding the winches is to be demonstrated.

11.4 Operational testing

11.4.1 Manoeuvring tests at maximum working capacity (SWL) are to be carried out over the whole working area of the lifting appliance concerned.

In particular, the load is to be handled over the whole outline of the working area.

11.4.2 These tests are to be carried out at the maximum working speed at which the lifting appliance may be used for each possible motion. When several motions may be carried out at the same time, the manoeuvring tests are also to be carried out under these conditions.

11.4.3 Correct operation of the rigging, of the machinery and of the control devices are to be checked during testing.

In particular, efficiency of all the brakes inclusive of those of emergency stopping devices are to be proved.

11.4.4 Correct winding of ropes on winch drums are to be checked under load, especially when the maximum length of ropes is wound on drum.

11.4.5 Safety devices such as end limit-switches, load and moment indicators are to be set definitively and their good operation proved.

11.4.6 It is to be proved that the load can be held stationary and can be lowered at low speed in case of failure of the power source.

11.4.7 Under the responsibility of the responsible person aboard the ship and with the consent of the Manufacturers, the manoeuvring tests under load may be performed with the proof load as per [11.3.1] under the conditions stated in [11.4].

11.5 Inspections after testing

11.5.1 After testing, fixed or movable parts of the lifting appliance and of its support are to be inspected by manufacturer under the attendance of the surveyor.

11.5.2 The thorough examination aims at verifying that the components of the lifting appliance and its supporting structures have not been damaged or permanently deformed during testing and that no defect likely to impede reliability of the lifting appliance is apparent.

11.5.3 The thorough examination consists in a visual inspection complemented by other means, such as dismantling or various non-destructive controls which may possibly be required by the Surveyor.

Special attention are to be paid to the connections of the lilting appliance with its support and to the places where the structures are discontinuous in shape.

The Society may require carrying out of special tests or examinations at some places after testing.

11.5.4 Repairs can be contemplated only after agreement with the Surveyor. If repairs concern load carrying elements, the overload test and possibly the manoeuvring tests are to be repeated under conditions to be accepted by the Surveyor.

11.5.5 When the result of the inspections after testing is satisfactory, the Surveyor marks the lifting appliance in accordance with the provisions of [13] and then issues a certificate as per Ch 1, Sec 1, [2].

12 Overall testing of lifting platforms

12.1 General

12.1.1 Test plans and procedures are to be submitted to the Society for approval and are to indicate the acceptance criteria for each test step.

The definition of tests is to be agreed early in the design process, so as to ensure their consideration in the design assessment.

12.1.2 Overall testing prior to putting into service is to be conducted with the vessel docked at quay.

If tests are to be conducted under other conditions, this is to be agreed with the Society and may be subject to additional requirements.

12.1.3 All components are to be properly configured, tensioned and calibrated prior to the conduct of testing.

12.1.4 The following tests are to be conducted as part of overall testing, in the order indicated:

a) No-load testing
b) Static overload testing
c) Dynamic overload testing
d) Operational testing
e) Safety device tests, which can be performed throughout the above sequence, on Designer’s proposal.

Inspections after testing are to be conducted according to [11.5].

12.1.5 Procedures for watertightness testing of closing devices are to be agreed with the Society.

12.2 No-load testing

12.2.1 The lifting platform is to be raised and lowered without load applied, for at least two cycles. On the first cycle the lifting platform is to be stopped at each deck served and locked in place.

12.3 Static overload testing

12.3.1 The static overload testing is to be conducted by applying a proof load in accordance with [12.4.1], in a number of configurations representative of the intended operating conditions (including worst cases). These configurations are to be agreed with the Society.

Note 1: The possible additional weight of the proof load handling device is to be anticipated in the design.

12.3.2 The static overload testing is to be carried out with the platform suspended 75mm above its lowest position. Under the proof load, it is to be verified that the brake does not slip.

12.3.3 After test, all elements of the system that were subject to load are to be visually inspected and show that there are no signs of permanent deformation, misalignment, loosening, leaks or other damage or unusual wear. At the conclusion of the test, a hoisting-lowering cycle, at least between two decks, is to be carried out without load.

12.4 Dynamic overload testing

12.4.1 Dynamic overload testing is to be conducted by applying a proof load, P_L, in a configuration specified by the Designer, and agreed with the Society.

The lifting platform is to be hoisted and lowered at low speed. As a minimum, the lifting winch drum is to be entirely rotated. In case of hydraulic lifting systems the lifting height is to be considered in a case-by-case basis.

The proof load P_L, in t, is specified in Tab 3.

Table 3 : Proof load for overload testing

Suspended mass, in t	P_L, in t
$(SWL + M_p) \le 20$	F_T 1,25 $(SWL + M_p) - M_p$
$20 < (SWL + M_p) \le 50$	F_T $(SWL + M_p + 5) - M_p$
$(SWL + M_p) \ge 50$	F_T 1,1 $(SWL + M_p) - M_p$

SWL : Safe working load, in t
M_p : Self-mass, in t, of the lifting platform including its permanent components and its machinery
F_T : Factor to be taken into account for the lifting platforms intended to be operated in sea-going condition and to be taken as the greater of:
- 1
- 0,75 α_{CZ}

12.4.2 Stationary position of the platform in case of failure of the power-source feeding the hoisting mechanism is to be demonstrated.

12.5 Operational testing

12.5.1 Operational testing is to be conducted by applying the SWL in the worst-case load configuration, including any asymmetric load distribution. The load distribution is to be specified by the Designer and agreed with the Society.

The test is to be carried out between the lowest and highest working positions at maximum working speed.

12.5.2 Where the system includes closing devices or equivalent features, their correct functioning is to be demonstrated.

12.5.3 Verification of correct functioning of the locking mechanism at each deck is to be demonstrated during the test.

12.5.4 Correct operation of the rigging, of the machinery and of the control devices are to be checked during testing.

In particular, efficiency of all the brakes inclusive of those of emergency stopping devices are to be proved.

12.5.5 Correct winding of ropes on winch drums are to be checked under load, especially when the maximum length of ropes is wound on drum.

12.5.6 It is to be proved that, in case of failure of the power source, the loaded platform can be held stationary, and that can be safely moved to a safe deck at a low speed.

12.5.7 An emergency stopping test is to be carried out with the lifting platform evenly loaded at its rated load. At the moment of activating the emergency stop signal, the lifting platform is to be moving downwards at rated speed.

The braking system is to stop the lifting platform within the distance specified in the design specification, as a rule not exceeding 1 metre.

12.5.8 After test, all elements of the system that were subject to load are to be visually inspected and are to be shown not to exhibit signs of permanent deformation, misalignment, loosening, leaks or other damage or unusual wear. It is to be verified that no inadvertent behaviour occurs.

12.6 Safety devices testing

12.6.1 Tests of all safety devices are to be conducted, verifying that they are activated under the correct conditions and that their performance satisfies design requirements. These tests are to be defined by the Designer and are to include manual tripping of governors and sensing or switching components, as far as practicable, in order to initiate automated actions intended to place the lifting platform into a safe state. Safe recovery of normal system function is to be verified upon deactivation of the safety features.

Safety functions are to be verified at the SWL and rated speed, but intermediate tests or no-load tests may be conducted where this is necessary and where this does not reduce the relevance of the test.

12.6.2 After testing the safety device, all components are to be correctly adjusted for normal use, a thorough visual inspection of relevant components is to be conducted, checking for damage or unusual wear, and sufficient raising and lowering of the lifting platform without load is to be conducted in order to verify correct functioning of the system under normal operation.

