Ship Conversion into Offshore Units – Redeployment and Life Extension of Offshore Units

November 2017

Guidance Note
NI 593 DT R01 E

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MARINE & OFFSHORE - GENERAL CONDITIONS

1. INDEPENDENCY OF THE SOCIETY AND APPLICABLE TERMS

1.1. The Society shall remain at all times an independent contractor and neither the Society nor any of its officers, employees, servants, agents or subcontractors shall be or act as an employee, servant or agent of any other party hereto in the performance of the Services.

1.2. 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.

1.3. The Society acts as a services provider. This cannot be construed as an obligation bearing on the Society to obtain a result or as a warranty. The Society is not and may not be considered as an underwriter, broker in Unit's sale or chartering, expert in Unit's valuation, consulting engineer, controller, naval architect, manufacturer, shipbuilder, repair or conversion yard, charterer or shipowner; none of them above listed being relieved of any of their expressed or implied obligations as a result of the interventions of the Society.

1.4. The Services are carried out by the Society according to the applicable Rules and to the Bureau Veritas' Code of Ethics. The Society only is qualified to apply and interpret its Rules.

1.5. The Client acknowledges the latest versions of the Conditions and of the applicable Rules applying to the Services' performance.

1.6. Unless an express written agreement is made between the Parties on the applicable Rules, the applicable Rules shall be the rules applicable at the time of the Services' performance and con tract's execution.

1.7. The Services' performance is solely based on the Conditions. No other terms shall apply whether express or implied.

2. DEFINITIONS

2.1. "**Certificate(s)**" means class certificates, attestations and reports following the Society's intervention. The Certificates are an appraisement given by the Society to the Client, at a certain date, following surveys by its surveyors on the level of compliance of the Unit to the Society's Rules or to the documents of reference for the Services provided. They 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.

2.2. "**Certification**" means the activity of certification in application of national and international regulations or standards, in particular by delegation from different governments that can result in the issuance of a certificate.

2.3. "**Classification**" means the classification of a Unit that can result or not in the issuance of a class certificate with reference to the Rules.

2.4. "**Client**" means the Party and/or its representative requesting the Services.

2.5. "**Conditions**" means the terms and conditions set out in the present document.

2.6. "**Industry Practice**" means International Maritime and/or Offshore industry practices.

2.7. "**Intellectual Property**" means all patents, rights to inventions, utility models, copyright and related rights, trade marks, logos, service marks, trade dress, business and domain names, rights in trade dress or get-up, rights in goodwill or to sue for passing off, unfair competition rights, rights in designs, rights in computer software, database rights, topography rights, moral rights, rights in confidential information (including know-how and trade secrets), methods and proto cols for Services, and any other intellectual property rights, in each case whether capable of registration, registered or unregistered and including all applications for and renewals, reversions or extensions of such rights, and all similar or equivalent rights or forms of protection in any part of the world.

2.8. "**Parties**" means the Society and Client together.

2.9. "**Party**" means the Society or the Client.

2.10. "**Register**" means the register published annually by the Society.

2.11. "**Rules**" means the Society's classification rules, guidance notes and other documents. 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 minimum requirements but are 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.

2.12. "**Services**" means the services set out in clauses 2.2 and 2.3 but also other services related to Classification and Certification such as, but not limited to: 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.

2.13. "**Society**" means the classification society '**Bureau Veritas Marine & Offshore SAS**', a company organized and existing under the laws of France, registered in Nanterre under the number 821 131 844, or any other legal entity of Bureau Veritas Group as may be specified in the relevant contract, and whose main activities are Classification and Certification of ships or offshore units.

2.14. "**Unit**" means any ship or vessel or offshore unit or structure of any type or part of it or system 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.

3. SCOPE AND PERFORMANCE

3.1. The Society shall perform the Services according to the applicable national and international standards and Industry Practice and always on the assumption that the Client is aware of such standards and Industry Practice.

3.2. Subject to the Services performance and always by reference to the Rules, the Society shall:

- review the construction arrangements of the Unit as shown on the documents provided by the Client;
- conduct the Unit surveys at the place of the Unit construction;
- class the Unit and enters the Unit's class in the Society's Register;
- survey the Unit periodically in service to note that the requirements for the maintenance of class are met. The Client shall inform the Society without delay of any circumstances which may cause any changes on the conducted surveys or Services.

The Society will not:

- declare the acceptance or commissioning of a Unit, nor its construction in conformity with its design, such activities remaining under the exclusive responsibility of the Unit's owner or builder;
- engage in any work relating to the design, construction, production or repair checks, neither in the operation of the Unit or the Unit's trade, neither in any advisory services, and cannot be held liable on those accounts.

4. RESERVATION CLAUSE

4.1. The Client shall always: (i) maintain the Unit in good condition after surveys; (ii) present the Unit after surveys; (iii) present the Unit for surveys; and (iv) inform the Society in due course of any circumstances that may affect the given appraisement of the Unit or cause to modify the scope of the Services.

4.2. Certificates referring to the Society's Rules are only valid if issued by the Society.

4.3. The Society has entire control over the Certificates issued and may at any time withdraw a Certificate at its entire discretion including, but not limited to, in the following situations: where the Client fails to comply in due time with instructions of the Society or where the Client fails to pay in accordance with clause 6.2 hereunder.

5. ACCESS AND SAFETY

5.1. The Client shall give to the Society all access and information necessary for the efficient performance of the requested Services. The Client shall be 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. Any information, drawings, etc. required for the performance of the Services must be made available in due time.

5.2. The Client shall notify the Society of any relevant safety issue and shall take all necessary safety-related measures to ensure a safe work environment for the Society or any of its officers, employees, servants, agents or subcontractors and shall comply with all applicable safety regulations.

6. PAYMENT OF INVOICES

6.1. The provision of the Services by the Society, whether complete or not, involve, for the part carried out, the payment of fees thirty (30) days upon issuance of the invoice.

6.2. Without prejudice to any other rights hereunder, in case of Client's payment default, the Society shall be entitled to charge, in addition to the amount not properly paid, interests equal to twelve (12) months LIBOR plus two (2) per cent as of due date calculated on the number of days such payment is delinquent. The Society shall also have the right to withhold certificates and other documents and/or to suspend or revoke the validity of certificates.

6.3. In case of dispute on the invoice amount, the undisputed portion of the invoice shall be paid and an explanation on the dispute shall accompany payment so that action can be taken to solve the dispute.

7. 7. LIABILITY

7.1. The Society bears no liability for consequential loss. For the purpose of this clause consequential loss shall include, without limitation:

- Indirect or consequential loss;
- Any loss and/or deferral of production, loss of product, loss of use, loss of bargain, loss of revenue, loss of profit or anticipated profit, loss of business and business interruption, in each case whether direct or indirect.

The Client shall save, indemnify, defend and hold harmless the Society from the Client's own consequential loss regardless of cause.

7.2. In any case, the Society's maximum liability towards the Client is limited to one hundred and fifty per-cents (150%) of the price paid by the Client to the Society for the performance of the Services. This limit applies regardless of fault by the Society, including breach of contract, breach of warranty, tort, strict liability, breach of statute.

7.3. All claims shall be presented to the Society in writing within three (3) months of the Services' performance or (if later) the date when the events which are relied on were first discovered by the Client. Any claim not so presented as defined above shall be deemed waived and absolutely time barred.

8. INDEMNITY CLAUSE

8.1. The Client agrees to release, indemnify and hold harmless the Society from and against any and all claims, demands, lawsuits or actions for damages, including legal fees, for harm or loss to persons and/or property tangible, intangible or otherwise which may be brought against the Society, incidental to, arising out of or in connection with the performance of the Services except for those claims caused solely and completely by the negligence of the Society, its officers, employees, servants, agents or subcontractors.

9. TERMINATION

9.1. The Parties shall have the right to terminate the Services (and the relevant contract) for convenience after giving the other Party thirty (30) days' written notice, and without prejudice to clause 6 above.

9.2. In such a case, the class granted to the concerned Unit and the previously issued certificates shall remain valid until the date of effect of the termination notice issued, subject to compliance with clause 4.1 and 6 above.

10. FORCE MAJEURE

10.1. Neither Party shall be responsible for any failure to fulfil any term or provision of the Conditions if and to the extent that fulfilment has been delayed or temporarily prevented by a force majeure occurrence without the fault or negligence of the Party affected and which, by the exercise of reasonable diligence, the said Party is unable to provide against.

10.2. For the purpose of this clause, force majeure shall mean any circumstance not being within a Party's reasonable control including, but not limited to: acts of God, natural disasters, epidemics or pandemics, wars, terrorist attacks, riots, sabotages, impositions of sanctions, embargoes, nuclear, chemical or biological contaminations, laws or action taken by a government or public authority, quotas or prohibition, expropriations, destructions of the worksite, explosions, fires, accidents, any labour or trade disputes, strikes or lockouts

11. CONFIDENTIALITY

11.1. The documents and data provided to or prepared by the Society in performing the Services, and the information made available to the Society, are treated as confidential except where the information:

- is already known by the receiving Party from another source and is properly and lawfully in the possession of the receiving Party prior to the date that it is disclosed;
- is already in possession of the public or has entered the public domain, otherwise than through a breach of this obligation;
- is acquired independently from a third party that has the right to disseminate such information;
- is required to be disclosed under applicable law or by a governmental order, decree, regulation or rule or by a stock exchange authority (provided that the receiving Party shall make all reasonable efforts to give prompt written notice to the disclosing Party prior to such disclosure.

11.2. The Society and the Client shall use the confidential information exclusively within the framework of their activity underlying these Conditions.

11.3. Confidential information shall only be provided to third parties with the prior written consent of the other Party. However, such prior consent shall not be required when the Society provides the confidential information to a subsidiary.

11.4. The Society shall have the right to disclose the confidential information if required to do so under regulations of the International Association of Classifications Societies (IACS) or any statutory obligations.

12. INTELLECTUAL PROPERTY

12.1. Each Party exclusively owns all rights to its Intellectual Property created before or after the commencement date of the Conditions and whether or not associated with any contract between the Parties.

12.2. The Intellectual Property developed for the performance of the Services including, but not limited to drawings, calculations, and reports shall remain exclusive property of the Society.

13. ASSIGNMENT

13.1. The contract resulting from to these Conditions cannot be assigned or transferred by any means by a Party to a third party without the prior written consent of the other Party.

13.2. The Society shall however have the right to assign or transfer by any means the said contract to a subsidiary of the Bureau Veritas Group.

14. SEVERABILITY

14.1. Invalidity of one or more provisions does not affect the remaining provisions.

14.2. Definitions herein take precedence over other definitions which may appear in other documents issued by the Society.

