



Classification of Mooring Systems for Permanent and Mobile Offshore Units

December 2015

**Rule Note
NR 493 DT R03 E**

Marine & Offshore Division
92571 Neuilly sur Seine Cedex – France
Tel: + 33 (0)1 55 24 70 00 – Fax: + 33 (0)1 55 24 70 25
Website: <http://www.veristar.com>
Email: veristarinfo@bureauveritas.com
© 2015 Bureau Veritas - All rights reserved

MARINE & OFFSHORE DIVISION

GENERAL CONDITIONS

ARTICLE 1

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

The Society:

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

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

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

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

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

ARTICLE 2

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

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

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

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

ARTICLE 3

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

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

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

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

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

ARTICLE 4

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

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

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

ARTICLE 5

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

5.2. - The certificates issued by the Society pursuant to 5.1. here above are a statement on the level of compliance of the Unit to its Rules or to the documents of reference for the Services provided for. In particular, the Society does not engage in any work relating to the design, building, production or repair checks, neither in the operation of the Units or in their trade, neither in any advisory services, and cannot be held liable on those accounts. Its certificates cannot be construed as an implied or express warranty of safety, fitness for the purpose, seaworthiness of the Unit or of its value for sale, insurance or chartering.

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

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

ARTICLE 6

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

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

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

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

ARTICLE 7

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

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

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

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

ARTICLE 8

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

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

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

ARTICLE 9

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

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

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

ARTICLE 10

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

ARTICLE 11

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

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

ARTICLE 12

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

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

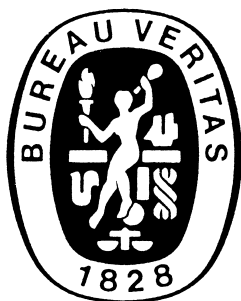
12.3. - Other disputes over the present General Conditions or over the Services of the Society are exclusively submitted to arbitration, by three arbitrators, in London according to the Arbitration Act 1996 or any statutory modification or re-enactment thereof. The contract between the Society and the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

ARTICLE 13

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

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

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



RULE NOTE NR 493

NR 493

Classification of Mooring Systems for Permanent and Mobile Offshore Units

SECTION 1	GENERAL
SECTION 2	IN-SERVICE SURVEYS
SECTION 3	DESIGN OF MOORING SYSTEM
SECTION 4	COMPONENTS OF MOORING LINES
SECTION 5	MOBILE MOORING
SECTION 6	MOORING AT A JETTY
APPENDIX 1	CHARACTERISATION OF THE LINE RESPONSE
APPENDIX 2	COMBINATION OF METOCEAN PARAMETERS
APPENDIX 3	STRUCTURAL STRENGTH CRITERIA

December 2015

Section 1 General

1	General	9
1.1	Application	
1.2	Exclusion	
2	Classification	9
2.1	Scope	
2.2	Class notations	
2.3	Construction mark	
2.4	Limits of notations POSA and POSA-HR and interfaces with Class	
2.5	Survey of installation and deployment	
2.6	Issuance of the class notation	
2.7	Maintenance of Class	
3	Documents to be submitted	11
3.1	Design data	
3.2	Components of mooring system	
3.3	List of documents to be submitted	
4	Definition and references	11
4.1	Definition	
4.2	Rules and related documents	
4.3	Other references	

Section 2 In-service Surveys

1	General	14
1.1	Application	
1.2	Permanent mooring	
1.3	Mobile mooring	
1.4	Units moored at a jetty	
2	Annual surveys	14
2.1	All units	
3	Intermediate surveys	14
3.1	Permanent units	
4	Class renewal surveys	15
4.1	Permanent units	
4.2	Mobile units	
4.3	Units moored at a jetty	
5	Survey summary	16
5.1	Intermediate and renewal surveys	
6	Renewal criteria for chains, steel wire and fibre ropes of permanent installations	16
6.1	General	
6.2	Chains	
6.3	Wire ropes	
6.4	Fiber ropes	

Section 3 Design of Mooring System

1	General	18
1.1	Scope	
1.2	Review of design	
1.3	General methodology	
2	Methods of evaluation	18
2.1	Purpose	
2.2	Fully coupled analysis	
2.3	Quasi-dynamic analysis	
2.4	Quasi-static analysis	
2.5	Model tests	
3	Environment, actions and unit response	19
3.1	Environment	
3.2	Actions	
3.3	Unit response	
4	Mooring system	23
4.1	Mooring pattern and initial tensions	
4.2	Mooring response	
4.3	Mooring stiffness	
5	Line response	24
5.1	Quasi-static line response	
5.2	Dynamic line analysis	
5.3	Characterization of the line response	
5.4	Dynamic line response	
6	Design tensions	26
6.1	Intact condition	
6.2	One-line damaged condition	
6.3	One-line failure (transient) condition	
6.4	Two-line damaged condition	
6.5	Loss of clump weights	
6.6	Thruster failure	
6.7	Design tension in line components	
6.8	Minimum design tension	
7	Offset	28
7.1	Intact conditions	
8	Fatigue analysis	28
8.1	Tension range	
8.2	In-Plane/Out-of-Plane Bending (OPB/IPB)	
9	Strength of line	29
9.1	General	
9.2	Breaking strength of line components	
9.3	Corrosion	
9.4	Tension-tension (T-T) fatigue endurance	
9.5	In-plane/out-of-plane bending endurance	
10	Selection of design conditions	31
10.1	General	
10.2	System configuration	