13 Marking

13.1 General

13.1.1 Marking of lifting appliances, their component parts, materials used, items of loose gear and equipment aims at:

- identifying the elements which have been subjected to surveys at works such as inspections of materials, construction surveys, final inspections and, if any, tests prior to putting into operation
- specifying characteristics such as SWL working pressure, quality grade of materials, etc.
- defining the location either of an item of loose gear on a lifting appliance or of an appliance aboard the ship/offshore unit.

13.1.2 Pieces of equipment which are not considered as part of loose gear (see [7.1.1]) are to be marked for identification as per [13.3].

13.1.3 Items of loose gear defined in [7.1.1] are to be marked in accordance with the provisions of [13.4].

13.1.4 In order to avoid confusion of SWL for an item of loose gear or a lifting appliance, as a rule, the proof load is not to be marked unless it is preceded by the notation PROOF LOAD written out in full.

13.1.5 To locate elements onboard the ship/offshore unit, reference is to be made to the hold served by its number, when applicable.

When a hold is served by several lifting appliances, the position of the appliance is to be defined by adding to the hold number the notation F or A depending on the portion of the hold served by the appliance (fore or aft) or/and the letter P or S depending on the location of the appliance to portside or starboard. For example, a crane located to starboard and serving the fore part of hold No.3 may be marked 3FS.

13.2 Marking of equipment and accessories

13.2.1 Marks are to be stamped in places where there is no stress concentration and clear of welds.

13.2.2 The stamps used are to have rounded edges and are not to be applied more deeply than is required to obtain a legible and durable mark.

13.2.3 When the marks are stamped directly on the element, the number of letters, figures and symbols is to be reduced to a minimum and the sizes of stamps are not to exceed the values shown in Tab 4.

Table 4 : Sizes for stamps

Type of element		Size, in mm
Elements of circular cross-section	diameter ≤ 13 mm	3,0
	13 mm < diameter ≤ 26 mm	4,5
	diameter > 26 mm	6,0
Other elements	SWL ≤ 2 t	3,0
	2 t < SWL ≤ 8 t	4,5
	SWL > 8 t	6,0

13.2.4 When the marks cannot be stamped directly on the element due to its shape or nature, they are to be affixed to a suitable support fixed permanently such as a small plate or ferrule made of durable material.

13.2.5 The SWL is to be given in kilograms (abbreviation kg) when they are lower than 1000 kg and in tonnes (abbreviation t, 1 t = 1000 kg) when they are greater than or equal to 1 t with the following accuracy:

- integer number without decimal for the SWL lower than 1000 kg
- integer number or number with a single decimal for the SWL laying between 1 t and 10 t except for the values which end with 0,25 or 0,75
- integer number or number with a single decimal which should be 5 for the SWL laying between 10 t and 100 t
- integer number for the SWL greater than or equal to 100 t.

13.2.6 If required by the National Regulations, marking of the SWL may be replaced by marking of the SWF in decanewtons (abbreviation daN) for the SWF lower than 10000 daN or in kilonewtons (abbreviation kN) for the SWF greater than or equal to 100 kN.

In such cases, no decimal is to be indicated.

13.3 Marking of equipment after construction survey or final inspection

13.3.1 Materials certified by the Society are marked in accordance with the requirements of NR216.

13.3.2 The crane jibs are to be marked near the heel fitting.

13.3.3 Wire and fibre ropes are to be marked on a plate or ferrule set in the rope.

When the wire or fibre ropes are fitted with end sockets, marking of these elements must be completed by the SWL (or SWF) of these elements.

13.3.4 In addition to the marking as per [13.3.1], the rated characteristics of equipment tested at works (exclusive of the loose gear as per [7.1.1] for which reference is to be made to the provisions of [13.4]) are to be shown on the manufacturer's plates.

In particular, the SWF and possibly the maximum holding force are to be shown on the winches.

The working pressure and the test pressure are to be indicated (in bar) on the hydraulic cylinders and pumps.

The type and rated characteristics of the electric motors are to be mentioned.

13.4 Marking of loose gear

13.4.1 The following marks are to be affixed to each item of loose gear:

- stamp ꝟ affixed by the Surveyor of the Society
- date (month by the number and year) of the test
- number of the test certificate or identification number (or reference number) which is to be mentioned on the test certificate
- steel quality grade mark (L, M, P, S, T or V) in accordance with Ch 2, Sec 4, Tab 1 or Ch 2, Sec 4, Tab 2 depending on whether a lifting chain or another accessory is concerned (see [13.4.2])
- SWL of the accessory preceded by the letters SWL: for example SWL 10 t or SWL 500 kg
- additional marking:
  - blocks: see [13.4.3]
  - lifting beams: see [13.4.4].

13.4.2 When an accessory consists of several elements made of steel of various grades, the quality grade is to be marked on each element, for instance the side plates of a block may be marked M, its head fitting P and the sheave pin S.

13.4.3 The maximum diameter, in mm, of rope for which the block is provided is to be marked (e.g.: 22 mm).

In case that a single sheave block is attached and tested together with a hook, the marking of SWL for the single sheave block can be equal to the maximum lifted load.

Blocks are to be marked on the side plates.

13.4.4 The actual self weight (tare) of the lifting beams, spreaders or other equivalent lifting aids is to be stamped on these elements when their weight is greater than 100 kg.

In addition, the SWL and the actual self weight (tare) are to be painted with easily legible letters and figures at least 75 mm high.

Example: TARE 1,5 t - SWL 22 t

When several slinging methods are provided for hanging the load (or the lifting beam) in relation to different SWL elements are to be properly marked to reduce to a minimum the risk of improper use.

13.5 Marking of the lifting appliance prior to putting into service

13.5.1 In addition to the marking of the component parts in accordance with the provisions of [13.3] and [13.4], the lifting appliances are to be marked with easily legible letters (for example with light coloured letters on a black ground) at least 75 mm high as mentioned in [13.5.2]. They are to be marked too as mentioned in [13.5.3].

13.5.2 Marking of cranes

The SWL, minimum and maximum radius, in m, of cranes are to be marked on jib.

When a crane is equipped with a main boom and an auxiliary jib, the SWL and corresponding radii of the main hook located at the end of the main boom are to be marked on the main boom; the SWL and corresponding radii of the auxiliary hook located at the end of the auxiliary jib are to be marked on the auxiliary jib.

For variable load/radius cranes, the diagram of the lifting capacities is to be posted at the control station.

Tab 5 gives some examples for marking the cranes.

Table 5 : Marking of cranes

Marks	Corresponding use (at port)
SWL 15 t (4 m - 22 m)	Crane of 15 t constant SWL for range of radii between 4 m and 22 m
SWL 50 t (5 m - 8 m) SWL 10 t - 30 m	Crane of variable load/radius • Maximum capacity 50 t for range or radii between 5 m and 8 m - Capacity 10 t at maximum radius 30 m Diagram of lifting capacities versus radius is to be posted at the control station.

13.5.3 The following marks are to be stamped near the crane jib pins:

- stamp ℣ affixed by the Surveyor of the Society
- date (month by the number and year) of the overall tests of the lifting appliance
- number of the test certificate or identification number (or reference number) which is to be mentioned on the test certificate
- marks similar to those as per [13.5.2] (SWL, minimum topping angle for derrick booms, minimum and maximum radii for cranes).

13.5.4 Specific requirement for lifting appliances used at sea

For the SWL marking, two options are left to the crane manufacturer:

- indicating, for all the elements, the allowable load corresponding to operation in port (harbour condition). In this case, the derating to be applied, approved according to operation conditions, will be clearly indicated in the Crane Manual and relevant instructions brought to the knowledge of the operator and the personnel using or serving the appliance
- indicating, only for hooks, the allowable load corresponding to use in open sea and approved according to the operating condition.

The first option is acceptable for supply cranes on board mobile units operating in ports as well as in open sea.

The second one is appropriate for work cranes specially designed to operate in open sea.