14.3. In case of doubt as to the interpretation of the Conditions, the English text shall prevail.

15. GOVERNING LAW AND DISPUTE RESOLUTION

15.1. The Conditions shall be construed and governed by the laws of England and Wales.

15.2. The Society and the Client shall make every effort to settle any dispute amicably and in good faith by way of negotiation within thirty (30) days from the date of receipt by either one of the Parties of a written notice of such a dispute.

15.3. Failing that, the dispute shall finally be settled by arbitration under the LCIA rules, which rules are deemed to be incorporated by reference into this clause. The number of arbitrators shall be three (3). The place of arbitration shall be London (UK).

16. PROFESSIONNAL ETHICS

16.1. Each Party shall conduct all activities in compliance with all laws, statutes, rules, and regulations applicable to such Party including but not limited to: child labour, forced labour, collective bargaining, discrimination, abuse, working hours and minimum wages, anti-bribery, anti-corruption. Each of the Parties warrants that neither it, nor its affiliates, has made or will make, with respect to the matters provided for hereunder, any offer, payment, gift or authorization of the payment of any money directly or indirectly, to or for the use or benefit of any official or employee of the government, political party, official, or candidate.

16.2. In addition, the Client shall act consistently with the Society's Code of Ethics of Bureau Veritas. http://www.bureauveritas.com/home/about-us/ethics+and+compliance/

GUIDANCE NOTE NI 593

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Ship Conversion into Offshore Units - Redeployment and Life Extension of Offshore Units

November 2017

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SECTION 1 GENERAL

1 General

1.1 Application

1.1.1 The present Guidance Note provides guidelines for the classification of surface offshore units further to the conversion of an existing ship and intended to be assigned with the structural type notation **offshore service ship** or **offshore service barge**, as defined in Pt A, Ch 1, Sec 2 of the Offshore Rules.

1.1.2 The present Guidance Note also provides guidelines for the redeployment and life extension of existing offshore units.

1.1.3 The present Guidance Note is to be used with the Offshore Rules and the Ship Rules as referenced in [1.6] and which remain applicable unless otherwise mentioned.

1.2 Scope

1.2.1 The present Guidance Note addresses:

- the structural assessment of the hull, including a methodology for the determination of the steel renewal criteria (see App 2)
- the machinery, electrical and safety systems, including principles for the status of unchanged, modified and new systems in case of conversion of a ship into an offshore unit
- the scope of survey during conversion work and before redeployment or life extension of existing offshore units.

1.3 Ship eligibility for conversion

1.3.1 Ship eligibility for conversion is conditional on a design approved by the Society or a member of the International Association of Classification Societies (IACS).

1.3.2 On a case-by-case basis, the Society may require additional assessment and information, as relevant, in order to agree on the suitability of the conversion for classification purpose.

1.4 Society's involvement

1.4.1 Conversion and redeployment

In addition to the involvement of the Society described in Part A of the Offshore Rules, in case of conversion or redeployment, the scope of classification covers the design approval and the conversion work survey as described in [4].

For each project, the detailed boundaries for the classification of units are to be defined in accordance with the Society and with reference to the requested class notations.

1.4.2 Life extension

When an offshore unit is expected to be used beyond its actual design life at the same site, life extension studies, in particular fatigue assessment as required in Sec 3 are to be performed.

These studies are to be supported by a condition assessment survey of the structure and the review of the unit's records.

1.5 Assignment and maintenance of class

1.5.1 The applicable rules for the assignment, maintenance and withdrawal of the class are detailed in Part A of the Offshore Rules.

1.6 Referenced documents

1.6.1 Offshore Rules

Offshore Rules means Bureau Veritas Rules for the Classification of Offshore Units (NR445). When reference is made to the Offshore Rules, the latest version of these ones is applicable.

1.6.2 Ship Rules

Ship Rules means Bureau Veritas Rules for the Classification of Steel Ships (NR467). When reference is made to the Ship Rules, the latest version of these ones is applicable.

1.7 Definitions

1.7.1 Conversion of a unit

For the purpose of the present Guidance Note, conversion of a unit means the engineering, repair/renewal, modification and/or construction works needed to transform an existing unit or ship into an offshore surface unit as defined in Part A, Chapter 1 of the Offshore Rules.

1.7.2 Redeployment of a unit

For the purpose of the present Guidance Note, redeployment of an existing offshore unit means the engineering, repair/renewal, modification and/or construction works needed when the unit is installed on a new site or when the units is substantially modified, i.e.:

- substantial extension of the topsides or superstructures area or mass, or
- addition of a new loading condition beyond the allowable hull girder loads in the loading manual of the unit, or
- addition of a new heavy equipment inducing important loads (e.g. crane, winch, mooring line, riser).

1.7.3 Life extension

For the purpose of the present Guidance Note, life extension of an existing offshore unit means the engineering and repair/renewal needed when the operating life is extended beyond the previous design life at the same location.

1.7.4 Ship areas / Offshore areas

The definition of ship areas and offshore areas are given in Part D, Chapter 1 of the Offshore Rules.

1.7.5 New Requested Design Life (RDL)

The new Requested Design Life, in years, corresponds to the new design life of the unit operated on the considered site, after its conversion work or redeployment.

2 Design Criteria Statement

2.1 General

2.1.1 Classification is based upon the design data or assumptions specified by the party applying for classification. A Design Criteria Statement is a document listing the services performed by the unit and the design conditions and other assumptions on the basis of which class is assigned to the unit.

The Design Criteria Statement is to based on the information provided by the party applying for classification.

The Design Criteria Statement is to be incorporated in the Operating Manual, as stated in Pt A, Ch 1, Sec 1 of the Offshore Rules.

The content of the Design Criteria Statement is specified in Pt D, Ch 1, Sec 1 of the Offshore Rules.

3 Transit

3.1 General

3.1.1 During transit operations, requirements given in Pt D, Ch 1, Sec 1 of the Offshore Rules are to be complied with.

Note 1: The surveillance of the transit is excluded from the scope of classification. A Marine Warranty Survey should be performed by a competent third party.

4 Inspection and testing

4.1 Conversion work survey

4.1.1 General

The survey occurring during conversion work is to include as a minimum the requirements of class renewal survey in terms of inspections, tests and checks as defined in Part A, Chapter 2 of the Offshore Rules and in particular:

- complete scantling measurement to evaluate the condition of the unit's structure
- bottom inspection

The measured scantlings of the existing structure is to be compared against the renewal scantlings criteria as defined in App 2.

Note 1: When the additional class notation **VeriSTAR-Hull CM** is assigned, close-up inspection of hot spot areas is to be performed.

4.1.2 Construction survey

Inspections of the new steel structure are to be in accordance with Pt B, Ch 3, Sec 6 of the Offshore Rules.

A construction survey scheme is to be established in compliance with NR426, Construction Survey of Steel Structures of Offshore Units and Installations. The construction survey scheme is to include the inspection requirements for:

- forming of rolled steel
- welding of steel and qualification of welding procedure and welders
- welding inspections (see App 1).

4.1.3 Tank and compartment testing

The tests of the various compartments and watertight members are to be conducted in the presence of the Surveyor and in accordance with Pt B, Ch 3, Sec 7 of the Offshore Rules.

4.2 Survey before redeployment

4.2.1 The survey occurring before redeployment of an offshore unit is to include as a minimum the requirements of class renewal survey in terms of inspections and testing as defined in Part A, Chapter 2 of the Offshore Rules and in particular:

- complete scantling measurement to evaluate the condition of the unit's structure
- bottom inspection
- condition assessment of the machinery, electrical and safety systems.

Note 1: When the additional class notation **VeriSTAR-Hull CM** is assigned, close-up inspection of hot spot areas is to be performed.

4.3 Survey before life extension

4.3.1 The survey occurring before life extension of an offshore unit is to include as a minimum the requirements of class renewal survey in terms of inspections and testing as defined in Pt A, Ch 2 of the Offshore Rules and in particular:

- complete scantling measurement to evaluate the condition of the unit's structure
- bottom inspection
- condition assessment of the machinery, electrical and safety systems
- close up inspection of structural details sensitive to fatigue.

Note 1: When the additional class notation **VeriSTAR-Hull CM** is assigned, close-up inspection of hot spot areas is to be performed.

4.4 In-service surveys on site

4.4.1 The surveys in-service are to be conducted in accordance with Part A, Chapter 2 of the Offshore Rules.

5 Structural assessment methodology

5.1 General

5.1.1 The party applying for classification is to propose a structural assessment methodology in accordance with the provisions of the present Guidance Note. The assessment methodology is to be agreed by the Society.

5.1.2 A general structural assessment methodology is proposed in Sec 3.

6 Protection of the hull structure

6.1 General

6.1.1 Protection system

It is the responsibility of the party applying for classification to choose the system that will perform the protection of the structure against corrosion.

A protection system is composed of one or a combination of the following methods:

- application of protective coatings
- cathodic protection (sacrificial anodes or impressed current system)
- selection of material.

It is also the responsibility of the party applying for classification to have the system applied in accordance with the manufacturer's requirements.

6.1.2 Protection methods

The protection methods and the design of corrosion protection systems are to be in accordance with the requirements of Part B, Chapter 3 of the Offshore Rules.

6.2 Plan for the corrosion protection

6.2.1 An overall plan for the corrosion protection of the structure is to be prepared and submitted to the Society, in accordance with the provisions of Part B, Chapter 3 of the Offshore Rules.

The plan for the corrosion is to cover the following areas of the structure:

- all external areas (e.g. submerged area, splash zone)
- internal areas (e.g. ballast tanks, storage tanks).

The plan for the corrosion is to take into account:

- the intended duration of operations and conditions of maintenance
- the particular conditions in each area.

7 Documents to be submitted

7.1 General

7.1.1 The documentation to be submitted for classification purpose is specified in:

- Offshore Rules, Pt A, Ch 1, Sec 4 and Offshore Rules, Pt D, Ch 1, Sec 1, and
- in [7.2] to [7.4], as applicable.

Any other document deemed relevant by the Society may be required.

7.2 Documentation of the existing ship or offshore unit

7.2.1 Required documentation of the ship or offshore unit under consideration is to include the following information:

- general arrangement drawings
- capacity plan
- lines plan and appendices on hull
- structural drawings
- trim and stability booklet
- loading manual
- repair and renewal history of hull structure
- all surveys reports and records from the Classification Society
- hull structure condition:
  - condition assessment report
  - table of complete scantling measurements of the structure

Note 1: The party applying for classification is to provide the actual hull scantlings based on a complete hull survey or wastage assumption of the steel structure.

- trading routes history in case of conversion of ship into offshore units

Note 2: As a rule, the routes history of the ship is to be provided in purpose of the calculation of the actual fatigue damage. In the case where incomplete routes history are provided, adequate assumptions on navigation coefficient are to be considered as stated in Sec 3, [4.2].