10.3	Metoccean conditions	
10.4	Extreme metoccean conditions	
10.5	Operating conditions	
10.6	Transient conditions	
10.7	Fatigue analysis	
10.8	Sensitivity studies	
11	Criteria	33
11.1	Mooring lines	
11.2	Anchors	
11.3	Minimum clearance	
11.4	Fatigue life	
11.5	Load testing of anchors and mooring lines	
12	Installation and service conditions	35
12.1	Chains and standard fittings	
12.2	Steel wire ropes	
12.3	Fiber ropes	
12.4	Anchoring devices	
12.5	Ancillary components	
12.6	Non standard fittings	

Section 4 Components of Mooring Lines

1	General	36
1.1	Purpose	
1.2	Scope	
1.3	General requirements	
2	Chains and standard fittings	37
2.1	General	
2.2	Designation	
2.3	Design	
2.4	Manufacturing and testing	
3	Steel wire ropes	37
3.1	General	
3.2	Designation	
3.3	Design of steel wire ropes	
3.4	Design of terminations	
3.5	Manufacturing and testing	
4	Fibre ropes	38
4.1	General	
4.2	Design	
4.3	Manufacturing and testing	
5	Non standard fittings	39
5.1	General	
5.2	Design	
5.3	Manufacturing and testing	
6	Anchoring devices	40
6.1	General	
6.2	Design	
6.3	Manufacturing	

7	Items at the unit-side end	42
7.1	General	
7.2	Design	
7.3	Manufacturing and testing	
8	Ancillary components	43
8.1	General	
8.2	Clump weights	
9	Monitoring system	43
9.1	Load monitoring system	

Section 5 Mobile Mooring

1	General	44
1.1	Application	
1.2	Applicability and limits	
1.3	In-service surveys	
1.4	General requirements	
2	Design	44
2.1	Environment	
2.2	Design loads	
2.3	Fatigue	
3	Components of mooring lines	44
3.1	General requirements	
3.2	Chains and standard fittings	
3.3	Deck appliances (winches and windlasses)	
3.4	Items at the unit-side end	
3.5	Anchoring devices	
4	Installation and service conditions	45
4.1	General requirements	
5	Thruster assisted mooring (TAM)	45
5.1	General	
5.2	Conditions of analysis	
5.3	Allowable thrust	
5.4	Analysis for thruster assisted mooring	
5.5	System requirements	
5.6	Sea trials	
6	Mooring equipment tests	47
6.1	Mooring equipment	
7	Operating manual	47
7.1	General	

Section 6 Mooring at a Jetty

1	General	48
	1.1 Application	
	1.2 Applicability and limits	
	1.3 In-service surveys	
	1.4 General requirements	
2	Design	48
	2.1 Environment	
	2.2 Design loads	
	2.3 Fatigue	
	2.4 Side-by-side configuration	
	2.5 Berth area	
	2.6 Dolphins system	
3	Mooring arrangements	49
	3.1 Mooring lines	
	3.2 Release mooring hooks	
	3.3 Winches	
	3.4 Mooring fittings	
	3.5 Fenders	
4	Design requirements for jetty	50
	4.1 General	
5	Operating manual	50
	5.1 Information to be included	

Appendix 1 Characterisation of the Line Response

1	General	51
	1.1 Test run	
	1.2 Characterisation	

Appendix 2 Combination of Metocean Parameters

1	General	52
	1.1 Scope	
2	Metocean data	52
	2.1 Metocean conditions and design data	
	2.2 Intensity and direction	
	2.3 Sea states	
	2.4 Wind	
	2.5 Current	
3	Metocean design conditions	54
	3.1 Principles	
	3.2 Directions	
	3.3 Intensities	
	3.4 Operating conditions	

4	Extratropical conditions	55
4.1	Applicability	
4.2	Typical design conditions	
4.3	Selection of return periods	
4.4	Reduction factors	
4.5	Conditions with swell	
5	Equatorial conditions	57
5.1	Applicability	
5.2	Typical design conditions	
5.3	Waves and wind	
5.4	Selection of return periods	
5.5	Directions	
6	Tropical storm conditions	58
6.1	Applicability	
6.2	Typical design conditions	
6.3	Data for the intensity of the elements	

Appendix 3 Structural Strength Criteria

1	General	59
1.1	Subject	
1.2	Design loads	
1.3	Elastic design	
1.4	Design Based on Elasto-plastic calculations	

SECTION 1 GENERAL

1 General

1.1 Application

1.1.1 The present Note provides requirements for the classification of the mooring system (station-keeping system) of:

- floating offshore units with permanent installations (disconnectable or not) as defined in [4.1]
- mobile units as defined in Sec 5
- units moored at a jetty, as detailed in Sec 6.

This Note covers, in general terms, the station keeping of any free-floating body by means of a principally passive system.

1.1.2 This Note deals with all the different types of anchoring patterns (such as spread mooring, internal or external turret, etc.), line make up, and the associated materials (such as chain, wires, fibre ropes, etc.) in catenary or taut configuration.

1.1.3 The present Note gives technical requirements, criteria and guidance on the design, construction and installation of the mooring systems, as a complement to the Rules mentioned in [4.2], for the granting of the following additional service features (referred to as 'notation' in this Note):

- **POSA**
- **POSA-HR** (higher redundancy)
- **POSA MU** (mobile unit)
- **POSA JETTY** (unit moored at a jetty).