13.5.5 Marking for lifting of personnel

The SWL in lifting of personnel mode is to be marked on the crane in addition to the SWL marking for cargo lifting.

Section 2 In-Service Surveys

1 General

1.1 Application

1.1.1 This Section is applicable to lifting appliances used at port or on open sea.

1.1.2 Unless otherwise specified, the term ship means a ship, an offshore unit or a fixed or mobile offshore platform.

1.2 Survey requirements for the fixed part of the lifting appliances in scope of ship or offshore unit classification

1.2.1 In order to maintain the class of the ship, the fixed parts of the lifting appliances (see Ch 1, Sec 1, [1.1.3]) are submitted either to the survey requirements of NR467, Part A or those provided for in NR445, Part A.

1.3 Maintenance of the Register of Lifting Appliances and Cargo Handling Gear and class notations for lifting appliances

1.3.1 In order to maintain the Register of Lifting Appliances and Cargo Handling Gear or to maintain the additional class notations defined in Ch 1, Sec 1, [3], the lifting appliances and their accessories are to be submitted to:

- an annual thorough examination, as detailed in Article [2].
- a quinquennial thorough examination including, in addition to a thorough annual examination, systematic checks and compulsory re-testing of the lifting appliances, as detailed in Article [3].

Note 1: These typical procedures are given for guidance only. They may be either reinforced or relaxed by the Surveyor depending on the general maintenance conditions or on any other element he would be acquainted with likely to affect his final decision (for example: special instructions from Manufacturer).

1.3.2 Thorough examination means a detailed visual examination attended by a surveyor of the Society and supplemented, if deemed necessary, by other suitable means such as non-destructive tests of parts of lifting appliance or accessory and the safety of the elements used to fix the lifting appliance or accessory.

For this purpose, the parts of the appliance or accessory are to be dismantled if the Surveyor deems it necessary.

1.3.3 A thorough examination of the lifting appliances and their accessories may be carried out simultaneously with a survey as required in [1.2.1]. In such a case, the thorough examination includes and replaces the aforesaid survey.

A survey as mentioned in [1.2.1] can neither replace a thorough examination nor ensure maintenance of classification of the lifting appliances and/or maintenance of validity of the Register of Lifting Appliances and Cargo Handling Gear.

1.3.4 In the case of discontinuance or suspension of the additional class notation of the lifting appliances and/or of expiration of the validity of the Register of Lifting Appliances and Cargo Handling Gear, the surveys as per [1.2.1] are again compulsory to maintain the classification of the ship or offshore unit.

1.3.5 Any noticeable incident or accident occurring during operation of the lifting appliances is to be notified to the Society in due time.

Any project concerning repair or alteration of the existing arrangements which would affect its strength or reliability is to be submitted to the agreement of the Society.

The lifting appliances are to be operated as originally designed and especially as mentioned in the Register of Lifting Appliances and Cargo Handling Gear and in the Certificate of the lifting appliances.

If these requirements are not complied with, the additional class notations may be suspended or withdrawn.

1.3.6 The carrying out of periodical thorough examinations does not relieve the person responsible aboard from having regular inspections performed by a designated member of his staff and from ensuring normal maintenance of the lifting appliances and their accessories.

1.3.7 For lifting appliances in the scope of classification, the applicable general principles of surveys, including possible postponment, are those defined in Pt A, Ch 2 of the Rules for steel ships or Rules for offshore units, as applicable.

1.4 National Regulations

1.4.1 Attention of Owners or Operators is drawn to the fact that the Administration concerned who have or have not ratified the ILO Conventions N°32 or N°152 and/or taken into account the IMO MODU Code and/or the ILO Code of practice concerning the construction of fixed offshore installations may apply more stringent Regulations than the requirements of this Chapter.

The Administration concerned may be the Flag Administration of the ship or offshore unit and/or those who have jurisdiction over the working site (Port Authorities or Coastal State Authorities).

It is the responsibility of the Owners or Operators to check that the requirements of this Section especially those concerning periodicity of surveys, examinations or postponements acceptable by the Administration concerned.

1.4.2 When a Register of Lifting Appliances and Cargo Handling Gear has been issued in compliance with National Regulations, the validity of this Register is to be maintained in accordance with these Regulations; however when the requirements of this Section are not consistent with the provisions of the National Regulations, they may be applied wholly or partly.

1.4.3 It is to be noted that the statutory surveys of lifting appliances according to National Regulations may be carried out by the Society only when authorized by the Administration concerned and acting on its behalf. The requests for such interventions are to be examined by the Society.

2 Annual thorough examinations

2.1 General

2.1.1 The Register of Lifting Appliances and Cargo Handling Gear and its attached documents are to be shown to the Surveyor who will ascertain that they are brought up to date and especially that no alteration has been made to the equipment since the last thorough examination.

2.1.2 The responsible person of the ship or of the offshore unit is to take all the necessary steps to allow the Surveyor to carry out thorough examinations under satisfactory conditions of safety.

As far as possible, the elements to be examined are to be brought down to deck. In particular, the derrick booms and the crane jibs are to be lowered to facilitate their inspection.

2.1.3 The ladders, gangways or other means of access (including their connections with the lifting appliance) used for inspection are to be in satisfactory condition. If not so, repairs may be required by the Surveyor before carrying out the examination.

The Surveyor may require the provision of a safety harness and fitting of guard rails or other protecting devices for his own safety.

2.1.4 The elements for which the Surveyor considers dismantling is necessary are to be dismantled and re-assembled by skilled personnel under the responsibility of a member of the ship's crew. They are to be suitably cleaned and greased out before examination.

2.1.5 The Surveyor may require removal of the protective coatings (planking, flooring, sheathing, painting, etc.) notably for crack and/or corrosion detection, or thickness checking.

2.1.6 The methods for repairs, the criteria for replacement and the re-testing due to repairs or replacements are defined in Article [4].

2.2 Fixed parts and connections with hull

2.2.1 The fixed structures of the lifting appliances are to be checked to ascertain that there is no corrosion, deformation and other damages likely to impede their reliability.

Special attention is to be paid to their connections especially with the hull, where risks of corrosion are the most important.

2.2.2 The structure adjacent to the places where lifting appliances are fixed to the structure of the ship is to be examined above and under deck.

The mounting rings for cranes and rails for gantry-cranes are to be carefully examined.

2.3 Removable structures and fittings

2.3.1 The joints of moving or hinged structures (forks, pivots, goosenecks, jib heel pins, span trunnions, etc.) are to be examined to ascertain that there is no crack or deformation and that they are in good maintenance condition and suitably greased.

It is recalled that the Surveyor is always authorized to ask for dismantling if necessary, in particular if abnormal clearances are noticed.

2.3.2 The crane jibs are to be examined to check that they are not distorted, buckled or corroded and that there is no trace of impacts or abnormal wear especially on the surfaces in contact with stowage cradles. The built-in sheaves are to be examined as per [2.4.3].

2.3.3 The connections of braces and struts of lattice structures are to be carefully inspected to detect possible cracks or corrosion.

2.3.4 The fittings intended for fixing the rigging accessories are to be examined as per [2.2.1].

2.3.5 The crane slewing rings and their fixing elements are carefully examined to detect possible cracks at random, by hammer tests or any other suitable means, and to ascertain that abnormal clearances have not developed. It is recommended to carry out this inspection in the presence of a representative from the crane manufacturer and to take into account his recommendations and those given in the operating manual of the crane.

2.3.6 The requirement [2.3.5] applies to bogies of gantry cranes or travelling cranes.

2.3.7 When fixing bolts have been removed to check their good condition they are to be tightened again to the torque stipulated by the Manufacturer or, failing that, to the torque given in Ch 2, Sec 3, [3.3.4] according to steel bolt quality. It is however recommended to replace the removed bolts by new bolts (see [4.2.6]).