7.3 Documentation for conversion and redeployment

7.3.1 Prior to conversion work, project documentation and structure assessment calculations are to be submitted to the Society.

a) structural calculations and drawings:
   - calculations assessment of the structure scantling
   - hull structural drawings showing:
     - gross thickness (t_G)

     Note 1: This gross thickness will be the new reference thickness for the in-service survey of the hull.

     - corrosion addition considered (t_c)
     - thickness increment (t_i), if any

- table of renewal thickness criteria during conversion/redeployment work

Note 2: The renewal or reinforcement scantlings are to be submitted preferably in the form of structural drawings with tables of renewal and reinforcement scantlings.

- drawings of new and modified superstructure and topsides.

b) conversion work specification including:

- foreseen steel renewal and structure reinforcements
- close-up inspection program.

c) machinery, electrical and safety systems:

- preservation plan with description of the existing machinery, electrical and safety systems intended to be retained and those intended to be modified
- description of the automation and control systems in the machinery spaces and an FMEA when relevant.

d) Local Authority requirements.

7.3.2 Attention is drawn to the following data and documents which are to be provided as required in Offshore Rules, Pt D, Ch 1, Sec 1:

a) design criteria and data:

- design data defined in [2]
- new site environmental data
- new operating loading conditions
- new loading manual with allowable hull girder loads
- new weight estimate and distribution
- requested design life after conversion
- thickness increments (as relevant when the notation **STI**, as defined in the Offshore Rules Pt A Ch 1 Sec 2, is assigned).

b) hydrodynamic analysis for site and transit condition.

c) general drawings:

- general arrangement with location of new systems, equipment and structures
- general arrangement of the hazardous areas
- capacity plan with new liquid characteristics.

7.4 Documentation for life extension

7.4.1 The following project documentation is to be submitted to the Society:

a) structural calculations and drawings:

- structure fatigue damage calculations
- hull structural drawings showing reinforced or modified details.

b) life extension specification including:

- foreseen steel renewal and structure reinforcements
- close-up inspection program.

Any other document deemed relevant by the Society may be required.

SECTION 2 DESIGN LOADS

1 General

1.1 Application

1.1.1 The present Section provides requirements for design loads applied for structural assessment of the unit.

Unless otherwise specified in the present Section, the design loads are to be assessed as per Part D, Chapter 1 of the Offshore Rules.

1.2 Documentation to be submitted

1.2.1 The documentation to be submitted is listed in Sec 1, [7].

1.2.2 All documents deemed necessary for the evaluation of the design loads of the unit before conversion or redeployment works are to be provided.

1.3 Design loads

1.3.1 Loading conditions

Loading conditions are to be representative of every configuration of weight distribution as defined in the loading manual of the unit.

As a rule, the loading conditions considered for the primary supporting members analysis are to include the design loading conditions specified in Pt D, Ch 1, Sec 7 of the Offshore Rules. Loading conditions which are prohibited in operation are to be explicitly mentioned in the loading manual.

Loading conditions are to be separated into five categories:

- maximum/minimum conditions
- intermediate conditions
- inspection conditions
- towing/transit condition
- accidental loading conditions.

1.3.2 Load cases

For each loading condition the load cases defined in Pt D, Ch 1, Sec 5 of the Offshore Rules are to be considered.

1.3.3 Loads

The assessment of the structure is to consider relevant loads associated with loading conditions including:

- still water loads
- extreme environmental loads during unit's expected life
- offloading loads, if relevant
- loads from limiting conditions before the disconnection from single point mooring, if relevant
- loads during maintenance or inspection operations
- transit/towing loads
- additional loads induced by process and other equipment, in above conditions, as relevant
- flooding loads
- collision loads.

1.3.4 Fatigue calculations

Loading conditions and load cases to be considered for fatigue assessment are described in Sec 3, [4].

2 Hydrodynamic analysis

2.1 Principle

2.1.1 Application

Hydrodynamics analysis is to be performed for both site conditions and towing/transit phases.

Hydrodynamic calculations are mandatory and are to be conducted as specified in Pt D, Ch 1, Sec 4 of the Offshore Rules.

2.1.2 Objectives

The purpose of hydrodynamic analysis is to obtain the parameters related to wave loading for on site and transit/towing conditions.

The main steps of the analysis are:

a) determine the floating unit responses for combination sets of headings, advance speeds and loading conditions

b) determine the extreme values of parameters related to wave loading

c) determine the design wave loads as per Pt D, Ch 1, Sec 5 of the Offshore Rules.

2.1.3 Site conditions and navigation notation

On a case-by-case basis, the Society may exempt the converted or redeployed unit from hydrodynamic analysis provided that a navigation notation completes the site notation of the unit and the site conditions are considered less severe than the navigation notation conditions.

3 Transit conditions

3.1 General

3.1.1 Transit wave loads are to be evaluated with an hydrodynamic analysis in accordance with [2].

On a case-by-case basis, the Society may exempt the unit from hydrodynamic analysis provided that a navigation notation completes the transit notation of the unit and the actual transit conditions are considered less severe than the navigation notation conditions.

SECTION 3 STRUCTURAL ASSESSMENT

Symbols

Age : Age of ship at the time of conversion, in years

D : Fatigue Damage ratio

RDL : Requested Design Life, in years, after conversion work, as defined in Sec 1, [1.7.5].

1 General

1.1 Application

1.1.1 The present Section provides requirements for the structural assessment of surface offshore units when converted from ships and for life extension or redeployment of existing offshore units.

1.2 Principles

1.2.1 Ship area

As a rule, the structural assessment of the ship areas is mandatory and is to be conducted according to Part D, Chapter 1 of the Offshore Rules.

On a case-by-case basis, the Society may grant exemptions from structural assessment provided the conditions defined in [1.3] are satisfied.

1.2.2 Offshore area

The structural assessment of the offshore areas should be conducted according to Part B, Chapter 3 of the Offshore Rules.

In case of ship conversion into an offshore unit, the offshore areas are not limited to the new structure.

Special consideration is to be given to fatigue analysis of existing offshore areas in case of redeployment or extension of design life of offshore units.

1.3 Structural assessment exemption

1.3.1 Strength assessment exemption

For the ship areas, on a case-by-case basis, the Society may grant exemption from yielding and buckling checks and hull girder strength verification provided the following conditions are respected:

- the new scantling draught is equal or lower than the actual one, and
- the new maximum cargo density is equal or lower than the actual one, and
- the new procedures for the loading/unloading of cargo tanks comply with the restrictions applicable to the existing ship (e.g. partial filling not allowed, alternate loading not allowed)
- the new still water hull girder loads are inside the actual allowable limit curves, and
- the new wave loads are considered less severe than unrestricted navigation (or actual navigation notation) or less severe than the previous site conditions, and
- the thickness diminution due to corrosion of the hull structure is under the renewal limits defined in Part A, Chapter 2 of the Offshore Rules, and
- no added topsides and in general no added weight onboard nor modifications of the weight distribution.

Exemption do not apply to additional structural assessment to be conducted under requirements of [3.5].

1.3.2 Fatigue assessment exemption

On a case-by-case basis, the Society may grant exemption from structural fatigue assessment provided that the RDL added to the age of the unit is less than the as-built design life.

1.4 Definitions

1.4.1 Reassessed net thickness (t_{reass})

The reassessed net thickness is the net scantling corresponding to the gross thickness defined in [1.4.4]:

$t_{reass} = t_G - t_c$

1.4.2 Rule corrosion additions (t_c)

Rule corrosion additions are to be considered in the structural assessment and calculated as defined in [2.2].

1.4.3 Thickness increment (t_i)

Thickness increments may be added for the new structural parts to the gross thickness t_G when requested by the party applying for classification, under the scope of the additional class notation **STI**.

The thickness increment values are to be provided by party applying for classification preferably at the earliest stage of the project and to be stated in the Design Criteria Statement.

1.4.4 Gross thickness (t_G)

The gross thickness is the gross scantling value of the structure, as defined on structural drawings as per Sec 1, [7.3.1], which is to comply with the criteria for structural assessment as defined in [3]:

$t_G = t_{reass} + t_c$

Note 1: The gross thickness t_G may be lower or higher than existing hull scantlings.

1.4.5 New structure thickness ($t_{new\ structure}$)

The new structure thickness is the gross thickness t_G with the addition of an owner specific increment (t_i), if any:

$t_{new\ structure} = t_G + t_i$

Table 1 : Corrosion additions t_C and corrosion rate C_R, for each exposed side

Compartment type		General **(1)**		Upper zone **(2)**	
		c_R mm/yr	$t_{c\,max}$ mm	c_R mm/yr	$t_{c\,max}$ mm
Ballast tank **(3)**		0,050	1,00	0,063	1,25
Cargo oil tank and fuel oil tank	Plating of horizontal surfaces	0,038	0,75	0,050	1,00
	Plating of non-horizontal surfaces	0,025	0,50	0,050	1,00
	Ordinary stiffeners and primary supporting members	0,038	0,75	0,050	1,00
Accommodation space		0,000	0,00	0,000	0,00
Compartments other than those mentioned above Outside sea and air		0,025	0,50	0,025	0,50

(1) General: corrosion additions t_c are applicable to all members of the considered item with possible exceptions given for upper and lower zones.

(2) Upper zone: area within 1,5 m below the top of the tank or the hold. This is not to be applied to tanks in the double bottom.

(3) Ballast tank: does not include cargo oil tanks which may carry ballast according to Regulation 3 of MARPOL 73/78.

2 Corrosion margins

2.1 Net scantling approach

2.1.1 The scantlings obtained by applying the criteria specified in this Section are net scantlings, i.e. those which provide the strength characteristics required to sustain the loads, excluding any addition for corrosion, and are to be compared to the reassessed net scantling as defined in [1.4.1] for strength assessment.

Except when specified otherwise in this Section, the structural checks are to be carried out on the basis of the net strength characteristics derived from the gross thickness t_G as specified in Ship Rules Pt B, Ch 4, Sec 2, [2].

2.2 Values of corrosion additions

2.2.1 As a rule, values of rule corrosion additions t_c for each exposed side are to be the smallest of:

$t_c = c_R$ RDL

$t_c = t_{c\,max}$

where:

c_R : Corrosion rate in mm per year to be taken from Tab 1

$t_{c\,max}$: To be taken from Tab 1.

t_c : To be taken not smaller than 0,25 mm for each exposed side.

If the party applying for classification specifies values of corrosion additions greater than those defined in Tab 1, the difference is to be stated in Design Criteria Statement as thickness increments t_i.

2.2.2 In general, the maximum corrosion addition ($t_{c\,max}$) to be considered for the plating forming the boundary between two compartments of different types is equal to:

- for plating with a gross thickness greater than 10 mm, the sum of the values specified in Tab 1 for one side exposure to each compartment
- for plating with a gross thickness less than or equal to 10 mm, the smallest of the following values:
  - 20% of the gross thickness of the plating
  - sum of the values specified in Tab 1 for one side exposure to each compartment.

