



# Whipping and Springing Assessment

**July 2015**

**Rule Note  
NR 583 DT R01 E**

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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](mailto:veristarinfo@bureauveritas.com)  
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## MARINE & OFFSHORE DIVISION

### GENERAL CONDITIONS

#### ARTICLE 1

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

The Society:

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

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

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

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

1.5. - The Society is neither and may not be considered as an Underwriter, Broker in ship's sale or chartering, Expert in Unit's valuation, Consulting Engineer, Controller, Naval Architect, Manufacturer, 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.

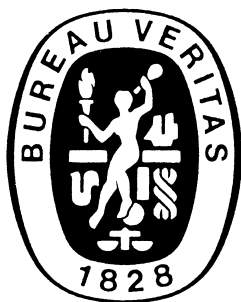
12.3. - Other disputes over the present General Conditions or over the Services of the Society are exclusively submitted to arbitration, by three arbitrators, in London according to the Arbitration Act 1996 or any statutory modification or re-enactment thereof. The contract between the Society and the 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 583

# NR 583 Whipping and Springing Assessment

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**SECTION 1 WHIPPING AND SPRINGING ASSESSMENT**

**APPENDIX 1 METHODOLOGY FOR LONG TERM DIRECT HYDRO-STRUCTURE CALCULATIONS INCLUDING WHIPPING AND SPRINGING RESPONSE**

July 2015

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Appendix 1 Methodology for Long Term Direct Hydro-Structure Calculations including Whipping and Springing Response

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# SECTION 1

# WHIPPING AND SPRINGING ASSESSMENT

## 1 Application

### 1.1 General

**1.1.1** The requirements of the present Rule Note apply to analysis criteria, structural modeling, load modeling and stress and fatigue calculation of ships intended to be granted the additional service feature or additional class notation **WhiSp**, as defined in NR467 Rules for Steel ships, Part A, Ch 1 Sec 2.

**1.1.2** This Rule Note deals with the part of structural analysis which aims at performing ultimate strength and fatigue assessment based on direct hydro-structure calculations including Whipping and Springing response.

**1.1.3** The additional class notation or additional service feature **WhiSp** is completed by **1**, **2** or **3** depending on the level of assessment, as defined in [1.4].

**1.1.4** The additional class notations or additional service features **WhiSp1**, **WhiSp2** and **WhiSp3** are assigned at the design stage.

### 1.2 Additional service feature WhiSp

**1.2.1** An additional service feature **WhiSp1**, **WhiSp2** or **WhiSp3** may only be assigned to ships granted with the service notation **container ship** as defined in NR467 Rules for Steel Ships, Part A, Ch 1 Sec 2.

**1.2.2** The additional service feature **WhiSp1** is to be assigned to container ships of more than 300 m in length between perpendiculars and up to 350 m, for which the requirements of this Rule Note are to be applied. **WhiSp2** or **WhiSp3** may be assigned instead of **WhiSp1** upon request.

**1.2.3** The additional service feature **WhiSp2** is to be assigned to container ships of 350 m in length between perpendiculars and above, for which the requirements of this Rule Note are to be applied. **WhiSp3** may be assigned instead of **WhiSp2** upon request.

### 1.3 Additional class notation WhiSp

**1.3.1** The additional class notations **WhiSp1**, **WhiSp2** or **WhiSp3** may be assigned to ships, other than those subject to [1.2], complying with the requirements of this Rule Note.

### 1.4 Scope

#### 1.4.1 Additional class notation or additional service feature WhiSp1

**WhiSp1** notation covers the effect of linear springing in the fatigue damage assessment, but whipping is not considered neither for fatigue nor for ultimate strength. This notation corresponds to the following calculation steps:

- Linear spectral fatigue assessment defined in [4].

#### 1.4.2 Additional class notation or additional service feature WhiSp2

**WhiSp2** notation corresponds to **WhiSp1** notation with additional whipping computation for ultimate strength assessment. This notation corresponds to the following calculation steps:

- Ultimate strength assessment defined in [3]
- Linear spectral fatigue assessment defined in [4].