1.2 Exclusion

1.2.1 The operational procedures for installation, anchoring line deployment, decommissioning, maintenance, etc. are not covered herein.

The integrity of risers, if any, connected to the moored unit is not addressed.

The Sec 4 and the NI 605, Geotechnical and Foundation Design, give methodology, requirements and recommendations on the anchoring point, e.g. drag anchor, driven pile, suction caisson, etc.

1.2.2 The **POSA** notations do not cover the tension leg platforms, which are not deemed free-floating bodies, nor their (tendons) mooring systems. This type of units is addressed in NR578, Rules for the Classification of Tension Leg Platforms (TLP).

1.2.3 The **POSA** notations cover the thruster assisted mooring (see [2.4.3]). However, the dynamic positioning installations are covered by the additional class notation **DYNAPOS** (refer to the Ships Rules, Pt E, Ch 10, Sec 6).

2 Classification

2.1 Scope

2.1.1 The classification activities span over all the phases of the project (considered as equivalent to the construction of a structure):

- design of the mooring system and of its components (engineering), including the related documentation, reviewed by the Society
- detailed design, manufacturing and testing of all the components of the mooring system (procurement) under survey of the Society,
- installation on unit and deployment at site of the mooring system under survey of the Society
- in-service inspection, for the maintenance of Class.

2.2 Class notations

2.2.1 Within the context of the classification of a floating offshore unit as defined in the Offshore Rules, the **POSA** notations are addressing the station-keeping capability of the unit, within the limits of applicability defined in [1.2] and [2.4].

2.2.2 In addition to the criteria required for the notation **POSA**, the notation **POSA-HR** covers strength analysis of the mooring system with two lines damaged (see Sec 3, [6.4.1]).

The notation **POSA MU** covers the station-keeping system of mobile units such as surface and column-stabilized mobile offshore units (list not exhaustive), in compliance with the requirements of the IMO MODU Code (see [4.2.3]) related to anchoring arrangements. The applicability, limits and scope of the notation **POSA MU** are defined in Sec 5.

The notation **POSA JETTY** is addressing the station-keeping capability of the floating offshore units moored at a jetty. This notation typically applies to FSRU's and FLNG's. The applicability, limits and scope of the notation **POSA JETTY** are defined in Sec 6.

2.3 Construction mark

2.3.1 In accordance with the provisions of Part A, Chapter 1 of the Offshore Rules and considering the provisions of [2.3.2] to [2.3.4], one of the construction marks ☒, ☒ or • is to be placed before each notation **POSA**, **POSA-HR**, **POSA MU** or **POSA JETTY**.

2.4 Limits of notations POSA and POSA-HR and interfaces with Class

2.4.1 The notations **POSA** and **POSA-HR** cover all the out-board elements of a mooring system, namely:

- the anchors, whatever the type (drag anchors, piles, suction piles, etc.)
- all the components of the load bearing lines, including line segments and connecting devices
- all the ancillary components such as buoys, clump-weights, and their attachment to the main lines (excluding installation aids).

2.4.2 These two notations also cover:

- fairleads and stoppers on the unit (totally, i.e. including unit-side female support parts)
- any associated load monitoring and control systems.

2.4.3 The notations **POSA** and **POSA-HR** do not cover windlass, winches and sheaves used for deployment of the system or for occasional handling of lines during unit operation, nor the associated monitoring and control systems (separate certification may be performed, on request). The NR595 gives specific requirements for Offshore Handling Systems (OHS).

Note 1: The notations **POSA MU** and **POSA JETTY** may have different scope and limits, especially regarding winches and windlass. Refer respectively to Sec 5 and Sec 6 for these notations.

However, the foundations of these items into the hull or on the turret are considered as part of the unit hull and, so, are covered by the classification of the unit.

For the granting of the notations **POSA** and **POSA-HR**, the pieces of equipment and systems related to thruster assistance, if any, are to comply with applicable sections of the Offshore Rules.

For other configurations not explicitly addressed hereabove, the limits of the notations **POSA** and **POSA-HR** are to be specified on a case-by-case basis.

2.5 Survey of installation and deployment

2.5.1 Installation on unit

Installation of the unit-side items (fairleads, stoppers, chain hawses, etc.) and on-board equipment, including the related systems, is to be performed under survey of the Society, in accordance with the applicable provisions of the Offshore Rules (these activities are usually to be carried out within the scope of the unit classification surveys).

The survey is to cover the quality of the construction work, particularly welds through non destructive tests (NDT). Load tests are normally not required but, if performed, are to be attended by a Surveyor. The NR426 gives specific recommendations for the surveys.

2.5.2 Deployment at site (installation)

The survey of the installation is to be performed on the basis of the general provisions of the Offshore Rules, particularly those given in Pt B, Ch 3, Sec 6 of the Offshore Rules.

The installation procedures prepared by the relevant Contractor are to be submitted to the Society for information.

The allowed tolerances for the installation are to be specified in the installation procedures, and are to be taken into account in the design calculations through sensitivity studies.

The installation operations are to be surveyed, including, but not limited to:

- installation of the anchors
- deployment of the mooring lines
- traceability of the components
- load tests of the anchors and lines (see Sec 3, [11.5])
- connection to the unit and tensioning
- post-installation inspection of the mooring system: survey by divers and/or remotely operated vehicles (ROV).