For an internal member within a given compartment, or for plating forming the boundary between two compartments of the same type, the corrosion addition to be considered is twice the value specified in Tab 1 for one side exposure to that compartment.

2.2.3 For structural members made of stainless steel, the corrosion addition t_c is to be taken equal to 0.

3 Structural assessment

3.1 Purpose

3.1.1 Purpose of the structural assessment is to obtain reassessed scantlings which satisfy the structural verification of the present Article for each structural element.

The following values are to be submitted:

- t_{reass} : reassessed net thickness, as defined in [1.4.1]
- t_G : gross thickness, as defined in [1.4.4].

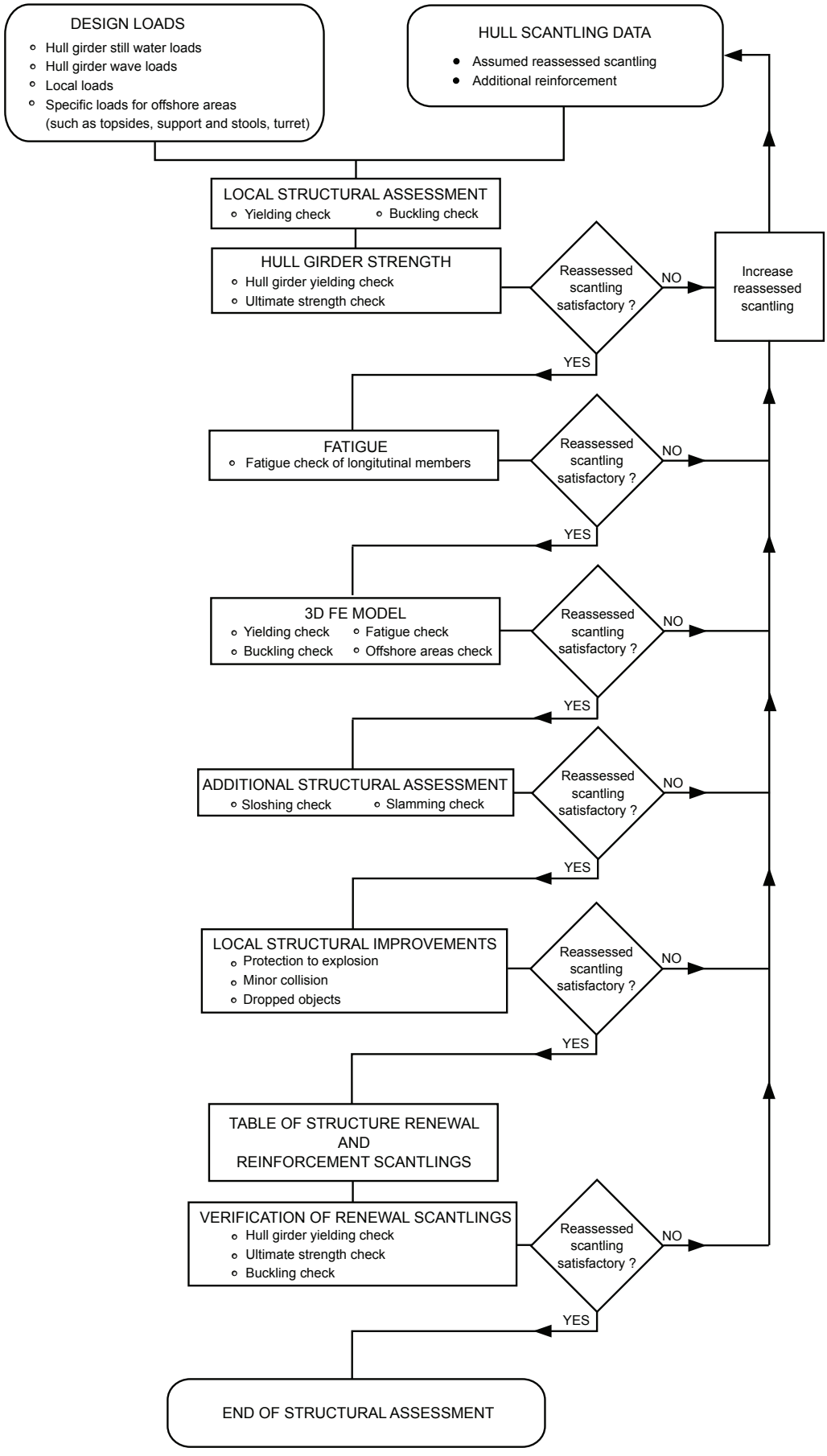
3.2 Methodology

3.2.1 The methodology for structural assessment is illustrated by the flow chart in Fig 1. Alternative methodology may be accepted provided that the following structural checks are included:

a) local structural assessment:
   - yielding check
   - buckling check.

b) hull girder strength:
   - hull girder yielding check
   - ultimate strength check.

Figure 1 : Flow chart of the methodology for structural assessment



c) fatigue:
   - fatigue check of longitudinal members.

d) finite element analysis with partial 3D model:
   - primary supporting members yielding and buckling checks
   - fatigue check of structural details.

e) additional structural assessment
   - sloshing check
   - slamming check.

f) local structural improvements:
   - protection to explosion
   - minor collision
   - dropped objects.

g) verification of renewal scantlings (see App 2):
   - hull girder check
   - ultimate strength check
   - buckling check.

Note 1: Several iterative calculations for the determination of minimum values of reassessed scantlings may be performed, as shown in Fig 1, in order to obtain the minimum steel renewal values.

3.3 Hull girder strength

3.3.1 The hull girder transverse sections are to comply with Pt D, Ch 1, Sec 6 of the Offshore Rules. The following checks are to be conducted for all members:

- hull girder yielding check, with gross section characteristics based on gross thicknesses
- ultimate strength, with net section characteristics based on reassessed net scantlings.

3.4 Local structural assessment

3.4.1 The hull reassessed net scantlings are to comply with yielding and buckling strength requirements in Pt D, Ch 1, Sec 7 of the Offshore Rules.

The local structural assessment due to new loads is mandatory.

3.5 Additional structural assessment

3.5.1 Sloshing

The sloshing assessment in the cargo tanks is mandatory and is to be conducted according to Pt D, Ch 1, Sec 5 of the Offshore Rules.

However, on a case-by-case basis, the Society may grant exemption from sloshing assessment provided the new loading conditions do not include any partial loading of cargo tanks which are not included in the actual loading manual.

3.5.2 Slamming

The structural assessment of the flat bottom forward area due to slamming load is mandatory and is to be conducted according to Pt D, Ch 1, Sec 8 of the Offshore Rules.

However, on a case-by-case basis, the Society may grant exemption provided the new minimum draft is higher than actual one.

3.6 Local structural improvements

3.6.1 The calculations of the structural improvements against collision, explosion and dropped objects may have to be submitted as defined in Pt B, Ch 3, Sec 9 of the Offshore Rules.

3.7 Finite element analysis

3.7.1 Application

Structural assessment through partial 3D finite element model is to be performed expect when exempted as stated in [1.3].

The finite element analysis is to be conducted according to Pt D, Ch 1, Sec 7 of the Offshore Rules.

The purpose of finite element analysis is to:

- assess the primary structure for yielding and buckling checks, and
- check the fatigue criteria of structural details as defined in [4], and
- define the hot spots areas when the additional class notation **VeriSTAR-Hull CM**, as defined in Ship Rules Pt A, Ch 1, Sec 2, is assigned.

Note 1: The purpose of the map of the hot spots is to locate the areas subject to close-up inspections during the conversion/redeployment works.

Note 2: In addition, units intended to receive the additional notation **VeriSTAR-Hull FLM** are to comply with the requirements of NR551 "Structural Analysis of Offshore Surface Units through Full Length Finite Elements Models".

4 Fatigue

4.1 General

4.1.1 Procedure

The procedure to be followed is detailed below:

a) calculate the past life accumulated fatigue damage ratio, $D_{past,}$ of the detail

b) calculate the fatigue damage ratio during transit phase, D_{tow}, when deemed necessary

c) calculate the fatigue damage ratio due to wave load on site, D_{site}

d) calculate low cycle fatigue damage ratio due to loading / unloading, $D_{L/U}$, when deemed necessary,

e) evaluate fatigue criteria combining above damages, as defined in [4.5].

The structural elements which are added or renewed during conversion work are not subject of D_{past} calculations.

4.1.2 Methods for fatigue analysis

For units intended to be granted the additional class notation **Spectral Fatigue ( )**, as defined in Part A of the Offshore Rules, the fatigue analysis should be performed according to NI 611 Guidelines for Fatigue Assessment of Steel Ships and Offshore Units.

The information between the brackets is a description of:

- past life conditions: the route/areas considered, or
- transit conditions, or
- site conditions, as applicable.

For all other units, a deterministic fatigue analysis is to be carried out in accordance with Pt D, Ch 1, Sec 7 of the Offshore Rules.

4.1.3 Structural details

The selection of structural details to be evaluated is to result from a screening analysis agreed with the Society. The list of minimum structural details to be checked is provided in Pt D, Ch 1, Sec 7 of the Offshore Rules.

4.1.4 Corrosion addition

The net scantling considered for fatigue calculations is to be as given in [2.1].

4.2 Past life accumulated fatigue damage

4.2.1 Accumulated damage calculations are to be assessed based on unit past life.

For conversion of a ship, the evaluation of accumulated fatigue damage may be based on routes history, if available, as defined in [4.2.2] or on defaults assumption as defined in [4.2.3].

All the structural details for which the fatigue is to be assessed on site as per [4.4], are also to be assessed for the past life fatigue.

For redeployment or life extension of an existing offshore unit, the evaluation of accumulated fatigue damage is to be based on past site conditions and all transits phases from construction yards to previous site when deemed necessary, in accordance with the Offshore Rules.

Note 1: The extent of the design fatigue calculation is to take into account any systematic fatigue deteriorations found during the hull survey. Similarly, the Society may require additional fatigue analysis if systematic fatigue deteriorations are discovered after submission of fatigue calculations.

4.2.2 Accumulated damage based on ship history

When available, accumulated damage ratio of the unit may be assessed based on trading routes history:

- past fatigue life: age of the ship (Age)
- sailing factor: based on history of ship
- loading conditions: based on history of ship
- wave statistics data: based on routes history of ship.

By using available wave statistics data on the routes, a scatter diagram giving probability of wave heights and wave periods is to be built. The methodology of decomposition of trading routes history is to be provided. A guidance is provided in App 3.

When the additional class notation **Spectral Fatigue ( )** is intended to be granted to the unit, spectral fatigue approach is to be used according to NI 611. For this purpose, 2D fatigue analysis of the longitudinal stiffeners may be accepted by the Society as an alternative to finite elements fatigue analysis.