2.4 Loose gear

2.4.1 Every item of loose gear is to be examined to check that it is not distorted or cracked and that wear or corrosion is within acceptable limits.

2.4.2 It is to be checked that locking devices of pins, nuts or swivels are not damaged or missing.

2.4.3 Blocks are examined to check that sheaves rotate freely around their axis and that grooves are not abnormally or excessively worn.

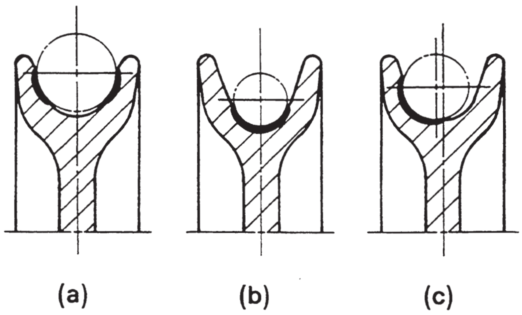
Three cases of abnormal wear of a block groove are shown on Fig 1:

a) Symmetrical wear on both sides of groove: in general means that the groove radius is not sufficient but may also means that the fleet angle of the rope (see Ch 2, Sec 6, [3.1.4]) is too great

b) Symmetrical wear very much localized at the bottom of groove: usually means that the radius of block groove is too great

c) Dissymmetrical wear on one side: usually occurs on blocks the head fitting of which is not free enough, the block is not freely positioned in the plane formed by both directions of the rope (no swivel for instance). In such a case, the block head fitting is to be carefully examined.

Figure 1 : Abnormal wear of block groove



2.4.4 The existing items of loose gear in wrought iron are to be replaced as soon as possible by accessories made of steel or other materials not subject to metallurgic ageing and which do not require to be heat-treated at regular intervals.

Until they are replaced, the items of loose gear in wrought iron (chains, rings, hooks, shackles, swivels) are to be annealed at regular intervals.

The periodicity for annealing is 6 months for the elements with a diameter lower than or equal to 12,5 mm and one year for the others. If however the above mentioned elements are part of hand-operated tackles or apparatus, the above periodicity may be doubled.

Annealing is to be carried out in a suitable furnace and not in an open fire.

2.5 Wire and fibre ropes

2.5.1 Wire and fibre ropes are to be inspected to check or to detect:

- corrosions or chemical attacks
- wear condition, especially on curved portions
- broken wires or strands
- deformation or straining of wires and strands (wire extrusions, kinks, protusions of core, bends, flattened portions, etc.)
- local increase or decrease in rope diameter
- condition of rope terminations inclusive of winch end fastenings.

2.5.2 Absence of internal corrosion or damage is to be checked at random preferably choosing places where the rope is especially exposed and where variations in diameter are noticed.

Generally, the internal examination at random of non- rotating ropes is necessary to ascertain that breaking of wires or strands not normally visible has not occurred.

2.5.3 The terminations of shrouds and pendants are to be carefully examined to detect corrosion due to infiltration into the rope sockets.

2.5.4 Temporary shrouds (removable stays) and slings in store are also to be examined.

2.5.5 After examination, the wire ropes are to be suitably lubricated.

2.5.6 Subsea lifting

When performing subsea lifting, the wires are to be lubricated every 6 months unless they are renewed every 2 years.

2.6 Winches

2.6.1 Winches and their reduction gears are to be examined to check their general maintenance conditions: absence of corrosion, suitable lubrication of the gear, condition of the attachments and foundations.

2.6.2 The locking devices (pawls, ratchet-wheels) are checked to detect possible cracks.

2.6.3 The connections of the end flanges with the drum are to be examined to detect corrosion and possible cracks.

2.6.4 Good condition of the rope end fastenings is to be checked.

It is to be ascertained that three safety turns remain on the drum in operating condition and two safety turns when the lifting appliance is in stowed condition.

2.6.5 Wear condition of the brake linings is to be checked.

2.7 Operation and safety devices

2.7.1 Good operation of the machinery, of its control devices and of the brakes is to be checked in carrying out no load manoeuvres in the presence of the Surveyor.

2.7.2 The visible parts of the electric, hydraulic or air circuits are to be examined to ascertain that they have not suffered damage likely to impede their reliability.

2.7.3 It is to be checked that the various safety devices (safety valves, fuses, guards, limit switches, load indicators, emergency stops, etc.) are fitted and in good operating conditions.

3 Quinquennial thorough examinations

3.1 General

3.1.1 The procedure described in [2] for annual thorough examinations is applicable to the quinquennial thorough examinations which is to be, as a rule, completed by dismantling, thickness measurements, systematic checks and by compulsory re-testing of the lifting appliances.

3.1.2 The typical procedure of the quinquennial thorough examination normally includes:

- checking for compliance of the existing arrangements with the rigging drawings and the certificates attached to the Register of Lifting Appliances and Cargo Handling Gear
- thickness measurements at random of the structural elements
- thorough examination of the dismantled elements
- re-testing of the lifting appliances after re-assembling
- thorough examination after testing.

3.1.3 Attention is drawn to the requirement of [1.3.1], Note 1 especially to the last paragraph which gives the Surveyor full discretion to strengthen or to reduce the typical procedure except for re-performing of the tests which is compulsory.

3.2 Systematic checking of the location and marking of loose gear

3.2.1 The Surveyor checks that the rigging list is up-to-date and corresponds actually to the existing arrangements.

3.2.2 It is to be ascertained that relevant test certificates of the existing loose gear are onboard.

3.3 Thickness measurements

3.3.1 The number of thickness measurements is determined by the Surveyor depending on the general maintenance conditions and on the results of the first measurements made.

3.3.2 When the thickness of an element cannot be measured directly, it is to be measured preferably by means of a suitably calibrated ultrasonic device or failing that by means of drillings (not to be carried out in highly stressed areas).

3.3.3 As a rule, from the third quinquennial thorough examination the thickness measurements are to be systematically made.

The check points and the resulting values are to be noted on a sketch to be kept together with the documents attached to the Register of Lifting Appliances and Cargo Handling Gear.

3.4 Systematic dismantling

3.4.1 As a rule, every hinged connection is to be stripped down to allow checking of the state of pins and bearings. In particular, this is true for:

- jib heel pins
- joints of rigid stays.

3.4.2 The blocks and their pins inclusive of the built-in sheaves are to be dismantled. The side plates of the blocks are to be carefully examined to detect possible cracks.

3.4.3 Several fixing bolts of the mounting and slewing rings of the cranes are to be removed to check their condition.

Systematic replacement of the fixing bolts (screws, nuts and washers) is recommended notably on cranes operated extensively on the open sea (see [4.2.6]).

The mounting and slewing rings of the cranes are to be especially examined to detect possible cracks by non-destructive tests (dye penetrant tests, ultrasonic or magnetic crack detection).

3.4.4 The ropes are to be examined externally over their whole length and internally in several places selected by the Surveyor.

3.4.5 All the dismantled elements are to be suitably greased before being re-assembled.

3.5 Re-testing

3.5.1 All the lifting appliances are to be tested upon each quinquennial thorough examination.

3.5.2 The requirements of Sec 1, [11] are applicable to re-testing, however the tests may be less complete than those required prior to putting into service of the lifting appliance provided the Surveyor agrees on it. However, they are to include at least:

- an overload test under the proof load specified in Sec 1, Tab 2
- manoeuvring tests which may be carried out with no load or under a load lower than the SWL of the lifting appliance.

3.5.3 The overload test may be carried out by means of a spring or hydraulic dynamometer when gauged loads are unavailable. This procedure is however to be exceptional and reserved to low capacity lifting appliances.

The guaranteed accuracy of the dynamometer is to be equal to ± 2,5% and calibration is to be checked biennially by a recognized organization. The relevant calibration certificate are to be available.