Reviews and surveys address the issues only under the scope of the Classification, particularly:

- conformity of all the components to the Classification requirements (as attested by the inspection certificates)
- integrity of the installed parts
- conformity to design of the as-installed system, particularly the setting of the line pretensions.

The operations at site are to be carried out in the presence of a Surveyor of the Society, following an agreed program.

The Surveyor is to review the records and other documentation of the installation operations, prior to the delivery of the certificate.

Note 1: The survey by the Society is, by no way, intended to be a substitute for the installation contractor's duty to fully document the mooring system installation.

2.6 Issuance of the class notation

2.6.1 Upon satisfactory completion of the mooring system installation, of all the prior activities and of the related surveys performed by the Society, one of the **POSA** notations defined in [2.2] is granted and entered in the Initial Hull Classification Certificates of the unit.

2.7 Maintenance of Class

2.7.1 Maintenance and renewal of the classification certificate are subject to the completion of in-service surveys, as described in Sec 2, to be performed by the Society.

3 Documents to be submitted

3.1 Design data

3.1.1 General

The Offshore Rules, Part A, Ch 1 and Part B, Ch 2, give general recommendations additional to those of this Article.

The party applying for classification is to provide the Society with the classification data and assumptions.

The design of the mooring system is to be performed on the basis of the design data, operational data and environmental data of the unit.

3.1.2 Site data

The party applying for classification is to specify:

- for permanent installations: the site at which the unit is to operate
- for mobile units: conditions in which the unit is to operate.

3.1.3 Operating conditions and loads

The operational data are to include the following information:

a) environmental conditions:

- extreme (survival conditions)
- fatigue (operational conditions)

Note 1: Operational conditions are to be understood as usual conditions (day-to-day conditions). This notion does not take into consideration any process or production.

- b) characteristics and range of loading conditions, with the associated responses, of the unit
- c) description of the mooring lines components from anchor to stopper
- d) mooring system layout (paid-out length and mooring leg azimuths, anchors locations)
- e) the following loads, in all the relevant loading conditions mentioned in item b):
 - environmental loads
 - anchoring/mooring loads
 - hawser line loads
 - risers loads
 - thruster loads
 - loads induced by other pieces of equipment.

3.2 Components of mooring system

3.2.1 Line components

Design specifications and design documentation are to be submitted to the Society for review.

For units with the construction marks , the manufacturing of materials and sub-components, and the construction of components are to be performed under survey of the Society, according to an approved program as described in NR320 (see [4.2.2], item e)) and NR266.

The certificates are to be delivered for each set of items, upon satisfactory completion of all the related reviews and surveys.

3.3 List of documents to be submitted

3.3.1 The submitted documents are to include the following information, in addition to the documentation specified in the Offshore Rules, Pt A, Ch 1, Sec 4:

a) Design criteria and data, as defined in [2]:

- metocean data, soil data, and background information (see the Offshore Rules, Pt B, Ch 2, Sec 2 and NI 605)
- characteristics and range of loading conditions of the unit
- reports of design analysis.

b) General drawings:

- layout description including positions of the anchor points, water depth, surrounding equipment (riser, well head, ...) and layout of the units located in close proximity (see Sec 3, [10.6.1])
- description of the mooring lines (from anchor to stopper)
- general arrangement showing location of fairleads and stoppers
- turret structure, if any.

c) Structural drawings, specifications and supporting documents:

- mooring systems foundations (fairleads, stoppers, winches, bollards, etc.), as applicable.

d) Drawings and specifications of the mooring fitting:

- connecting systems
- ancillary elements
- anchoring systems.

e) Model tests (when performed):

- specification
- final report.

f) Monitoring and control system:

- monitoring system description
- control system description.

4 Definition and references

4.1 Definition

4.1.1 Permanent mooring

As defined in the Offshore Rules, a permanent installation is an installation performing its service for a duration not less than 5 years on a single site.

The mooring system of a permanent installation is considered as a permanent mooring system.

4.1.2 Disconnectable permanent mooring

As defined in the Offshore Rules, a disconnectable permanent installation is a permanent installation able of disengaging from its mooring and riser systems in extreme environmental or emergency conditions.

The mooring system of a disconnectable permanent installation is considered as a disconnectable permanent mooring system.

When the installation is disconnected, the mooring system stays at location.

4.1.3 Mobile mooring

As defined in the Offshore Rules, a mobile unit is a unit which is neither a permanent installation nor a disconnectable permanent installation.

The mooring system of a mobile unit is considered as a mobile mooring system and is designed for station keeping at a specific location for less than 5 years.

Mobile mooring systems can be removed and redeployed.

4.1.4 Unit moored at a jetty

A unit moored at a jetty is a specific type of permanent or disconnectable permanent installation as defined in [4.1.1] and [4.1.2].

The mooring system of a unit moored at a jetty is considered as a permanent or disconnectable permanent mooring system.

4.2 Rules and related documents

4.2.1 Rules

- a) NR216 Rules on Materials and Welding for the Classification of Marine Units
referred to as the Rules on Materials and Welding in this Rule Note
- b) NR445 Rules for the Classification of Offshore Units
referred to as the Offshore Rules in this Rule Note
- c) NR467 Rules for the Classification of Steel Ships
referred to as the Ship Rules in this Rule Note.