4.2.3 Accumulated damage based on default assumptions

If complete trading routes history of the ship is not available, defaults assumptions are to be considered:

- past fatigue life: age of the ship (Age)
- sailing factor: 0,85
- two loading conditions: ballast and full load. Part of ship's sailing life in full load is to be taken as 0.6 and in ballast as 0,4 except otherwise specified based on history of ship
- wave statistics data: North Atlantic or Worldwide.

Note 1: Worldwide wave statistics may be used when agreed by the Society. In that case, the damage obtained with rule values based on North Atlantic may be divided by 2.

The cumulative damage ratio, D, is to be calculated based on deterministic approach according to the methodology described in Pt B, Ch 7, Sec 4 of Ship Rules or equivalent (e.g. NR606 Common Structural Rules).

The damage ratio adjusted to the age of the ship, D_{past}, is then obtained with the following formula:

$$D_{past} = D\frac{Age}{20}$$

4.2.4 Repair or reinforcement during ship history

If such repairs have been performed then D_{past} of the concerned detail is to be evaluated by using the repaired detail instead of the as-built detail and by replacing age of the vessel by the age of the repaired detail.

4.3 Fatigue damage during transit

4.3.1 Accumulated damage during transit D_{tow}

D_{tow} during transit phase is to be evaluated.

When the additional class notation **Spectral Fatigue (transit)** is intended to be granted to the unit, spectral fatigue approach is to be used according to NI 611.

4.4 Fatigue damage on site

4.4.1 Wave environment

Wave scatter diagrams or hindcast data for in-situ conditions are to be submitted and used for fatigue calculations.

4.4.2 On site damage calculations D_{site}

In-situ damage D_{site} is to be assessed according to Pt D, Ch 1, Sec 7 of the Offshore Rules.

When calculating D_{site}, RDL of the unit on site is to be used.

Loading patterns used for the fatigue analysis is to be based on the loading/unloading sequences on site.

For units intended to be assigned with the additional class notation **Spectral Fatigue ( )**, spectral fatigue calculations according to NI611 are to be performed. For the longitudinal stiffeners, 2D fatigue analysis may be accepted by the Society as an alternative to finite element fatigue analysis.

4.4.3 Loading / unloading damage calculation $D_{L/U}$

The fatigue due to loading / unloading are to be assessed when deemed necessary.

By default one loading/unloading per week is taken into account. In this case the calculation is to take into account the wave at a probability level not less than 10^{-4}.

4.5 Fatigue criteria

4.5.1 Checking Criteria

The following criteria is to be fulfilled:

$$D_{past} + (SF_{tow}D_{tow} + SF_{site}D_{site} + SF_{L/U}D_{L/U}) \times \gamma_R \leq 1$$

where:

SF_{tow} , SF_{site} , $SF_{L/U}$: Safety factors as defined in Tab 2, according to the fatigue calculation method.

γ_R : Partial safety factor covering uncertainties on resistance to be taken equal to 1,02.

Typically, for spectral fatigue analysis, SF = 2 for details of connection of longitudinal stiffeners with transverse bulkhead or primary member.

If the above criteria is not fulfilled, then the design of the structural detail or the reinforcement is to be enhanced in order to comply with Pt B, Ch 3, Sec 3, [7] of the Offshore Rules.

Regular monitoring of the details may be accepted on a case by case basis by the Society instead of reinforcements. This may be accepted only if the concerned details have never experienced any crack in the past life of the unit.

Table 2 : Fatigue damage safety factors

Method	Deterministic analysis with navigation notation **(1)**	Deterministic analysis with hydrodynamic loads **(2)**	Spectral analysis **(3)**
Safety factor	1	2	see Tab 3

(1) Loads derived from navigation notation. In case that all hydrodynamic values and distributions are lower than minimum or rule values and distribution with significant margin (as a rule hydrodynamic loads lower than 25% of the rule loads).

(2) Loads derived from hydrodynamic analysis.

(3) Fatigue damage derived from spectral analysis.

Table 3 : Safety factors for spectral fatigue analysis

Consequence of failure	Degree of accessibility for inspection, maintenance and repair		
	Not accessible **(1)**	Underwater inspection **(2)**	Dry inspection
Critical **(3)**	10	4	2
Non-critical	5	2	1

(1) Includes areas that can be inspected in dry or underwater conditions but require heavy works such as dry-docking for repair.

(2) Includes areas that can be inspected in dry conditions but with extensive preparation and heavy impact on operation.

(3) Critical damage includes loss of life, uncontrolled pollution, collision, sinking, other major damage to the installations and major production losses. All the structural elements are to be considered as critical, unless duly justified by an analysis of the consequences of failure.

SECTION 4 MACHINERY, ELECTRICITY AND SAFETY SYSTEMS

1 General

1.1 Application

1.1.1 The present Section provides guidelines and requirements for the Machinery, Electricity and Safety systems of an existing ship intended to be converted into an offshore unit or for a redeployed offshore unit.

1.1.2 The provisions of this Section are complementary to those of Part C and Part D of the Offshore Rules, which remain applicable, except where otherwise specified.

1.2 Principles

1.2.1 In principle, all systems on-board are to comply with the Rules of the Society in force at the date of contract for conversion or redeployment.

1.2.2 Systems not affected by the new functions of the unit could be exempted from design assessment subject to Society agreement and provided that the system remains unchanged.

Systems on which a piece of equipment is replaced or refurbished may benefit from the above exemption if the new or refurbished piece of equipment is of the same type and characteristics as the original one.

1.2.3 Bridge visibility

If the visibility from the navigation bridge of a self-propelled unit is affected during the conversion, alternative solutions such as CCTV or permanently manned lookout station at the bow of the unit are to be provided to compensate the lack of visibility. In any case, a watch-keeping procedure is to be established for ensuring a safe navigation.

Note 1: Attention is drawn to the need for Flag acceptance in case of alternative to visibility from navigation bridge.

1.2.4 Self-propelled unit

If the unit is intended to be self-propelled, all marine systems (such as propulsion, steering, navigational equipment, radio-communication) are to be maintained during the conversion as for an operating ship, meeting all requirements of the vessel's Flag Administration and international regulations for safe operation (see [2.1.3]).

1.3 Documents to be submitted

1.3.1 The documents to be submitted are listed in Sec 1, [7].

2 Machinery systems

2.1 General

2.1.1 Sea water system

Sea water intakes located in the hull and below the maximum draft water line are to be modified, adding mechanical fasteners welded to the outside of the hull in order to block the sea chest from the outside whenever required for inspection and maintenance.

The isolation is to guarantee the tightness of the sea chest for the safe removal of a sea water intake valve and/or other component downstream of it, without risking the ingress of water from the outside of the unit. Such system is to be approved by the Society on a case-by-case basis.

The cross-over sea water pipe is to be furnished with a valve able to isolate one section of the cross-over pipe from the one being blocked. This valve cannot be a butterfly valve despite the material selected for its fabrication.

The cross-over piping shall allow room for the installation of a spectacle flange on each side of the said middle valve to ensure positive isolation from the pipe section opened to the sea.

When internal sea water lift pumps are used, vertical trunk-type sea water inlets located inside the hull are accepted, provided they are built of the same material as the hull plates.

The opening at the bottom of the trunk shall allow the free flow of sea water to the lift pumps. However, no lateral opening shall be allowed on the lateral wall below the maximum draft waterline.

Means of access for inspection of sea water internal trunk inlets are to be watertight and adequately flanged, similarly to those used in tanks.

Any piercing in the trunk for running cables or pipes is to be done from the top end of the trunk; whereas the discharge pipes from lift sea water pumps are to be flanged accordingly and isolation valves provided.

2.1.2 Engine room and other machinery spaces

Whenever machinery spaces previously designed for manned operations are intended to be modified in view of operations in an unmanned mode, the automation shall prove to be compatible with the equipment and an FMEA shall be submitted for approval, on a case-by-case basis.

Pipe sections connecting non-hazardous areas passing through hazardous areas are to be made out of a single seamless pipe section or several welded pipe lengths keeping, as far as reasonably practicable, the number of welds to a minimum.

The welding should be of the full penetration type and subject to a NDE 100% radiograph and pressure tested according to the rule requirements prior to installation.

When these pipe sections have diameters for which radiographic examination may give questionable results, they may be examined by other means, subject to the approval of the Society.

Any section of an existing piping system intended to be modified will be subject to the applicable rule requirements; whereas the piping and instrumentation diagrams are to be made on the existing original diagrams.

Different arrangement which does not jeopardize the safety and integrity of Non-Hazardous spaces can be accepted on case-by-case basis when duly justified.

2.1.3 Preservation of propulsion machinery while permanently moored at site

Propulsion machinery, when intended to be preserved for future use after the offshore unit has been duly moored at site, is to be subject to a case-by-case approval, upon receipt of a detailed preservation plan.

The preservation philosophy is to be submitted for approval, whereas the plan is to be adequate with the operational philosophy of the surface unit and the type of connection to production well(s) or web.

When self-propulsion for intermediate transit conditions is optional or due to emergency disconnection, or when future deployment over other sites is planned, the main propulsion machinery as well as the propeller shafting and the sealing are to be preserved to guarantee the good starting and post-operation of the ship as a self-propelled sea-going ship. A programme for the propulsion preservation is to be submitted for approval and monitored accordingly under the supervision of the Society while the offshore unit remains at site.

When the propulsion shafts are no longer used and the unit is considered irreversibly and permanently a moored offshore unit, the shaft sealing as well as the monitoring philosophy are to be submitted for approval on a case-by-case basis.

2.1.4 Steering system

Following the conditions required for the preservation of the propulsion system, the preservation of the steering system, including its auxiliaries and rudder sleeve bearings, is to be submitted for approval.

2.1.5 Boilers

Any boiler rated at 0,5 bar and above intended to be overhauled or modified, as well as any system required for its safe operation, including its monitoring and control, are to be subject to a case-by-case approval and to additional standards and codes, to the discretion of the Society.

Alternative operation modes may be accepted for the safe running of boilers, depending on the criticality of the steam users, the transit plan or other operational requirements. The modifications made to the original operation mode will have to be approved by the Society, on a case-by-case basis.

2.1.6 Electric power generation drivers

Any additional electric power generators intended to be installed on the topside to carry out process activities related to hydrocarbon fluids from production wells are not considered as main power generators for marine systems, whatever their rated power output or operation mode.

When the aforesaid machines are also used as a main power generator for marine systems, these machines are to be of a type approved by the Society or subject to a case-by-case approval.

Any temporary electric power generator intended to be used during transit as a temporary power supply on board, whether located on the weather deck or other topside deck, is to be fixed to the unit structure by suitable means equivalent to those for a permanent installation and is to be subject to special consideration, on a case-by-case basis.

