



**BUREAU
VERITAS**

LNG Carrier Conversion to FSRU or FSU

July 2018

**Guidance Note
NI 655 DT R00 E**



**BUREAU
VERITAS**

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 contract'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 appraisal 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 protocols 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 appraisal 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. 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 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.

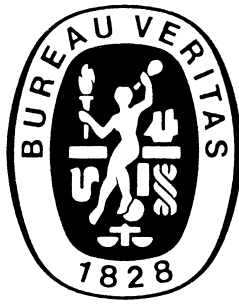
- 15.2. The Society and the Client shall make every effort to settle any dispute amicably and in good faith by way of negotiation within thirty (30) days from the date of receipt by either one of the Parties of a written notice of such a dispute.

- 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. PROFESSIONAL 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 655

NI 655

LNG Carrier Conversion to FSRU or FSU

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SECTION 1

GENERAL

1 General

1.1 Application

1.1.1 The present Guidance Note provides guidelines for the conversion of an existing liquefied natural gas carrier (LNG carrier) into a floating LNG gas storage unit (FSU) or a floating LNG gas storage unit fitted with a regasification plant (FSRU).

Units converted in compliance with the present Guidance Note may be classed and assigned one of the Classification Notation listed in [1.2.1].

1.2 Classification notation after conversion

1.2.1 In compliance with the applicable requirements of NR645 “Rules for the Classification of Floating Storage Regasification Units”, a converted unit will be assigned one of the following service notations:

- **Liquefied gas carrier - FSRU**
- **Liquefied gas carrier - FSU**
- **FSRU**
- **FSU-LNG.**

1.3 Principles

1.3.1 FSRU or FSU have some differences from a design and operation perspective comparing to a LNG carrier, including:

- site specific environmental loading at the intended operating site
- increased potential for cryogenic hazard due to LNG handling and processing
- increased fire/explosion impact on process deck and main deck due to potential gas leakage
- reinforcement of hull and hull interface with topside due to additional topside loads
- permanent mooring at the intended operating site
- sloshing effects due to partial filling
- potential inspection, maintenance and repair without dry-docking.

1.4 Scope

1.4.1 The present Guidance Note addresses:

- the scope of survey during conversion work
- the structural assessment of the hull
- the cargo containment system
- the machinery, electrical and safety systems,
- the mooring system
- the development of the in-service inspection program.

1.4.2 The general methodology for the conversion is illustrated by the flow chart given in Fig 1 to Fig 4.

2 Ship eligibility for conversion

2.1 General

2.1.1 Ship eligibility for conversion is conditional on a design approved by an IACS Society with regards to the hull.

2.1.2 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.

3 Re-assessment exemption

3.1 Hydrodynamic analysis exemption

3.1.1 On a case-by-case basis, the Society may exempt the converted units from hydrodynamic analysis in accordance with Sec 3, [3.1.3].

3.2 Structural assessment exemption

3.2.1 General

Exemptions given in [3.2.2] and [3.2.3] are not applicable to the added new structure and local reinforcement at the interface with the existing hull for which structural assessment is to be carried out in accordance with NR645.

3.2.2 Strength assessment exemption

On a case-by-case basis, the Society may exempt the converted units from some re-assessment, in accordance with Sec 4, [3.1.2].

3.2.3 Fatigue assessment exemption

On a case-by-case basis, the Society may exempt the converted units from some re-assessment, in accordance with Sec 4, [5.1.4].

3.3 Sloshing on-site assessment exemption

3.3.1 On a case-by-case basis, the Society may grant exemption from direct sloshing calculation for several relevant partial filling levels in accordance with Sec 5, [3.1.1].

4 Condition assessment

4.1 General

4.1.1 A full assessment of the unit status before conversion is to be performed through a Condition Assessment survey. This survey is to cover the hull structure, the cargo machinery and fittings, the propulsion if maintained onboard, the cargo containment system and the bridge and navigation system.

The Condition Assessment Survey is based on several inspection criteria such as visual, coating status, measured thickness, function test, oil analysis, vibration measurements.

The Condition Assessment survey is also supported by a full Ultrasonic Thickness Measurements (UTM) campaign of the unit, and a structural and fatigue analysis in order to identify the hot spot areas to be close up inspected.

5 Life extension

5.1 General

5.1.1 When the FSRU or the FSU 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 4 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.

6 Risk analysis

6.1 General

6.1.1 A risk analysis is required to identify how new systems and operations may affect overall design and safety.

Note 1: Cargo operations and simultaneous operations are to be taken into account in the risk analysis, if relevant.

Relevant hazards and risks scenarios with respect to regasification operation are to be identified as defined in NR645, Sec 10, [1.4.1].

7 Regasification system

7.1 General

7.1.1 As defined in the NR645, Section 2, the additional service feature **REGAS** is assigned to units with the service notation **liquefied gas carrier - FSRU** or **FSRU** and the regasification System is to be compliant with requirements in NR645, Section 10.

8 Inspection and testing

8.1 Conversion work survey

8.1.1 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 NR645, Section 14 and in particular:

- complete scantling measurement to evaluate the condition of the unit's structure
- bottom inspection
- a complete inspection of the cargo containment systems.