The test force is to be applied long enough to keep in position the pointer of the dynamometer for 5 min at least.

The fixing points of the dynamometer are to be suitably reinforced to withstand the test force.

3.5.4 The manoeuvring tests aim at checking good operation of the lifting appliances, of their mechanisms and of their control systems. Special attention is to be paid to good operation of the locking and braking devices.

4 Repairs and criteria to replace equipment or accessories

4.1 General

4.1.1 The elements which are excessively deformed, cracked, worn or corroded are to be either repaired or replaced in agreement with the Surveyor.

4.1.2 The rusted elements or those the paint of which has been removed for examination are to be repainted with a suitable anti-corrosive paint.

4.1.3 When an element or accessory is in such a condition that it is necessary either to repair it or to replace it shortly but not at once, the Surveyor may allow a certain period of time to do so; this period is not to end after the due date of the next thorough examination.

The contemplated repair or replacement and the period of time allowed are to be mentioned on the Register of Lifting Appliances and Cargo Handling Gear.

4.1.4 The Surveyor may exceptionally accept temporary repair to permit continued service of the lifting appliance.

The fact that repair is temporary and the period of time allowed until final repair (duration which is not to exceed the one as per [4.1.3]) are to be duly noted on the Register of Lifting Appliances and Cargo Handling Gear.

4.1.5 In some cases, the Surveyor may require and mention on the Register of Lifting Appliances and Cargo Handling Gear that a special attention is to be paid to the satisfactory behaviour in service of repair or replacement.

4.1.6 In the cases as per [4.1.3], [4.1.4] and [4.1.5], it is the responsibility of the responsible person aboard the ship or offshore unit to have the elements concerned frequently inspected, by a designated member of the staff, for satisfactory behaviour.

4.1.7 The final decision concerning repair or replacement of parts is to be made by the Surveyor of the Society.

4.2 Wear limits and criteria for replacement

4.2.1 The maximum allowable wear by friction or corrosion is estimated by the Surveyor depending on the element concerned, on its working conditions and on the possible effects of its failure on the reliability of the lifting appliance.

4.2.2 The maximum wear limits are given hereafter for guidance, however repair or replacement of the element concerned may be required by the Surveyor before these limits are reached (see [4.1.3]):

- plate thickness of load carrying members:
  - 10% reduction in thickness at any point
  - 20% for very localized wear or corrosion which concerns only a small portion of the cross-section of a structure
- sections:
  - 10% reduction in cross sectional area for any primary element in case of wear or corrosion evenly distributed over the considered cross-section
  - 20% locally when the section concerned is a secondary element only
- elements of circular cross-sectional area:
  - 3% reduction in diameter at any point on the same cross-section (with 1 mm at least)
  - 5% locally in a particular direction (with 1 mm at least).

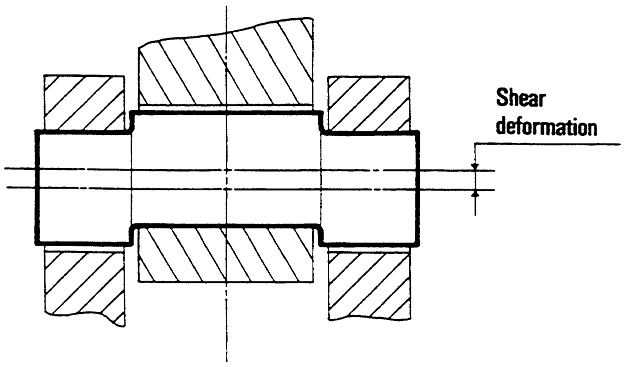
4.2.3 When the plates, sections and elements of circular cross-section have reached the maximum wear limit mentioned above, they are to be replaced.

In agreement with the Surveyor, very localized corroded areas may be built up by welding.

4.2.4 The pins which have reached the wear limit are to be replaced.

It is to be necessary to check that the apparent wear of a pin is not actually a deformation due to shear which requires immediate replacement, whatever the magnitude of the deformation noticed (see Fig 2).

Figure 2 : Pin deformed by shearing



4.2.5 It is to be remembered (see [2.4.4]) that the existing items of loose gear in wrought iron are to be replaced as soon as possible by items made of steel or other materials which do not require to be periodically heat-treated.

No new item of loose gear or other accessory in wrought iron will be accepted.

4.2.6 When prestressed high tensile steel bolts are removed (see [2.3.7] and [3.4.3]), it is recommended to replace them by new ones.

The screws may however be kept until the next dismantling if they are in excellent condition; the washers and nuts are to be replaced systematically upon each dismantling.

Replacement of fixing bolts is to be made before retesting the lifting appliance.

4.3 Rope discard criteria

4.3.1 The wire ropes are to be discarded and replaced in the following cases:

- when damages such as wire extrusions, kinks, core protusions, bends, flattened portions, increase or decrease in diameter, etc., are noticed
- when the sectional area of the outer wires is reduced by 40% due to wear or corrosion
- when internal corrosion is noticed
- when a strand is broken
- when the number of broken wires results in 5% reduction of the metal sectional area of the rope on a rope length equal to 10 times its diameter. For application of this criterium, wires highly corroded or deformed and those which have reached the wear limit of 40% mentioned above are to be considered as broken.

4.3.2 The above criteria are given for guidance. Reference can also be made to the standard ISO 4309 "Wire rope for lifting appliances - Code of practice for examination and discard", which gives detailed particulars in this respect.

Each time deemed necessary, the Surveyor may require replacement of a wire rope before the discard criteria are entirely met (see [4.1.3]).

4.4 Repairs

4.4.1 Repairs are to be made in agreement with and under the survey of a Surveyor of the Society.

4.4.2 The materials used for repairs are to be inspected in accordance with the requirements of Ch 2, Sec 8. The inspection certificates or attestations, as the case may be, are to be shown to the Surveyor.

Reference is to be made to the original construction drawings in order to determine the quality of the materials to be used.

4.4.3 When repairs by welding are concerned they are to be ascertained that the elements to be repaired are of weldable quality and that welding is not likely to impair their characteristics.

Usual precautions are to be taken to avoid residual welding stresses especially when an element with no free contraction after welding is concerned.

In some cases, heat-treatment may be required after welding.

4.4.4 When repairs after important or repeated damages are concerned, the Surveyor may require reinforcements in order to prevent their recurrence. When deemed necessary, the Surveyor may ask the Society for its opinion.

4.4.5 All cracks are to be entirely eliminated. Dye penetrant or magnetic crack detection tests are to be carried out to ensure this.

4.4.6 Reconditioning of pins, rotating parts or bearings by means of remachining can only be accepted by the Surveyor, if the reduction of the diameter of the pin or the increase of the bore does not exceed 2% of the diameter originally provided. Outside these limits, the opinion of the Society is to be requested prior to repairing.

4.4.7 The repairs of crane slewing rings and more generally of mechanisms are to be carried out in specialized workshops and in accordance with the recommendations of the Manufacturer.

4.5 Tests after repairs or replacements

4.5.1 Items of loose gear repaired in such a way that their strength may be affected are to individually be re-tested in accordance with the requirements of Sec 1, [7].

When an item of loose gear is replaced by a new one the latter is to be tested separately as here above stated.

In both above mentioned cases, the lifting appliance need not be re-tested (except within the scope of quinquennial thorough examination). The test certificates of the new or re-tested items of loose gear are to be attached to the Register of Lifting Appliances and Cargo Handling Gear.

4.5.2 When repairs or replacements concern a load carrying element of a structure or an accessory for which an individual test is not required, the lifting appliance is to be re-tested after repair.

The purpose of this re-testing is to submit the concerned element to a strength test and possibly the lifting appliance to a manoeuvring test if repairs are liable to affect its good working.