2.1.7 Venting pipes

Any modification intended to be made on tank venting pipes that may require the addition of pipe sections and their fittings is to take into consideration the additional pressure losses corresponding to the added pipe length. When the modification requires a new pressure safety vacuum valve, the selected model is to be compatible with the new arrangement and the tank filling mode.

2.2 Fuel bunkering and transfer

2.2.1 Any intention to carry, in the cargo area, fuel to be used:

- as bunkering during transit, or
- for the bunkering of other units during transit or during set up activities and afterwards,

is to be approved by the Society, on a case-by-case basis.

3 Electrical systems

3.1 General

3.1.1 The electrical power balance of the main and emergency sources of electrical power is to be revised, to take into consideration the increased power demand due to the new consumers.

3.1.2 The existing switchboards and distribution boards can be re-used if their short-circuit capabilities are appropriate with the revised short-circuit current calculations.

3.1.3 After conversion, the hazardous areas may extend outside the limits defined for an oil tanker. Precautions are to be taken to ensure that all the electrical equipment provided on the main deck and in adjacent spaces remains appropriate to the revised hazardous area classification.

3.1.4 In case of emergency shutdown causing loss of the main and emergency sources of electrical power, the electrical equipment allowing the safe escape of personnel is to be supplied by a transitional source of power remaining available during half an hour. This includes also the emergency lighting provided over sides to illuminate adequately the area of water where the survival craft will be launched (see [5.6.3]).

4 Automation and control systems

4.1 General

4.1.1 The interconnection of the marine control and safety systems with the control and safety systems used for the hydrocarbon process equipment is not to jeopardize the safety and the functionality of the marine systems.

5 Safety

5.1 Arrangement of the unit

5.1.1 Accommodation and control stations are to be located outside the hazardous areas and are not to be located above processing or storage areas.

5.1.2 The arrangement and lay-out of the processing plant should be considered in view of fire and explosion hazards, depending on the size and complexity of the plant, as well as its location, in relation to the accommodations, escapes, shelters and evacuation facilities.

5.1.3 If deemed necessary by the Society, a risk analysis is to be performed to validate the arrangement and to determine the accidental loads that the equipment and the systems are capable to withstand.

5.1.4 When a helideck is added, the helideck location should permit an access facing the prevailing winds and should avoid the flight over the installation or other facilities (such as export tanker), as far as practicable, during landing and takeoff.

Note 1: Exhaust pipes (Funnel) are to terminate in a place where the safety of helicopter operations is not impaired.

5.1.5 Existing cargo control rooms having windows facing the production facilities are not to be retained, unless duly justified.

5.1.6 In general, chemicals, such as methanol, stored in integral tanks are located at the end of the unit farthest from the living quarters, for safety reasons.

5.1.7 When the existing bridge is intended to be retained, the openings and windows may have to be protected, depending on the protection required for the nearby zones.

5.1.8 Major information and commands with respect to safety shutdown and emergency shutdown are to be made available on-board for designated persons.

5.1.9 Access for maintenance in cargo pump room is to be taken into account for utility area design.

5.1.10 Where two or more cylinders of oxygen and acetylene are intended to be carried in enclosed spaces, separate dedicated storage rooms are to be provided for each gas.

5.2 Hazardous areas

5.2.1 For a conversion into a production unit with a plated topside process deck, the space between the main deck and the process deck is to be classified as hazardous area zone 1 due to limited ventilation.

5.3 Structural fire protection

5.3.1 Attention is to be paid to a clear definition of each category of spaces, the location of the new equipment being taken into account.

5.3.2 The spaces such as the emergency generator room or the fire pump room may have to be re-engineered due to the increase in power. On offshore production units, these spaces are generally classified as machinery spaces of category A.

5.3.3 Windows and sidescuttles, with the exception of the navigating bridge windows, should be of non-opening type. The navigating bridge windows may be of the opening type, provided the design of such windows permits quick closure.

5.3.4 Windows and sidescuttles facing the storage area and the sides of the superstructures and deckhouses within the limits specified in Pt D, Ch 1, Sec 11 of the Offshore Rules are to be of non-opening type. Such windows and sidescuttles are to be constructed of "A-60" class standard.

5.3.5 External doors in superstructures and deckhouses should be constructed of at least"A-0" class standard and be self-closing, where practicable.

5.4 Fire and gas detection

5.4.1 Gas leak is not a major risk on tankers, however gas ingress is a potential hazard for offshore units. Therefore, for rooms and buildings located in hazardous areas and protected by pressurization, a fixed gas detection system is to be installed at the ventilation air intakes, in compliance with Pt C, Ch 4, Sec 3 of the Offshore Rules.

5.4.2 Production facilities may involve the presence of hydrogen sulfide in some parts of the unit. Therefore, a H_2S gas detection and alarm system in compliance with Pt C, Ch 4, Sec 5 of the Offshore Rules is to be provided.

5.4.3 Accommodation spaces, services spaces and control stations are to be provided with fixed fire detection and alarm systems in compliance with Pt C, Ch 4, Sec 5 of the Offshore Rules.

5.4.4 The fire and gas detection systems and the emergency shutdown system are to comply with the requirements applicable to offshore production or storage units. When these systems are intended to be retained from the existing ship, duly justification is to be provided.

5.5 Fire-fighting systems

5.5.1 The fixed deck foam system required by SOLAS on board tankers usually consists in monitors and foam applicators distributed on the main deck. However, due to topside structure, this type of arrangement is generally not suitable for offshore production units. Another equivalent system is to be proposed (e.g. deluge system).

5.5.2 Attention is drawn towards the foam concentrate used for the fixed deck foam system, which, in case methanol tanks are protected by this system, is to be suitable for polar solvent cargoes (type A foam concentrate in accordance with Offshore Rules Pt D, Ch 1, Sec 11, [7]).

5.5.3 Methanol transfer areas are to be protected with a fire-fighting equipment.

5.5.4 At least one of the required fire pumps is to be dedicated to fire-fighting duties and available for such duties at all times.

5.5.5 If the existing fire-fighting system of the ship is intended to be retained, its capacity and design pressure are to be sufficient for the new extent of water coverage on the production facilities.

Design pressure is usually to be determined by the height of the monitors serving the helideck.

5.5.6 In case of a small production facility, a minor upgrading of the existing fire fighting system may be sufficient in terms of pump head and capacity, providing the general condition of the pumps and piping is satisfactory. Where there is a water requirement substantially greater than what the unit system can deliver, checks are to be carried out to establish whether the existing system can operate in conjunction with the new one, in terms of pump curve compatibility. It may become necessary to dispense with the existing pumps and to use the existing fire network as an extension of the new system for the production facilities.

5.5.7 Where practicable, the fire main is to be routed clear of hazardous areas and arranged in such a manner as to make a maximum use of any thermal shielding or any physical protection afforded by the unit structure.

5.6 Escape

5.6.1 There should be two separate escape routes from the bow to the stern, one on each side of the unit.

5.6.2 On hull deck, there should be a secondary escape route across the unit, allowing to reach the opposite side at each cargo tank row.

5.6.3 In addition to the emergency lighting, the means of escape in accommodation areas, including stairways and exits, are to be marked by lighting or photoluminescent strip indicators placed not more than 300 mm above the deck at all points of the escape route, including angles and intersections.

The marking is to enable personnel to identify the escape routes and readily identify the escape exits. If electric illumination is used, it is to be supplied by the emergency source of power and so arranged that the failure of any single light or cut in a lighting strip will not result in the marking being ineffective. Additionally, escape route signs and fire equipment location markings are to be of photoluminescent material or marked by lighting.

Such lighting or photoluminescent equipment is to be evaluated, tested and applied in accordance with IMO FSS code.

5.6.4 Consideration is to be given to the sitting of superstructures and deckhouses such that, in the event of fire on the storage or process area, at least one escape route to the embarkation position and the survival craft is protected against radiation effects of that fire, as far as practicable.

6 Cargo storage and production

6.1 General

6.1.1 Attention should be paid to the discharge of oily water overboard.

6.1.2 Due attention is to be paid to the possible trim of the offshore unit compared to the trim of the existing ship, when verifying the tank pump characteristics.

6.2 Inert gas and hydrocarbon blanketing system

6.2.1 When a hydrocarbon blanketing system is to be implemented on the unit in addition to the inert gas system, the following provisions are to be considered:

- a cargo tank vents gas recovery system is to be provided in accordance with Pt D, Ch 1, Sec 10 of the Offshore Rules
- venting system for the cargo tanks are to be reassessed, given the fact that venting lines will discharge hydrocarbons instead of inert gas
- the main vent is to be designed for dispersion under the most adverse weather and process conditions.

6.2.2 The P/V valve discharge is to be positioned so that dispersion, radiation toxicity or oxygen content reducing during high degassing do not generate any issue for the safety of the crew, the operations on the deck or topsides, or for the approach and mooring of service boats.

Note 1: As a rule, the P/V valve discharge should not be positioned below the process deck.

6.2.3 Tank vent openings are to be positioned according to the normal trim, so as to ensure their continuous contact with inert gas or hydrocarbon blanketing and to avoid entrapped pocket gas.

6.2.4 The existing arrangement of inert gas headers and venting mast on the main deck may not be compatible with the topsides. In this case, the pipe network on the main deck should be redesigned with two lines and new positions for vent tips.

6.2.5 Crude oil may contain a significant quantity of H_2S, even after processing. When this is the case, vent systems are to be designed to ensure that tank vapours are vented well away from the deck.

6.2.6 Equipment which is adapted to be fuelled with gas coming from the process installation is to comply with the relevant requirements of Pt D, Ch 1, Sec 13 of the Offshore Rules, as applicable to dual fuel systems.

6.3 Piping

6.3.1 The cargo piping suction ends are to be located at the lowest point in the cargo tanks with respect to the intended trim of the unit.

6.3.2 The material and the welding of the existing cargo piping intended to be retained are to be carefully assessed.

Any piping sections intended to be added to an already existing system are to conform to a recognized standard or code and be compatible with the existing piping on board.

Piping systems and fittings installed anywhere on the weather deck, and within a vertical distance of 2,4 m from the weather deck, are subject to class requirements up to, and including the first flange or isolation valve located beyond the said limit.

6.3.3 The new cargo piping is to be designed and constructed according to the requirements of the Offshore Rules, Pt C, Ch 1, Sec 7 applicable to piping systems of class I.

6.3.4 When existing class III cargo piping is intended to be used, inspection and testing as applicable to class I piping is to be performed.

6.3.5 Existing hydraulically-operated cargo and ballast tank valves intended to be retained are to be specially assessed.

APPENDIX 1 WELDING INSPECTION

1 General

1.1 Scope

1.1.1 This Appendix specifies the applicable rules for the welding inspections at yard during the conversion or redeployment works.