4.2.2 Guidance Notes (NI) and Rule Notes (NR)

- a) NI 425 Software Assessment for Shipboard Computer Based System
- b) NI 432 Certification of Fibre Ropes for Deepwater Offshore Services
- c) NI 604 Fatigue of Top Chain
- d) NI 605 Geotechnical and Foundation Design
- e) NR320 Certification Scheme of Materials and Equipment for the Classification of Marine Units
- f) NR426 Construction Survey of Steel Structures of Offshore Units and Installations
- g) NR494 Rules for the Classification of Offshore Loading and Offloading Buoys.

4.2.3 IMO Publications

Code for the Construction and Equipment of Mobile Offshore Drilling Units, 2009 (2009 MODU Code).

4.2.4 IACS Unified Requirements

- a) IACS UR W18: Materials and Welding - Anchor Chain Cables and Accessories Including Chafing Chain for Emergency Towing Arrangements
- b) IACS UR W22: Materials and Welding - Offshore Mooring Chain
- c) IACS UR Z17: Survey and Certification - Procedural Requirements for Service Suppliers.

4.2.5 IACS Recommendations

- a) IACS Rec. 34 (2001): Standard Wave Data
- b) IACS Rec. 38 (2010): Guidelines for the Survey of Offshore Mooring Chain Cable in Use.

4.2.6 Other industry documents

- a) API RP 2SK: Recommended Practice for Design and Analysis of Stationkeeping Systems for Floating Structures, 3rd edition, 2005
- b) API Spec 9A: Specification for Wire Rope, 26th edition, October 2011
- c) API RP 2I: Recommended Practice for In-service Inspection of Mooring Hardware for Floating Structures, 3rd edition, April 2008
- d) API RP 2A-LRFD: Recommended Practice for Planning, Designing and Constructing Fixed Offshore Platforms - Load and Resistance Factor Design, 1993
- e) API RP 2A-WSD: Recommended Practice for Planning, Designing and Constructing Fixed Offshore Platforms - Working Stress Design, 2007
- f) API RP 2GEO: Geotechnical and Foundation Design Considerations
- g) ISO 1704:2008: Ships and marine technology - Stud-link anchor chains
- h) ISO 2232:1990: Round drawn wire for general purpose non-alloy steel wire ropes and for large diameter steel wire ropes - Specifications
- i) ISO 10425:2003: Steel wire ropes for the petroleum and natural gas industries - Minimum requirements and terms of acceptance
- j) ISO 18692:2007: Fibre ropes for offshore stationkeeping - Polyester
- k) ISO/TS 14909:2012: Technical specification on Fibre ropes for offshore stationkeeping - High modulus polyethylene (HMPE)
- l) ISO 19901-7:2013: Petroleum and natural gas industries - Specific requirements for offshore structures - Part 7: Stationkeeping systems for floating offshore structures and mobile offshore units
- m) OCIMF-MEG3 2008: Mooring Equipment Guidelines, Oil Companies International Marine Forum
- n) NORSOK U-102: Underwater operation - Remotely operated vehicle (ROV) services, 2012.

4.3 Other references

4.3.1

- a) L. Leblanc, J.L. Isnard, H. Wilczynski: A Complete and Consistent Methodology for the Assessment of Mooring Systems, OTC-7709, May 1995
- b) M. François & al: Statistics of extreme and fatigue loads in deep water moorings, OMAE'01-2162, June 2001
- c) X. B. Chen: Approximation on the quadratic transfer function of low-frequency loads, 7th International BOSS conference, 1994
- d) M. Le Boulluec & al.: Recent advances on the slow-drift damping of offshore structures, 7th International BOSS conference, 1994
- e) M. Francois, P. Davies, F. Grosjean, F. Legerstee: Modeling Fiber Rope Load-elongation Properties - Polyester and Other Fibers, OTC 20846, May 2010
- f) P.J. Clark, S. Malenica and B. Molin (1993): An heuristic approach to wave drift damping, Applied Ocean Research, 15, 0141-1187/93, p. 53-55
- g) B. Molin (1994): Second-order hydrodynamics applied to moored structures - A state-of-the-art survey, Ship Technology Research, Vol. 41, 2, 59-84
- h) B. Molin (2002): Hydrodynamique des structures offshore", Editions Technip
- i) C. Morandini, F. Legerstee, J. Mombaerts: Criteria for Analysis of Offloading Operation, OTC-14311-MS, May 2002
- j) M. François & al.: Multi-variate I-FORM contours for the design of offshore structures (practical methodology and application to a West Africa FPSO), ISOPE-2007-JSC-434
- k) F. Legerstee, M. François, C. Morandini, S. Le-Guenneec: Squall: Nightmare for Designers of Deepwater West African Mooring Systems, OMAE2006-92328, 171-176
- l) G. de Hauteclocque, F. Rezende, O. Waals, X. B. Chen: Review of Approximations to Evaluate Second-Order Low-Frequency Load, OMAE2012-83407, 363-371
- m) C. Monroy, G. de Hauteclocque, X. B. Chen: Systematic Accuracy Assessment of Two Frequently Used QTF Approximations in the Case of a Rectangular Barge, OMAE2014-24600.

SECTION 2 IN-SERVICE SURVEYS

1 General

1.1 Application

1.1.1 Remotely operated vehicles (ROVs)

The use of ROVs for carrying out the in-water survey is acceptable. The company providing this service is to be approved as a service supplier for carrying out in-water surveys, as per the requirements of IACS UR Z17 (see Sec 1, [4.2.4]).