#### 1.4.3 Additional class notation or additional service feature WhiSp3

**WhiSp3** notation corresponds to **WhiSp2** notation with additional whipping computation for fatigue assessment. This notation corresponds to the following calculation steps:

- Ultimate strength assessment defined in [3]
- Linear spectral fatigue assessment defined in [4]
- Non-linear fatigue assessment defined in [5].

1.5 Documentation to be submitted

1.5.1 The following data is to be submitted by the Designer:

- The necessary loading conditions as required in [2]
- A provisional lightship distribution
- A list of structural details which will be considered for fatigue calculations. This list is to be agreed on by the Society
- A complete ship finite element model, as described in App 1, [3.2.1]
- Local very fine mesh models for all considered structural details, as described in App 1, [3.2.2].

2 Loading conditions

2.1 Container ships

2.1.1 Ultimate strength assessment

Extreme response analysis is to be carried out for a single loading condition, selected so as to maximise the still water bending moment in hogging.

2.1.2 Fatigue assessment

Fatigue analysis is to be carried out for a single loading condition, selected so as to maximise the still water bending moment in hogging.

2.2 Other types of ships

2.2.1 Ultimate strength assessment

Extreme response analysis is to be carried out for the following loading conditions:

- A full load condition, selected so as to maximise the still water bending moment in hogging or in sagging, as relevant
- A representative ballast condition.

2.2.2 Fatigue assessment

Fatigue analysis is to be carried out for the following loading conditions:

- A representative full load condition, selected in hogging or sagging, as relevant
- A representative ballast condition.

2.3 Additional loading conditions

2.3.1 Additional loading conditions may be considered for these calculations on a case-by-case basis, if deemed relevant by the Society.

3 Ultimate strength assessment

3.1 General

3.1.1 Ultimate strength is checked as shown in Tab 1, using a fully non-linear dynamic structural response including whipping and springing effects.

Table 1 : Ultimate strength assessment

|                                                                    |              | Hydrodynamic loads |                   |          |
|--------------------------------------------------------------------|--------------|--------------------|-------------------|----------|
|                                                                    |              | Linear             | Weakly non-linear | Slamming |
| Structural response                                                | Quasi-static | X                  | (X)               |          |
|                                                                    | Dynamic      |                    |                   | X        |
| Note 1: Optional calculations steps are displayed within brackets. |              |                    |                   |          |

3.2 Ship operational profile

3.2.1 Operating conditions

The vessels are designed for unrestricted navigation. The wave scatter diagram for North Atlantic from IACS Recommendation No. 34 is to be used. This scatter diagram is given in App 1, Tab 1.

The sea states are to be modeled by a Pierson-Moskowitz spectrum and a “cos n” spreading function with n = 2, as defined in App 1, [2.1.2].

### 3.2.2 Loading conditions

The extreme response analysis is to be carried out for the loading conditions defined in [2], depending on the ship type and on the way she is operated. Additional loading conditions may be contemplated on a case-by-case basis.

### 3.2.3 Wave heading

Wave headings are considered uniformly distributed from 0° to 360°.

A different distribution may be used if accurate information is available. The probability of each wave heading (relative angle between the ship route and the wave direction) is then to be defined before running the computations.

### 3.2.4 Speed profile

The ship speed is to be taken as 5 knots in all sea states.

Different speed profiles may be used if accurate information is available. They may be based on full-scale measurement data. The speed dependence on the sea states is then to be defined before running the computations.

## 3.3 Computation of extreme vertical bending moment

### 3.3.1 Linear extreme bending moment

A list of longitudinal locations where the vertical bending moment will be computed is to be defined. This list of cross-sections is to include at least a calculation point in each hold, plus any additional locations deemed necessary.

The vertical bending moment RAO at each cross-section is to be computed using the linear hydrodynamic loads defined in App 1, [3.3.1]. A linear long-term analysis is performed and the extreme value corresponding to a return period of 25 years is computed with a probability of exceedance  $\alpha = 0,63$  (see App 1, [5.2.2]).

Note 1: Vertical bending moment means total vertical bending moment, i.e. it includes the still water bending moment and the wave bending moment.

### 3.3.2 Weakly non-linear loads

This calculation step is optional but can be useful to separate the non-linear effects induced by wave non-linearities and those induced by pure whipping.