1.2 Offshore areas

1.2.1 The welding inspections of the offshore areas are to be carried out in accordance with the Rule Note NR426 Construction Survey of Steel Structures of Offshore Units and Installations.

1.3 Ship areas

1.3.1 The welding inspections of the ship areas are to be carried out in accordance with Part B, Chapter 11 of the Ship Rules.

1.4 Materials and welding

1.4.1 The general requirements relevant to fabrication by welding and qualification of welding procedures are given in NR216, Materials and Welding.

APPENDIX 2 DETERMINATION OF RENEWAL THICKNESS

1 General

1.1 Application

1.1.1 This Appendix applies for the determination of the steel renewal thickness of surface offshore units when converted from ships and for life extension or redeployment of existing offshore units.

1.2 Scope

1.2.1 This Appendix provides guidelines for the determination of the steel renewal thickness of the existing structure, once the reassessed scantling (i.e. minimum required thickness) has been determined in accordance with Sec 3.

1.2.2 Other methodology may be accepted subject to Society agreement.

1.3 Principles

1.3.1 A hull survey with complete measurements of the scantlings is required to evaluate the corrosion status of the unit as specified in Sec 1, [4].

1.3.2 The thickness measured is to be compared to the renewal thickness as defined in [2.1].

1.3.3 In any case, the unit is to comply with the in-service survey requirements as stated in Part A of the Offshore Rules and the renewal thickness cannot be less than the minimum acceptance thickness.

1.3.4 As a rule, the renewal thickness is to be greater or equal to the reassessed thickness.

If not, the renewal scantlings are to satisfy the additional verifications detailed in [3.3].

1.3.5 The renewal thickness is to be verified in accordance with [3] except if it is greater or equal to the new structure thickness.

1.4 Definitions

1.4.1 Renewal thickness (t_{renew})

The renewal thickness is a gross thickness based on a substantial corrosion thickness increased by the rules corrosion margin.

The renewal thickness is obtained according to the following formula (see Fig 1):

$$t_{renew} = t_{sub} + t_c + t_{Ri}$$

Note 1: the renewal thickness (t_{renew}) needs not to exceed the reassessed new structure thickness ($t_{new\ structure}$) defined in Sec 3.

1.4.2 Minimum acceptance thickness (t_{min})

The minimum acceptance thickness is the thickness to be compared against measured scantling during inspection in service, as defined in Pt A, Ch 2, App 1 of the Offshore Rules.

For the purpose of the present Note, the minimum acceptance thickness is to be obtained according to the following formula:

$$t_{min} = \left(1 - \frac{W}{100}\right)(t_{reass} + t_{cmax})$$

1.4.3 Wastage allowance in service (W)

The wastage allowance in service is the maximum percentage of acceptable thickness diminution.

For the purpose of determination of renewal thickness, the wastage allowance in service to consider corresponds to the "item" verification criteria as defined in Pt A, Ch 2, App 1 of the Offshore Rules and reproduced in Tab 1.

1.4.4 Substantial corrosion thickness (t_{sub})

The substantial corrosion thickness is obtained according to the following formula (see Fig 1):

$$t_{sub} = \left(1 - \left(0,75\frac{W}{100}\right)\right)(t_{reass} + t_{cmax})$$

As defined in the Offshore Rules Part A, areas of substantial corrosion identified during class surveys are subjected to special consideration during annual in-service surveys.

1.4.5 Thickness measured (t_M)

The thickness measured means the gauged thickness issued from the hull survey during conversion work. The requirements for thickness measurements and in particular the extent and location of the measures are defined Pt A, Ch 2, App 1 of the Offshore Rules as applicable for the measurement of an item of structure.

1.4.6 Renewal thickness increment (t_{Ri})

When requested by the party applying for classification, renewal thickness increments may be added to rule corrosion additions in the determination of renewal thickness during conversion work (see Fig 1).

The renewal thickness increment values are to be provided by party applying for classification preferably at the earliest stage of the project and to be stated in the Design Criteria Statement.

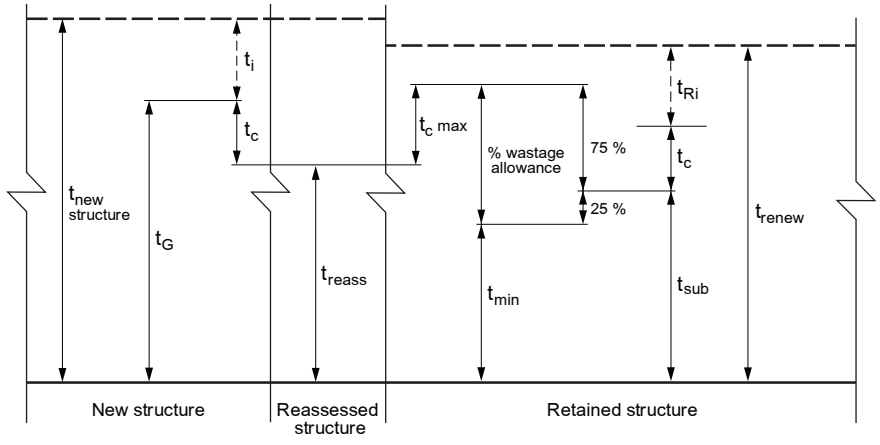
Table 1 : Wastage allowances

Description of items			W (%)
ITEMS CONTRIBUTING TO THE LONGITUDINAL STRENGTH (TRANSVERSE SECTION)			
DECK ZONE			
	Deck plating, deck stringer, sheer strake and longitudinal bulkhead upper strake **(1)**		20
	Deck and sheer strake longitudinals	web flange	20 15
	Deck longitudinal girders	web flange	20 15
	Longitudinals connected to long. bulkhead upper strake **(1)**	web flange	20 15
NEUTRAL AXIS ZONE			
	Side shell plating **(1)**		20
	Side shell longitudinals and stringers **(1)**	web flange	20 15
	Longitudinal bulkhead plating		20
	Longitudinal bulkhead longitudinals and stringers	web flange	20 15
BOTTOM ZONE			
	Bilge and bottom strakes, longitudinal bulkhead lower strake and keel plate **(1)**		20
	Bilge and bottom longitudinals **(1)**	web flange	20 15
	Longitudinals connected to longitud. bulkhead lower strake	web flange	20 15
	Bottom girders	web flange	20 15
OTHER ITEMS			
Deck transverse web frame		web flange brackets / stiffeners	20 15 20
Side shell web frame		web flange brackets / stiffeners	20 15 20
Longitudinal bulkhead web frame		web flange brackets / stiffeners	20 15 20
Bottom transverse web frame		web flange brackets / stiffeners	20 15 20
Cross tie		web flange brackets / stiffeners	15 15 15
Transverse bulkheads **(2)**		plating stringer web stringer flange stiffener web stiffener flange	20 20 15 20 15

(1) The structural elements of the inner skin (plating, longitudinals, girders, bulkheads) are to be included in the corresponding elements of the outer skin.

(2) Including swash bulkheads, forward and aft peak bulkheads.

Figure 1 : Determination of renewal thickness



2 Renewal criteria

2.1 General

2.1.1 The comparison of the measured thickness (t_M) with the renewal thickness has the following consequences:

a) If $t_M \geq t_{renew}$, no need for steel renewal

b) If $t_M < t_{renew}$, as a rule, the structural member is to be renewed with a thickness not less than the new structure thickness $t_{new\ structure}$ defined in Sec 3, [1.4.5].

Subject to the agreement of the Society, if the structural member is not renewed, the following will apply:

1) if $t_{sub} \leq t_M < t_{renew}$: the structural member has reduced margins regarding the anticipated corrosion during its new requested design life and steel renewal during its service life may be necessary

2) if $t_{min} \leq t_M < t_{sub}$: the structural member will be subject to close up inspection during each annual survey, as required in Part A of the Offshore Rules.

3 Verification of renewal thickness

3.1 Application

3.1.1 The following verification of the renewal thickness are to be performed:

- hull girder yielding check as defined in [3.2], in any case, except if $t_{renew} \geq t_{new\ structure}$
- if for any longitudinal member, $t_{renew} < t_{reass}$, the ultimate strength and the hull girder buckling strength of identified members have to be checked according to [3.3.1] and [3.3.2] respectively.

3.2 Hull girder yielding check

3.2.1 The section modulus of the hull girder transverse sections are to be not less than the section modulus defined in Pt D, Ch 1, Sec 6 of the Offshore Rules.

The shear stresses induced by hull girder loads and obtained according to Pt D, Ch 1, Sec 6 of the Offshore Rules, are to be not less than the allowable stress defined in Pt D, Ch 1, Sec 6 of the Offshore Rules.

The check is to be done with gross section characteristics based on $t_{renew} - t_{Ri}$.

3.3 Additional structural checks

3.3.1 Ultimate strength

When deemed necessary according to [3.1.1], the ultimate strength of the hull girder is to be checked according to Pt D, Ch 1, Sec 6 of the Offshore Rules.

The check is to be done with net section characteristics based on $t_{renew} - t_{Ri}$.

3.3.2 Hull girder buckling strength

When deemed necessary according to [3.1.1], the buckling strength of longitudinal plating, ordinary stiffeners and primary supporting members is to be checked according to Pt D, Ch 1, Sec 7 of the Offshore Rules. Only hull girder normal and shear stresses need to be considered for buckling check.

The check is to be done taking $t_{renew} - t_{Ri}$ as net thickness.

APPENDIX 3 FATIGUE DAMAGE CALCULATIONS BASED ON SHIP ROUTES HISTORY

Symbols

H_S : Significant wave height, in m

T_Z : Zero up-crossing period, in sec

W : Wave direction sector, in degrees

C : Course of the ship (north is 0°, east is 90°), in degrees

D : Cumulative Fatigue damage ratio

θ : Relative heading in degrees $\theta = C + 180 - W$

Nrte : Number of routes with associated loading conditions during the time spent in navigation before the conversion of the ship

N_{zone} : Number of zones entered by the ship for a given route

N_{track} : Number of tracks in a given zone for a given route

N_{dir} : Number of wave directions sectors in a given zone

N_{ss} : Number of sea states in a given zone for the given wave direction sector

i : Index for the ship route

j : Index for the zone in wave statistics

u : Index for the ship track

ι : Index for the sea state (defined by (H_S, T_Z))

g : Index for the wave direction sector

k : Index for the relative heading (i.e. relative wave direction)

$p(rte_i)$: Frequency of the route i with associated loading condition during the time spent in navigation before the conversion of the ship

$p(z_j|i)$: Frequency of the zone j on the route i with associated loading condition

$p(trk_u|i,j)$: Frequency of the track u within the zone j for the route i

$p(ss_\iota|j,g)$: Frequency of the sea state ι for the zone j and a given wave direction sector g

$p(ss_\iota|i,j,k)$: Frequency of the sea state ι for the route i, for the zone j and a given relative heading index k

$p(W_g|j)$: Frequency of wave direction sector g within zone j

$p(\theta_k|i,j)$: Frequency of relative heading index k within zone j, for the route i.