ROVs are to be equipped in order to produce general visual inspection (GVI). ROV capacity is to comply with Sec 1, [4.2.6], item n), or equivalent.

For all testing and inspection performed by sampling, the number of links surveyed is to be agreed by the Society.

1.2 Permanent mooring

1.2.1 The in-service mooring system surveys of permanent units granted with the notation **POSA**, **POSA-HR** or **POSA JETTY** are carried out the unit being on site. No disruption of the unit's operation is required.

1.3 Mobile mooring

1.3.1 The in-service mooring system surveys of mobile units granted with the notation **POSA MU** may lead to an offshore inspection, as for the permanent offshore units, or dockside inspection. The document API RP 2I (see Sec 1, [4.2.6], item c)) gives recommended in-service inspection procedures and methods for chains, wire ropes, anchor jewellery and anchor handling equipment.

1.3.2 According to the definition of mobile mooring (see Sec 1, [4.1.3]), all the mooring lines are to be inspected out of the water every five years.

1.4 Units moored at a jetty

1.4.1 For units granted with the notation **POSA JETTY**, the hawsers are to be replaced at regular intervals. The exact replacement interval is to be specified by the hawser manufacturers.

1.4.2 At constant time intervals, the entire length of the hawser is to be inspected. The frequency of these inspections is to be determined on a case-by-case basis, according to the rope manufacturer recommendations.

1.4.3 Specific guidelines for inspection and removal of wire and fiber ropes can be found in the OCIMF-MEG3 Mooring Equipment Guidelines (see Sec 1, [4.2.6], item m)).

2 Annual surveys

2.1 All units

2.1.1 The records of operation of the -keeping equipment and the records of the examination carried out by the unit's crew at the time of tensioning changes, if any, are to be presented to the Surveyor at each annual survey, for review.

2.1.2 The examination of the mooring components (chain wires or fiber ropes) adjacent to winches or windlasses, stoppers and fairleads is to be performed.

Where relevant, visual inspection of the winches and quick release hooks is also to be performed.

2.1.3 In the case of significant damages revealed during these examinations, or if the Surveyor determines that problems have been experienced since the last annual survey, a more extensive survey may be required by the Surveyor.

3 Intermediate surveys

3.1 Permanent units

3.1.1 General

An intermediate survey is to be performed every two and a half years (2,5) between two renewal surveys. Due to season alternance, a tolerance of ± 9 months may be accepted.

The overall integrity of the mooring system is to be examined, e.g. by general visual inspection of:

- all the lines, in their critical areas
- selected lines, over their full length.

Examination, by visual inspection or other appropriate methods, of the integrity of the critical components with respect to corrosion, wear, overload, fatigue and other possible modes of degradation is to be performed.

The condition of the corrosion protection systems, as applicable, is to be verified.

Pretension setting (or angle value) of each line is to be confirmed.

Additional inspections/tests in accordance with the specific inspection programme are also to be performed.

3.1.2 Global anchoring lines

The records of operation of the -keeping equipment and the records of the examination carried out by the unit's crew at the time of handlings, if any, are to be presented to the Surveyor at each intermediate survey, for review.

3.1.3 Connection with the stoppers

For all the lines, a visual inspection is to be performed, as far as practicable, for the links closest to the stopper. This requirement could be mitigated in case of difficulty of access to this part of the chain (e.g. bell hawse stopper).

3.1.4 Fairleads or stoppers above water level

For units having fairleads or stoppers above water level, the following inspections are to be performed, for all the mooring lines:

- visual examination of the whole line length above water level
- dimensional checks of at least one link in the last 5 meters of chains measured from above water level (two measurements per link is deemed sufficient)
- additional dimensional checks of a link sample in this portion
- measurement of chain angle (or chain tension) at top.

3.1.5 Underwater fairlead or stoppers

For units having fairleads or stoppers below water level, the following inspections are to be performed:

- for all the lines, visual examination of the first 10 m of chain from the fairlead or stopper
- dimensional checks of a link sample in the first 10 m of this chain portion, for a representative number of lines (at least one per bundle in case of bundle configuration).

Specific provisions applicable to fibre rope mooring lines are given in NI432 (see Sec 1, [4.2.2], item b)).

3.1.6 Bottom line segments

For all types of anchoring systems, general visual inspection by divers or ROVs of a representative chain length close to the contact with seabed is to be performed for all the lines.

3.1.7 Jewelleries

General visual inspection of all the jewelleries (sockets, shackles, ...) is to be performed for a representative number of mooring lines.

4 Class renewal surveys

4.1 Permanent units

4.1.1 General

Every five years, at class renewal survey, the overall integrity of the mooring system of permanent units is to be examined, e.g. by general visual inspection of all the lines, over their full length, by ROVs or divers.

Examination, by visual inspection or other appropriate methods, of the integrity of the critical components with respect to corrosion, wear, overload, fatigue and other possible modes of degradation is to be performed.

Marine growth cleaning is not to be performed for the whole length of the mooring line.

When the strength of the upper part of chains, the wire rope sockets and the anchoring devices is relying on corrosion protection systems, the condition of these systems is to be verified by proper means, as applicable. The condition of the anodes, where installed, is to be verified by visual inspection, as applicable. The cathodic protection is also to be verified by direct measurements of the cathodic potential along the cathodically protected parts of the mooring lines and the outcropping parts of the anchors.