These tests are to include at least a test with an overload in compliance with the requirements of Sec 1, [11] carried out in such a way that the concerned element be submitted to the maximum forces it has to withstand in the most critical load conditions.

These test conditions are to be determined in agreement with the Surveyor and specified on the relevant test certificate.

The tests thus carried out will not result in postponing the date of the next overall tests to be performed within the scope of a quinquennial thorough examination.

4.5.3 In spite of the requirements as per [4.5.2], in some cases (for example replacement of a pin) waiving of the tests of the lifting appliance as rigged may be accepted provided that the concerned element be submitted separately to a proof load determined as per the requirements of Sec 1, [7] (see Note 1) and provided that the load conditions during testing be representative of the load conditions to which the element would have had to withstand during a test of the lifting appliance as rigged.

It is necessary however to ascertain that the element concerned may withstand the prescribed overload (see Note 1) without damage. In doubt, it is advisable to dispense with this special test procedure and to carry out the overall test.

Note 1: For the purpose of this requirement the proof load is to be determined as indicated in d) of Sec 1, Tab 1.

4.5.4 When a lifting appliance has been dismantled and then re-assembled, it is to be re-tested.

If only its fastening with the support has been dismantled, the tests may be limited to an overload test under the conditions corresponding to the maximum overturning moment. (Replacement of fixing bolts are to be regarded as dismantling).

If dismantling is complete, the tests are to include manoeuvring tests to the Surveyor's satisfaction in addition to the overload test.

5 Occasional interventions after damage or conversion

5.1 Survey after damage

5.1.1 If a lifting appliance or the local structure supporting it is damaged the Owner or his Representative are to apply to the Society as soon as possible to have the lifting appliance surveyed.

5.1.2 When the damage concerns elements within the scope of classification of the ship, i.e. parts of the lifting appliance definitively fixed to the ship and the local hull structure support, the aim of the survey is double:

a) Maintaining of the class of the ship

b) Maintaining of the additional class notations and of the validity of the Register of Lifting Appliances and Cargo Handling Gear.

5.1.3 When the damage concerns elements outside the scope of classification of the ship, the survey is carried out to maintain additional class notation and validity of the Register of Lifting Appliances and Cargo Handling Gear.

5.1.4 The circumstances and, where known, the probable origin of the damage are to be communicated to the Surveyor who have to mention them in his report in giving the origin of the gathered information.

5.1.5 The proposed repairs are to be accepted by the Surveyor and carried out under his survey in accordance with the applicable provisions of [4.3].

If re-building differs from the original construction, the relevant drawings are to be submitted to the Society for approval, within the limits fixed in Ch 1, Sec 2, [1].

5.1.6 The Society is entitled to require additional studies, reinforcements or fitting of additional safety devices to prevent recurrence of the damage.

5.1.7 When the necessary repairs cannot be carried out at once and provided the damage does not affect the overall strength of the ship, the Surveyor puts on the Register of Lifting Appliances and Cargo Handling Gear that the use of the damaged lifting appliance is not allowed until it is repaired.

5.1.8 After repair, the lifting appliance is to be tested as per [4.5].

5.2 Conversion

5.2.1 Any project of conversion which aims at modifying the characteristics of the lifting appliance and affecting either its strength or its operation is to be submitted to the Society for approval prior to starting the corresponding works.

5.2.2 When change in the main characteristics of a lifting appliance (for example increase in SWL or span or alteration of the operating service conditions) is contemplated, it is strongly recommended to entrust a specialized yard with the relevant study or, preferably, the original manufacturer of the lifting appliance; it is their responsibility to submit the study to the Society for approval.

5.2.3 In some cases however, the Society may accept the execution of a study at the request of the Owner, in order to inform him about feasibility of the conversion project.

If an increase in SWL is contemplated, the study would consist:

- on one hand, of analysing the forces involved in order to determine whether the scantlings of the ropes are still acceptable and whether the individual SWL of the items of loose gear remains sufficient
- on the other hand, of verifying the scantlings of the structural elements of the lifting appliance and of its support in order to determine whether the existing scantlings are still acceptable or whether reinforcements are necessary.

Items of loose gear the SWL of which is not sufficient are to be either replaced by new ones to be tested and inspected as per Sec 1 or re-tested as per Sec 1, [7] when their strength is considered as sufficient.

The drawings showing the alterations and final reinforcements are to be submitted to the Society for approval.

5.2.4 The materials used are to comply with the requirements of Ch 2, Sec 8 and the alteration works are to be carried out under the survey of a Surveyor of the Society in accordance with the applicable provisions of [4.4] and of Sec 1.

5.2.5 After conversion, the lifting appliance is to be re-tested in compliance with the applicable requirements of [4.5] and of Sec 1, [11].

6 Additional requirements for lifting platforms

6.1 General

6.1.1 In-service Surveys of lifting platforms are to be conducted according to this Section and the requirements described in Sec 1, [12].

6.1.2 If at any moment in service any criterion for replacement of suspension elements is met, the lifting platform is not to be operated until replacement of these elements and associated examinations and testing agreed with the Society have been carried out.

Appendix 1 Verification of Lifting Pad Eyes

1 General

1.1 Principles

1.1.1 At Owner's request, the Society may carry out the verification of lifting pad eyes in accordance with Ch 1, Sec 1, [5.3].

1.2 Documentation to be submitted

1.2.1 The following documents are to be submitted:

- design specification for information
- construction drawings for approval
- description of location, SWL and loading direction for information.

2 Design assessment

2.1 General

2.1.1 The lifting pad eye design and structural scantlings are to comply with the requirements of Ch 2, App 3, with the design load P_L defined in Tab 1.

Note 1: Alternatively, the design may be based on a recognised standard for pad eyes subject to the agreement of the Society.

Table 1 : Design load P_L for lifting pad eyes

SWL of the pad eye in t	Design load P_L in kN
SWL ≤ 3	20,0 SWL
3 < SWL < 20	17,5 SWL
SWL ≥ 20	15,0 SWL

3 Scope of survey

3.1 Pad eyes with SWL less than or equal to 1t

3.1.1 Pad eyes with SWL less than or equal to 1t are subject to the following requirements:

- examination of material certificates
- visual inspection by attending Surveyor
- Surveyor's on the spot evaluation of pad eyes scantling
- either individual marking or group marking of the pad eyes in accordance with [3.4.1].

3.2 Pad eyes with SWL greater than 1t and less than or equal to 3t

3.2.1 Pad eyes with SWL greater than 1t and less than or equal to 3t are subject to the following:

- examination of material certificates
- visual inspection by attending Surveyor
- proof load test: either 100% load test and sample NDT or sample load test and 100% NDT (see [4.1.2])
- either individual marking or group marking of the pad eyes in accordance with [3.4.1].

3.3 Pad eyes with SWL greater than 3t

3.3.1 Pad eyes with SWL greater than 3t are subject to the following:

- examination of material certificates
- visual inspection by attending Surveyor
- individual proof load test
- individual NDT
- individual marking.

3.4 Group marking

3.4.1 When group marking is applied then a common signboard is to be installed in each room/space with several identical pad eyes. In case of pad eyes with different SWL in the same room/space, individual marking (for instance a colour distinguishing system) for the pad eyes is to be applied.

4 Testing

4.1 Proof load test

4.1.1 Where proof load testing of pad eyes is required as per Article [3], the proof load is to be according to Tab 2.

4.1.2 For standardized pad eyes with SWL ≤ 3t, sample testing may be carried out subject to the agreement of the Society.

Table 2 : Proof loads of pad eyes

SWL of the pad eye, in t	Proof load, in t
SWL ≤ 20	1,25 SWL
20 < SWL < 50	SWL+5
SWL ≥ 50	1,10 SWL

Appendix 2 Certification of Materials and Components

1 General

1.1 Scope

1.1.1 The present Appendix provides the certification scheme for materials and components intended to be part of the lifting appliances.