1 General

1.1 Scope

1.1.1 The purpose of this Appendix is to provide a method to calculate the fatigue damage that the ship has accumulated during its tanker life, based on its trading routes history.

1.2 Definitions

1.2.1 General

Segment: Rhumbline between two waypoints. A segment is entirely located within one zone

Track : An oriented segment. A course angle is associated to a track.

1.2.2 Ship routes

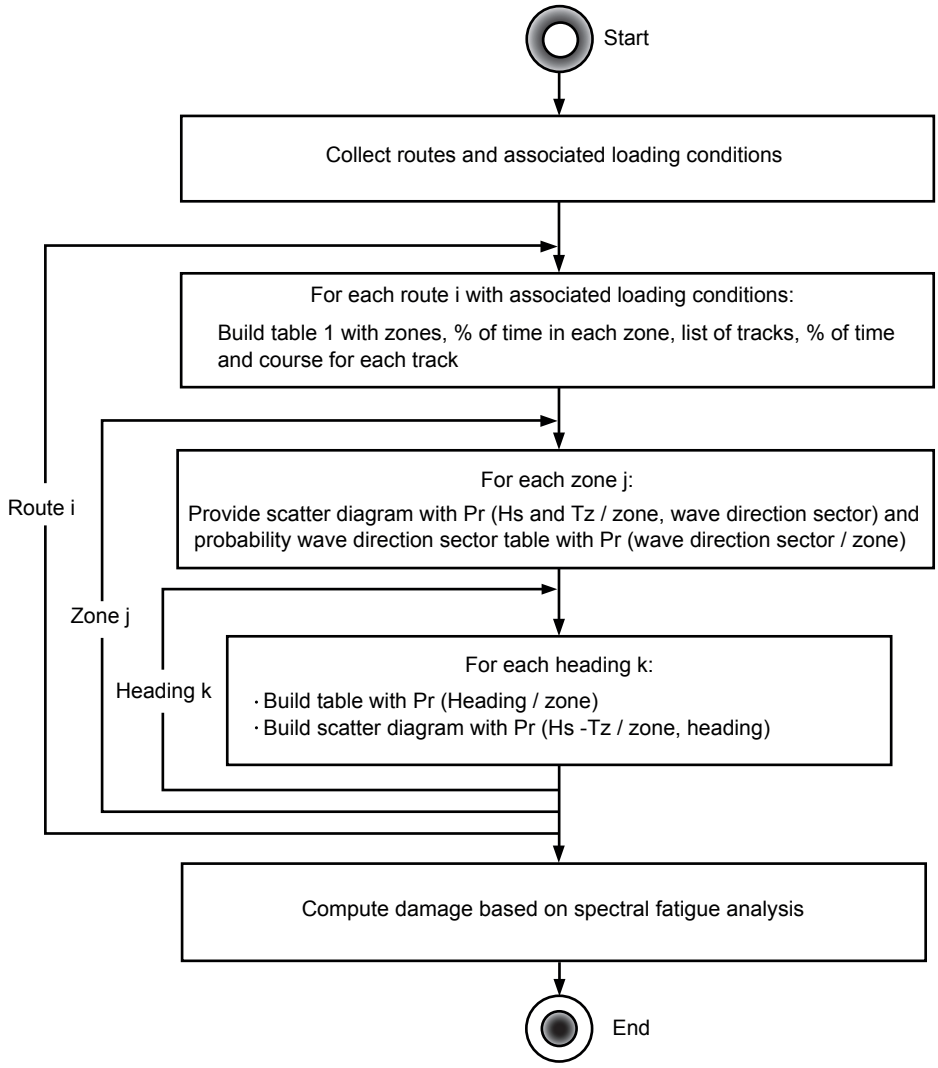
The ship routes are described as a sequence of loading states encountered during the time spent in navigation before the conversion of the ship.

1.2.3 Loading state

Each loading state corresponds to the combination of:

- a route defined between two ports, which is associated to a loading condition (full load or ballast)
- a zone defined in a wave statistics database
- a track with respective direction within zone
- a wave direction sector within zone
- a short term sea state defined for the zone and the wave direction sector.

Figure 1 : Fatigue assessment procedure



2 Routes decomposition methodology

2.1 Procedure

2.1.1 The method includes the following steps:

- 1st step of the procedure is to collect the routes and associated loading conditions of the ship (full load, ballast)
- 2nd step of the procedure is to decompose each route with associated loading condition in zones and tracks per zone and to determine respective frequency
- 3rd step is to provide for each zone a wave scatter diagram giving the probability of the sea states for each wave direction sector. The probability associated to each wave direction sector has to be provided.

The procedure is illustrated in Fig 1.

2.2 Description of the routes

2.2.1 Definition

The route is defined as a single trip between two ports with an associated loading condition. Each route is defined by the entered zones, tracks for each zone and associated track course.

2.2.2 Route trace

The objective of this step is to trace the routes followed by the ship against the zones defined in a wave statistics database. The method is to define a number of waypoints (providing longitude and latitude) and to trace rhumbline segments between these waypoints. The advantage of this procedure is that the course angle is constant along a rhumbline and represented by straight lines on the map.

Considering a constant ground speed during all the passages, it is then possible to build a table (see Tab 1) for each considered route, according to the following:

a) a segment is entirely located within one zone. As a consequence, the intersection between a route and a zone boundary is a waypoint

b) a track corresponds to an oriented segment.

Table 1 : Example of decomposition of route with associated loading condition in zones and tracks per zone

Route: 1 Port 1 to Port 2		Frequency of the route i $p(rte_i)$: 15% Loading condition: LC 1		
Zone j	Frequency of zone j $p(z_j\|i)$	Tracks	Frequency of track in zone j $p(trk_u\|i,j)$	Track course C_u
Zone A	30%	T1(A)	70%	170°
		T2 (A)	30%	102°
Zone B	20%	T1(B)	100%	90°
Zone C	50%	T1(C)	10%	70°
		T2(C)	25%	130°
		T3(C)	65%	175°

2.2.3 Calculation of frequencies

For each route followed by the ship during the time spent in navigation, the following frequencies values are calculated:

- the frequency of the route ($p(rte_i)$) is equal to the percentage of time spent on route i during the time spent in navigation before the conversion of the ship
- the frequency of the zone ($p(z_j|i)$) is equal to the percentage of time spent in zone j on route i
- the frequency of the track ($p(trk_u|i,j)$) is equal to the percentage of time spent on the track u in zone j

with:

$$\sum_{i=1}^{Nrte} p(rte_i) = 1$$

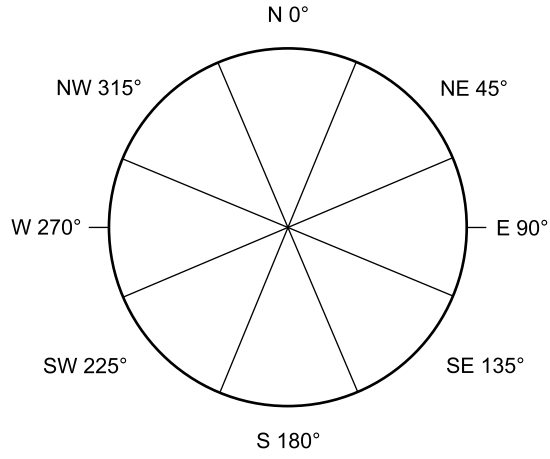
$$\sum_{j=1}^{Nzone} p(z_j|i) = 1$$

$$\sum_{u=1}^{Ntrack} p(trk_u|i,j) = 1$$

2.3 Wave scatter diagram for each zone and each relative heading

2.3.1 For each zone, a wave scatter diagram associated to each wave direction sector is provided in a wave statistics database. The wave scatter diagram gives probability of occurrence of the sea state (H_S, T_Z) for the given wave direction sector g (see Fig 2) within zone j and it is noted $p(ss_t|j,g)$.

Figure 2 : Wave direction sectors



The probability of occurrence of wave direction sector g within zone j is provided in a wave statistics database.

The probability of occurrence of sea states and wave direction sector can be provided either in terms of annual values or seasonal values if relevant.

For each relative heading k, one can compute:

$$p(\theta_k|i,j) = \sum_g p(\theta_k, g|i,j)$$

$$p(ss_t|i,j,k) = \frac{\sum_g [p(\theta_k, g|i,j) \cdot p(ss_i|j,g)]}{p(\theta_k|i,j)}$$

The probability $p(\theta_k,g|i,j)$ of encountering waves from the wave sector g with the relative heading index k is calculated as follow:

$$p(\theta_k, g|i,j) = \frac{p(W_g|j)}{2\Delta W} \sum_{u=1}^{Ntrack} p(trk_u|i,j).[I_{u,g}(\theta_k + \theta\Delta) - I_{u,g}(\theta_k - \Delta\theta)]$$

where:

- $2\Delta W$ is the width of the wave direction sectors, in degrees
- $2\Delta\theta$ is the width of the relative wave heading sectors, in degrees
- $I_{u,g}(\theta)$ is defined as follow:

  $I_{u,g}(\theta) = 0$ for $\theta \le \theta_{u,g\,min}$

  $I_{u,g}(\theta) = \theta - \theta_{u,g\,min}$ for $\theta_{u,g\,min} \le \theta \le \theta_{u,g\,max}$

  $I_{u,g}(\theta) = 2\Delta W$ for $\theta_{u,g\,max} \le \theta$

  with the following bounds:

  $\theta_{u,g\,min} = 180 + C_u - W_g - \Delta W$

  $\theta_{u,g\,max} = \theta_{u,g\,min} + 2\Delta W$

3 Spectral fatigue analysis

3.1 Methodology

3.1.1 Spectral fatigue analysis is to be conducted according to NI 611 Guidelines for Fatigue Assessment of Steel ships and Offshore Units.

3.2 Computation of long term damage

3.2.1 The long term damage is to be calculated as follow:

$$D = \frac{L_{ref}}{T_{ST}} \sum_{i=1}^{Nrte} p(rte_i) \left\{ \sum_{j=1}^{Nzone} p(z_j|i) \left[\sum_{k=1}^{Nheading} p(\theta_k|i,j) \left(\sum_{\iota=1}^{Nss} p(ss_\iota|i,j,k).D_{\iota,k} \right) \right] \right\}$$

with:

L_{ref} : Period of exposure, in sec

T_{ST} : Short time duration of the sea states, in sec

$D_{\iota,k}$: Damage for sea state ι and wave heading k, to be computed by spectral analysis.