Pretension setting (or angle value) of each line is to be confirmed.

Additional inspections/tests in accordance with the specific inspection programme are also to be performed.

4.1.2 Global anchoring lines

The records of operation of the -keeping equipment and the records of the examination carried out by the unit's crew at the time of tensioning changes or modifications, if any, are to be presented to the Surveyor at each class renewal survey, for review.

4.1.3 Fairleads or stopper above water level

For all the lines, an inspection, a dimensional check and a visual inspection are to be performed, as far as practicable, for the links connected to the stopper.

4.1.4 Underwater fairleads or stoppers

For units having fairleads or stoppers below water level, the following inspections are to be performed, for all the mooring lines:

- visual inspection of the chain portion adjacent to the stopper
- dimensional checks of all the links in this portion
 - 3 links just below the fairlead or stopper
 - 3 links between 5 to 10 meters from the fairlead or stopper
- measurement of chain angle (or chain tension) at top.

4.1.5 Wire ropes

Visual inspection is to be performed all along the wire rope segment and any excessive corrosion, visible broken wire, bird-caging damages, damages in the sheathing (if any) are to be reported. The diameter of the wire rope is to be measured all along the wire rope segment of the line.

4.1.6 Fibre ropes

Specific provisions applicable to fibre rope mooring lines are given in NI 432 (see Sec 1, [4.2.2], item b)).

4.1.7 Anchors and buried chains

For anchors and buried chains, the following inspections are to be performed:

- visual inspection of the soil around the anchors, in particular to check the absence of scouring in the vicinity of the anchors

- the buried part of the chains and the connection with the anchors being generally not inspectable, the operation logs are to be examined to have the confirmation that each leg was recently subjected to a significant loading and that the segment has not failed.

Note 1: In addition, IACS Rec. 38 (see Sec 1, [4.2.5]) is to be applied.

4.1.8 Jewellery

General visual inspection of all the jewellerys (sockets, shackles, ...) of all the lines is to be performed.

4.2 Mobile units

4.2.1 The class renewal survey of the mooring system of mobile units granted with the notation **POSA MU** is to be carried out, as far as practicable, the unit being in sheltered waters.

4.2.2 Every five years, at class renewal survey, the following inspections of the mooring system of mobile units are to be performed:

- inspection of chain cables, wire ropes and fiber ropes, consisting in:
 - close visual inspection of their whole length
 - NDT, such as Magnetic Particle Inspection (MPI) of their whole length
 - dimensional checks
- examination of joining shackles and other accessories
- general examination of fairleads, including testing of free rotation capability and NDT (MPI) as necessary, together with visual examination of all the fairlead chain pockets
- general examination of windlasses, including testing of holding ability, together with visual inspection of all the windlass chain pockets
- general examination of winches, including testing of holding ability and of proper laying down of the wire on drum
- examination of the soundness of the load path from the deck appliances to the unit's structure
- functional test of the mooring system during anchor handling operation
- anchor visual examination.

4.3 Units moored at a jetty

4.3.1 Where relevant, the provisions of [4.1] are to be applied for Units moored at a jetty.

4.3.2 Every five years, at class renewal survey, the following inspections of the mooring system of units moored at a jetty are to be performed where relevant:

- general examination of quick release hook, including testing of release ability
- general examination of winches, including testing of holding ability and of proper laying down of the wire on drum
- Visual examination of fenders
- General examination of mooring fittings

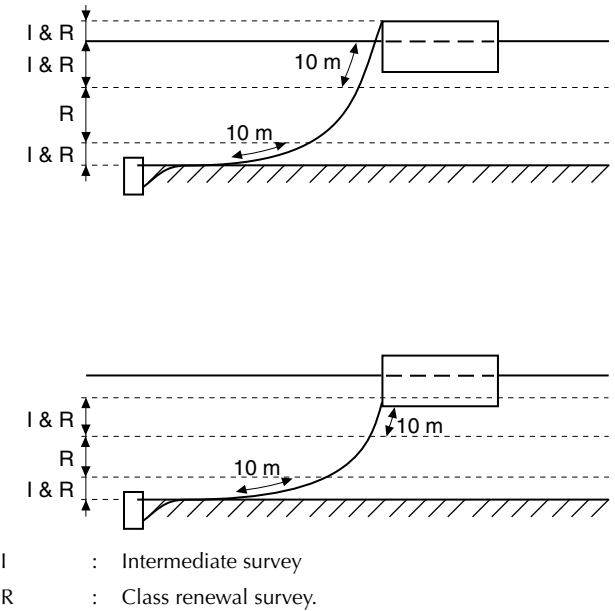
5 Survey summary

5.1 Intermediate and renewal surveys

5.1.1 Fig 1 summarises the intermediate and class renewal surveys to be performed along the anchoring lines of permanent units.

For mobile units, the intermediate and class renewal surveys are to be performed all along the mooring lines (100% of the line is to be inspected).

Figure 1 : Survey summary for permanent units



6 Renewal criteria for chains, steel wire and fibre ropes of permanent installations

6.1 General

6.1.1 For the requirements in this Article, measurements are to be performed after cleaning of the marine growth only at the measurement points.

Note 1: For the purpose of [6.1], it could be referred to API RP 21 (see Sec 1, [4.2.6], item c)).