1.1.2 When the lifting appliance is intended for certification in compliance with statutory Regulations, as described in Ch 1, Sec 1, [2], materials and components are to be certified in accordance with:

- Tab 1 for cranes and derrick systems
- Tab 3 for lifting platforms.

When the lifting appliance is intended to be under the scope of classification of the supporting ship or offshore unit, as described in Ch 1, Sec 1, [3], materials and components are to be certified in accordance with:

- Tab 2 for cranes and derrick systems
- Tab 4 for lifting platforms.

2 Certification of materials and components

2.1 General

2.1.1 The Society reserves the right to modify the requirements given in the present Appendix to formulate new ones or to change their application in order to take into account the particulars of a given construction, as well as local circumstances.

2.1.2 The particular conditions and requirements expressed by National Flag Authorities, owners, shipyards or manufacturers may lead to additional surveys or other services to be specified and agreed in each case by the concerned parties.

2.2 Explanatory notes, symbols and abbreviations

2.2.1 Tab 1, Tab 2, Tab 3 and Tab 4 are consistent with the definitions of NR266 Requirements for Survey of Materials and Equipment for the Classification of Ships and Offshore Units.

2.2.2 Symbols

C : BV product certificate is required with invitation of the Surveyor to attend the tests unless other- wise agreed, in addition to the manufacturer's document stating the results of the tests performed and/or compliance with the approved type as applicable.

W : Manufacturer's document is required, stating the results of the tests performed and/or stating compliance with the approved type (as applicable).

X : Examinations and tests are required.

Where fitted, each additional index (h, ndt) indicates a specific type of test:

h : Hydraulic pressure test (or equivalent)

ndt : Non-destructive tests as per Rules.

2.2.3 Column 1 (item name)

Column 1 contains the name of the equipment or component with, eventually, its sub-systems.

2.2.4 Column 2 (design assessment / approval index)

Column 2 contains the design assessment / approval index. The meaning of letters TA and DA is the following:

TA : Type Approval is required

TA_{HBV} : Type Approval is required with work's recognition (HBV scheme as per NR320)

DA : Design assessment / Appraisal of the product is required; this one may be carried out as applicable:

- either for a specific unit, or
- using the Type Approval procedure.

Note 1: Where nothing is mentioned in column 2, a design assessment/approval of the specific unit is not required.

2.2.5 Column 3 (raw material certificate)

Column 3 indicates the nature of the document that is to be submitted by the manufacturer or supplier of the concerned raw material. Consistently with the Rules or agreed specifications, this document includes data such as material tests (chemical composition and mechanical properties), non- destructive tests and surface hardness (if hardened).

2.2.6 Column 4 (examination and testing)

Column 4 indicates that examination and/or testing are required, and are to be carried out by the manufacturer. For the type of examination and/or testing required, reference is to be made to the relevant provisions of the present Note

Note 1: As a general rule, even if a cross “X” is not fitted in a cell under column 4, examination and tests during fabrication may be required with invitation/attendance of the Society's Surveyor.

2.2.7 Column 5 (product certificate)

Column 5 indicates the nature of the document to be supplied by the manufacturer of the concerned product.

2.2.8 Column 6 (remarks)

Column 6 indicates the remarks (if any) associated to the concerned equipment or component.

Table 1 : Lifting appliances within the scope of statutory regulations of ships or offshore units (lifting platforms excluded) - Equipment and materials certification requirements

Item	Product certification				Remarks
	Design assessment	Material certificate	Examination and testing	Product certificate	
Lifting appliances	DA		X (1)	C (2)	(1) Refer to Sec 1, [6] and Sec 1, [11] (2) Product certificate is issued when all tests required by NR526 are performed, in particular: - overload test - functional test.
1 - Main structure					(1) The material inspection certificate is to be of type EN 10204-3.2 and is to indicate the guaranteed chemical and mechanical properties as well as the results of the tests performed. (2) For welded construction. The extent and the nature of the non-destructive examinations are subject to the Society's agreement. Refer to Sec 1, [3] (3) The material inspection certificate is to be of type EN 10204-3.1 or 3.2 and is to indicate the guaranteed chemical and mechanical properties as well as the results of the tests performed. (4) Refer to NR467 Ship Rules
- Slewing/flange rings	DA	W (1)	X ndt (2)	W	
- Jib, boom, crane body	DA	W (3)	X ndt (2)	W	
- Pedestal (not welded to the hull)	DA	W (1)	X ndt (2)	W	
- Load bearing pins	DA	W (3)	X ndt (2)	W	
- Mast and boom supports	DA	W (1)	X ndt (2)	W	
- Derrick booms	DA	W (1)	X ndt (2)	W	
- Other load carrying structural elements	DA	W (3)	X ndt (2)	W	
- Fixed parts of lifting appliances and elements connecting them with the ship structure (4)	DA	C	X	C	
2 - Mechanical elements					
- Slewing bearing	DA	W	X	C	
- Screws and nuts		W	X ndt	W	
3 - Machinery components and hydraulic systems (1)					(1) Refer to Sec 1, [3] (2) Refer to Ch 2, Sec 6, [6]. (3) Refer to NR266 item G30 (4) Refer to NR266 items G26 / G27 (5) As per Society's agreement
- Winches	DA / TA	W	X (2)	C (2)	
- Reduction gears with a transmitted power P ≥ 110 kW	DA / TA	W	X	W	
- Reduction gears with a transmitted power P < 110 kW		W	X	W	
- Hydraulic accumulator (3)	DA / TA	W	X	W / C	
- Hydraulic motors / pumps		W	X	W	
- Hydraulic luffing cylinders class I	DA / TA	W	X h ndt	C	
- Flexible hoses	TA	W	X h	W	
- Piping system (4)		W	X h ndt	W / C	
- Other auxiliary machinery items essential for the function of the lifting appliance	(5)	(5)	(5)	(5)	

Item	Product certification				Remarks
	Design assessment	Material certificate	Examination and testing	Product certificate	
4 - Electrical equipment					
- Electric motors for essential functions of the lifting appliance	DA / TA			W	
- Cables	DA / TA			W	
- Circuit breakers	DA / TA			W	
- Contactors	DA / TA			W	
- Convertors	DA / TA			W	
- Switchboard	DA		X	W	
- Slip rings	DA / TA			W	
- Other electrical equipment essential for the function of the lifting appliance				W	
5 - Loose gear					(1) DA for element not complying with a Standard (2) Refer to Sec 1, [3] (3) Depending on SWL as per Sec 1, [7] (4) For welded construction, the extent and the nature of the non-destructive examinations are subject to the Society's agreement.
- Blocks, hooks, shackles, swivels, chains, rings, rigging screws, slings, hand operated tackles (used with pitched chains, rings, hooks, shackles and swivels permanently attached) and other loose gears having similar use	DA (1) / TA	W (2)	X ndt (3) (4)	C	
- Lifting beams	DA (1)	W (2)	X ndt (3) (4)	C	
6 - Ropes					1) As per NR216. As alternative, tests and checking carried out in compliance with international or national standards may be accepted if they are considered as equivalent (e.g. ISO 3178 “Steel wire ropes for general purposes - Terms of acceptance”). Refer to Sec 1, [5] (2) As per NR216. Refer to Sec 1, [5]
- Steel wire ropes		W	X (1)	C	
- Fibre ropes		W	X (2)	C	
7 - Secondary structure (cabins, accesses, etc.)		W		W	

Table 2 : Lifting appliances within the scope of classification of ships or offshore units (lifting platforms excluded) - Equipment and materials certification requirements