The extreme vertical bending moment, corresponding to a return period of 25 years with a probability of exceedance  $\alpha = 0,63$ , is computed at each cross-section, using a Design Sea State approach (see App 1, [5.3]) together with a weakly non-linear time domain hydro-structure model (see App 1, [3.3.2]). The Design Sea State is based on the most contributive sea state to the linear extreme vertical bending moment amidships computed in [3.3.1].

### 3.3.3 Whipping simulations

The extreme vertical bending moment, corresponding to a return period of 25 years with a probability of exceedance  $\alpha = 0,63$ , is computed at each cross-section, using a Design Sea State approach (see App 1, [5.3]) together with a non-linear time domain hydro-structure model including slamming forces (see App 1, [3.3.3]). The Design Sea State is based on the most contributive sea state to the linear extreme vertical bending moment amidships computed in [3.3.1].

## 3.4 Criteria

**3.4.1** It is to be checked that the hull girder ultimate bending capacity at any cross-section is in compliance with the following formula:

$$\frac{M_U}{\gamma_R} \geq M$$

where:

- $M_U$  : Ultimate bending capacity of the hull transverse section defined in NR467, Pt B, Ch 6, Sec 3, with the difference that strength characteristics of the cross-section are obtained considering half of the corrosion additions defined in NR467, Pt B, Ch 4, Sec 2, [2]
- $M$  : Extreme vertical bending moment computed in [3.3.3]
- $\gamma_R$  : Partial safety factor taken equal to 1,1.

4 Linear spectral fatigue assessment

4.1 General

4.1.1 The linear fatigue assessment is computed as shown in Tab 2, with and without springing. The difference between the two computed fatigue damages represents the effect of linear springing on fatigue damage.

Table 2 : Linear fatigue assessment

|                     |              | Hydrodynamic loads |                   |          |
|---------------------|--------------|--------------------|-------------------|----------|
|                     |              | Linear             | Weakly non-linear | Slamming |
| Structural response | Quasi-static | X                  |                   |          |
|                     | Dynamic      | X                  |                   |          |

4.2 Ship operational profile

4.2.1 Operating conditions

The scatter diagram to be used is the worldwide scatter diagram, as defined in App 1, Tab 3. Other scatter diagrams could be considered on a case-by-case basis, if a ship is designed for a specific area.

The sea states are to be modeled by a Pierson-Moskowitz spectrum and a “cos n” spreading function with n = 2, as defined in App 1, [2.1.2].

4.2.2 Loading conditions

The fatigue analysis is to be carried out for the loading conditions defined in [2], depending on the ship type and on the way she is operated. Additional loading conditions which could significantly contribute to the fatigue damage may be contemplated on a case-by-case basis.

4.2.3 Wave heading

Wave headings are considered uniformly distributed from 0° to 360°.

A different distribution may be used if accurate information is available. The probability of each wave heading (relative angle between the ship route and the wave direction) is then to be defined before runing the computations.

4.2.4 Speed profile

The ship speed is to be taken as 60% of the ship design speed in all sea states.

Different speed profiles may be used if accurate information is available. They may be based on full-scale measurement data. The speed dependance on the sea states is then to be defined before runing the computations.

4.3 Fatigue computation

4.3.1 Linear quasi-static fatigue damage

The linear quasi-static stress RAO is computed for each structural detail (defined in [1.5]) according to App 1, [3.3.1] and App 1, [3.4.1]. The linear fatigue damage and the corresponding fatigue life are then derived using sea state statistics from the considered scatter diagram and the appropriate S-N curve (see App 1, [4.2.2]). The damage shall be computed for a return period of 20 years, or xx years when the additional class notation **VeriSTAR-HULL DFL xx years** is assigned.

4.3.2 Linear dynamic fatigue damage

The linear stress RAO including dynamic structural response is computed for each structural detail (defined in [1.5]) according to App 1, [3.3.1] App 1, [3.4.2]. The fatigue damage and the corresponding fatigue life are then derived using sea state statistics from the considered scatter diagram and the appropriate S-N curve. The damage shall be computed for a return period of 20 years, or xx years when the additional class notation **VeriSTAR-HULL DFL xx years** is assigned.