6.2 Chains

6.2.1 As a rule, for studless or studlink chains, a link is to be considered as defective if one of the following criteria is not satisfied:

- the average of the two measured diameters (90 degrees apart) is to be greater than 95% of the nominal diameter
- the diameter, in any direction, is to be greater than 90% of the nominal diameter.

The final criterion to replace chains is linked to the initial computation hypotheses (mainly the hypotheses on wear and corrosion during design of the mooring system).

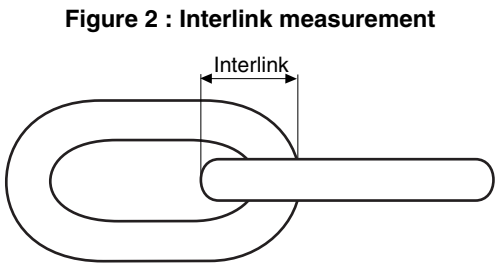
6.2.2 In the case of mooring systems designed taking into account a corrosion margin, the following criterion is to be fulfilled:

$$D_m > 95\% (D - C)$$

where:

- Dm : Weakest measured diameter
- D : Nominal diameter
- C : Total design corrosion margin (annual corrosion rate multiplied by the initial design life).

6.2.3 At least one measurement at the interlink (see Fig 2) and one measurement in another location visually judged as the worst are to be performed.



The presence of large pitting corrosion patterns or remarkable corrosion patterns near link flash butt welding is to be checked with proper means.

Pitts are to be identified and measured. An evaluation of the criticality of the damage is to be submitted to the Surveyor.

6.2.4 In the case the criterion in [6.2.2] is not fulfilled, the party applying for the classification has to demonstrate the compliance of the mooring system with the present note, or is to replace the defective segment.

6.2.5 For studlink chain, if a stud is missing, the link is considered as defective.

6.2.6 Replacement of a link considered as defective is to be based on a plan subject to the Society approval.

6.3 Wire ropes

6.3.1 Damage on the core of the wire ropes or on the sheathing is to be analysed on a case-by-case basis. The API RP 2I (see Sec 1, [4.2.6], item c)) give criteria and recommendations for wire ropes analysis.

6.4 Fiber ropes

6.4.1 For the recommendations and requirements regarding the fiber rope renewal criteria, reference is to be made to NI 432 (see Sec 1, [4.2.2], item b)).

SECTION 3

DESIGN OF MOORING SYSTEM

Symbols

- T_p : Peak period of the wave spectrum, in s
 T_z : Zero-upcrossing period of the wave spectrum, in s
 T_0 : Largest natural period of the system for motions in the horizontal plane, in s
 n_f : Number of elementary Airy wave components.

1 General

1.1 Scope

1.1.1 The scope of the present Section is to provide Class requirements related to the design of a mooring system, with a view to the assignment of one of the **POSA** notations to a floating offshore unit.

The present Section includes:

- guidance methodology for mooring analysis
- design criteria.

Consideration will be given to alternative methodologies, on a case-by-case basis, provided they are demonstrated to provide a safety level equivalent to the one resulting from the application of the present Rule Note.

Note 1: Unless otherwise specified, the documents quoted in Sec 1, [4.2.6] are for general reference and may complement, but not replace, the requirements of the present Rule Note.

1.2 Review of design

1.2.1 For the granting of the **POSA** notations, the proposed design and supporting documentation are reviewed, including the documents in Sec 1, [3.3.1].

Verification is generally performed by independent analysis, following the methodology of this Rule Note.

Note 1: Independent analysis is, by no way, intended to be a substitute for the designer's duty to fully document his design.

1.3 General methodology

1.3.1 The assessment for the assignment of a **POSA** notation covers the following items:

- global lines
- mooring components
- fairleads / stoppers
- anchors.

The global lines are to be assessed for strength (intact, damaged and transient conditions) and for fatigue endurance: Tension-Tension (T-T) and In-Plane/Out-of-Plane Bending (OPB/IPB).

Additional considerations for the integrity of the lines are also to be given (contact of connectors with soil, up-lift at anchor, clashing, synthetic rope minimum tension, ...). All these items are covered by this Rule Note.

2 Methods of evaluation

2.1 Purpose

2.1.1 The purpose of the analysis is to obtain information on the unit motions, the resulting excursions and the line tensions, under some specified metocean conditions representative of:

- either the extreme conditions at intended site, or some limit operating conditions, for the evaluation of design (extreme) values, or
- more frequently occurring conditions, for the assessment of components fatigue.

2.1.2 Available methods

The available analysis methods vary based on the approach taken to evaluate:

- overall system response and resulting excursions and unit motions
- line response and resulting tensions.

Model tests are another possible source of information (see [2.5]).

Guidance and criteria in the present Section are made with reference to the quasi-static, quasi-dynamic and dynamic line response analyses, as defined from [2.4] to [2.5].

2.2 Fully coupled analysis

2.2.1 This method is based on floater dynamic response to a dynamic behavior of the mooring system. The dynamic anchor leg response affects the first and second order motions of the floaters.

Fully coupled analysis is the most accurate and general method.

Fully coupled analysis might be used when couplings are deemed important, or for calibration purpose.

2.3 Quasi-dynamic analysis

2.3.1 Methodology

The quasi-dynamic analysis is a methodology for the analysis of mooring systems developed by the Society, as mentioned in Sec 1, [4.3.1], item a).

This method is based on floater dynamic response to a static behavior of the mooring system.