Item	Product certification				Remarks
	Design assessment	Material certificate	Examination and testing	Product certificate	
Lifting appliances	DA		X (1) (2) (3)	C (4)	(1) Refer to Sec 1, [6] and Sec 1, [11] (2) for offshore cranes refer to Sec 1, [8] (3) for lifting of personnel refer to Sec 1, [9] (4)Product certificate is issued when all tests required by Sec 1 are performed, in particular: - overload test - functional test.
1 - Main structure					(1) For welded construction, the extent and the nature of the non-destructive examinations are subject to the Society's agreement. Refer to Sec 1, [3] and Sec 1, [4] (2) Refer to NR467 ship rules.
- Slewing/flange rings	DA	C	X ndt (1)	C	
- Jib, boom, crane body	DA	C	X ndt (1)	C	
- Pedestal (not welded to the hull)	DA	C	X ndt (1)	C	
- Load bearing pins	DA	C	X ndt (1)	C	
- Mast and boom supports	DA	C	X ndt (1)	C	
- Derrick booms	DA	C	X ndt (1)	C	
- Other load carrying structural elements	DA	C	X ndt (1)	C	
- Fixed parts of lifting appliances and elements connecting them with the ship structure (2)	DA	C	X	C	
2 - Mechanical elements					
- Slewing bearing	DA	C	X	C	
- Screws and nuts		W	X ndt	W	
3 - Machinery components and hydraulic systems (1)					(1) Refer to Sec 1, [3] and Sec 1, [4] (2) Refer to Ch 2, Sec 6, [6]. (3) Refer to NR266 item G30 (4) Same considerations for pumps. See NR266 item G31 (material certificates according to the piping class) (5) Refer to NR266 item G28 (6) Refer to NR266 items G26 / G27 (7) As per Society's agreement. Diesel engines to be type approved as marine engines. Survey requirements as per NR266 item E1 and applicable provisions of NR467, Pt C, Ch 1, Sec 2
- Winches	DA / TA	C	X (2)	C (2)	
- Reduction gears with a transmitted power P ≥ 110 kW	DA / TA	C	X h ndt	C	
- Reduction gears with a transmitted power P < 110 kW		W	X	W	
- Hydraulic accumulator (3)	DA / TA	W / C	X h ndt	W / C	
- Hydraulic cylinders class I	DA / TA	C	X h ndt	C	
- Hydraulic motors / pumps belonging to class I and II	DA / TA (4)	W (4)	X h ndt	C	
- Hydraulic motors / pumps belonging to class III			X h	W	
- Flexible hoses (5)	TA	W	X h	C	
- Piping system and fittings (6)		W / C	X h ndt	W / C	
- Other auxiliary machinery items essential for the function of the lifting appliance	(7)	(7)	(7)	(7)	

Item	Product certification				Remarks
	Design assessment	Material certificate	Examination and testing	Product certificate	
4 - Electrical equipment (1)					(1) Electrical motors and equipment to be considered as intended 'for essential services'. Survey requirements as per NR266 item K. (2) Refer to NR266 item K5 (3) Refer to NR266 item K14 (4) As per Society's agreement.
- Electric motors for essential functions of the lifting appliance (2)	DA / TA		X	C / W	
- Cables	DA / TA			W	
- Circuit breakers	DA / TA			W	
- Contactors	DA / TA			W	
- Convertors	DA / TA		X	C	
- Switchboard (3)	DA		X	C	
- Slip rings	DA / TA		X	C	
- Other electrical equipment essential for the function of the lifting appliance	(4)	(4)	(4)	(4)	
5 - Loose gear					(1) DA for element not complying with a Standard (2) Depending on SWL as per Sec 1, [3] (3) For welded construction, the extent and the nature of the non-destructive examinations are subject to the Society's agreement. Refer to Ch 4, Sec 1 [4] (4) Proof load as per Sec 1, [7]
- Blocks, hooks, shackles, swivels, chains, rings, rigging screws, slings, hand operated tackles (used with pitched chains, rings, hooks, shackles and swivels permanently attached) and other loose gears having similar use	DA (1) / TA	W / C (2)	X ndt (3) (4)	C	
- Lifting beams	DA (1)	W / C (2)	X ndt (3) (4)	C	
6 - Ropes					1) As per NR216. As alternative, tests and checking carried out in compliance with international or national standards may be accepted if they are considered as equivalent (e.g. ISO 3178 "Steel wire ropes for general purposes - Terms of acceptance"). Refer to Sec 1, [5] (2) As per NR216. Refer to Sec 1, [5]
- Steel wire ropes		W	X (1)	C	
- Fibre ropes		W	X (2)	C	
7 - Secondary structure (cabins, accesses, etc.)		W		W	

Table 3 : Certification of lifting platforms within the scope of statutory regulations of ships or offshore units - Equipment and materials certification requirements

Item	Product certification				Remarks
	Design assessment	Material certificate	Examination and testing	Product certificate	
Lifting platforms	DA		X (1) (2)	C (3)	(1) Refer to Sec 1, [6] and Sec 1, [12] (2) for lifting of personnel refer to Sec 1, [9] (3) Product certificate is issued when all tests required by Sec 1 are performed, in particular: - overload test - functional test.
1 - Main structure					(1) For welded construction, the extent and the nature of the non-destructive examinations are subject to the Society's agreement. Refer to Sec 1, [3] (2) Refer to applicable Rules.
- Platform deck structure	DA	W	X ndt (1)	W	
- Guide rails	DA	W	X ndt (1)	W	
- Other load carrying structural elements	DA	W	X ndt (1)	W	
- Fixed parts and elements connecting the equipment with the ship structure (2)	DA	C	X	C	
2 - Mechanical elements					
- Locking devices		W	X	W	
- Safety gear		W	X	W	
- Screws and nuts		W	X ndt	W	
3 - Machinery components and hydraulic systems	(1)	(1)	(1)	(1)	(1) Refer to Tab 1, item 3)
4 - Electrical equipment	(1)	(1)	(1)	(1)	(1) Refer to Tab 1, item 4)
5 - Lifting accessories	(1)	(1)	(1)	(1)	(1) Refer to Tab 1, item 5)
6 - Ropes	(1)	(1)	(1)	(1)	(1) Refer to Tab 1, item 6)

Table 4 : Certification of materials and components for lifting platforms intended to be under the scope of classification of the supporting ship or offshore unit

Item	Product certification				Remarks
	Design assessment	Material certificate	Examination and testing	Product certificate	
Lifting platforms	DA		X (1) (2)	C (3)	(1) Refer to Sec 1, [6] (2) for lifting of personnel refer to Sec 1, [9] (3) Product certificate is issued when all tests required by Sec 1 are performed, in particular: - overload test - functional test.
1 - Main structure					(1) For welded construction, the extent and the nature of the non-destructive examinations are subject to the Society's agreement. Refer to Sec 1, [3] (2) Refer to applicable Rules.
- Platform deck structure	DA	C	X ndt (1)	C	
- Guide rails	DA	C	X ndt (1)	C	
- Other load carrying structural elements	DA	C	X ndt (1)	C	
- Fixed parts and elements connecting the equipment with the ship structure (2)	DA	C	X	C	
2 - Mechanical elements					
- Locking devices		C	X	C	
- Safety gear		C	X	C	
- Screws and nuts		W	X ndt	W	
3 - Machinery components and hydraulic systems	(1)	(1)	(1)	(1)	(1) Refer to Tab 2, item 3)
4 - Electrical equipment	(1)	(1)	(1)	(1)	(1) Refer to Tab 2, item 4)
5 - Lifting accessories	(1)	(1)	(1)	(1)	(1) Refer to Tab 2, item 5)
6 - Ropes	(1)	(1)	(1)	(1)	(1) Refer to Tab 2, item 6)

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