Figure 1 : Overview of the conversion principles - Input data

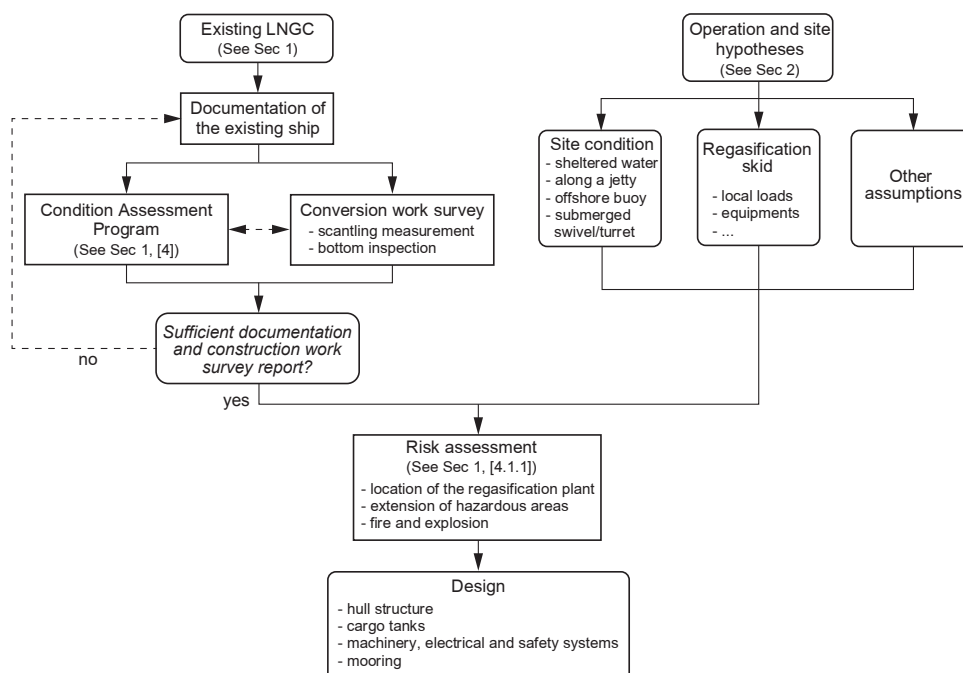


Figure 2 : Overview of the conversion principles - Design 1/2

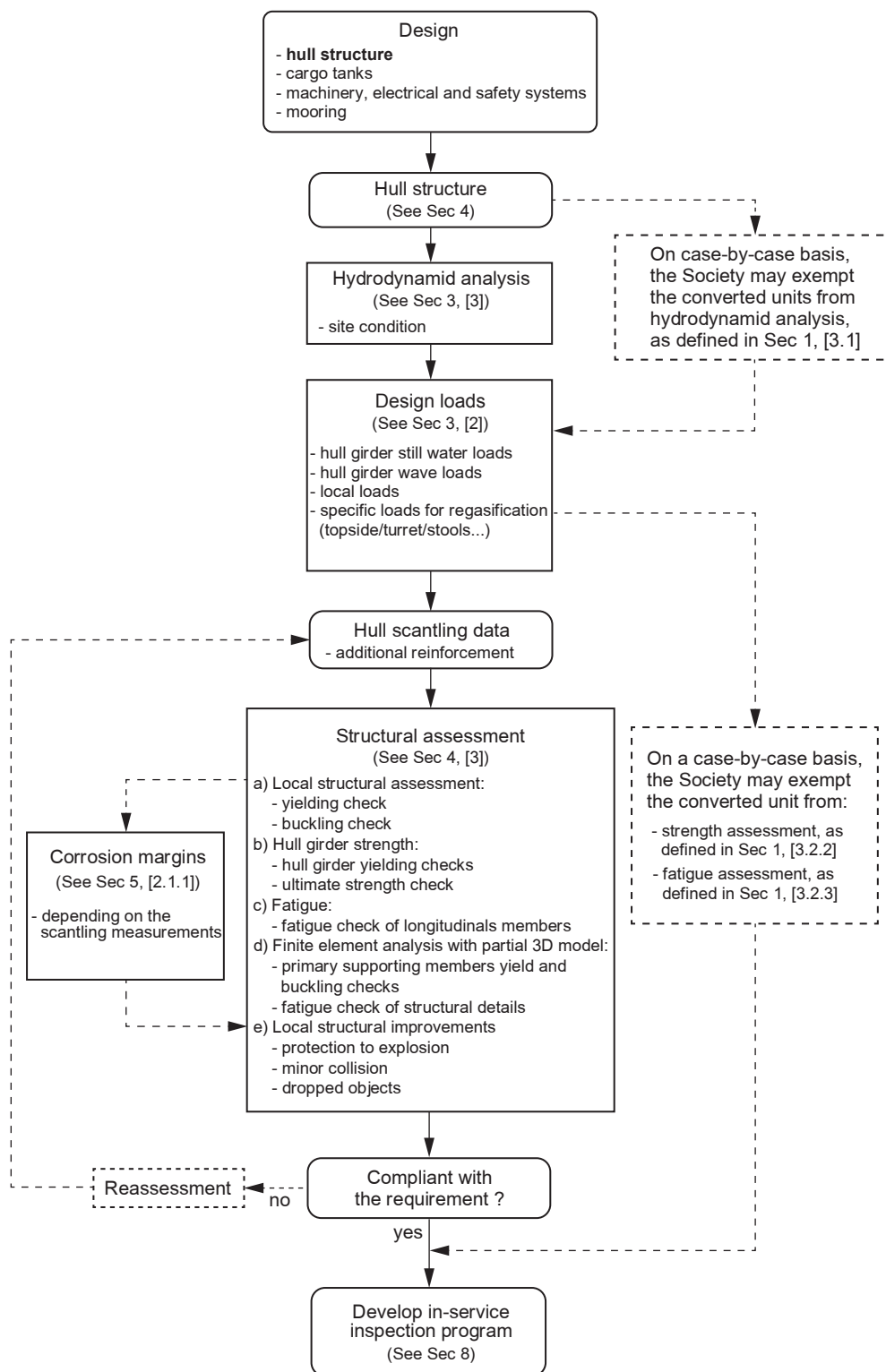


Figure 3 : Overview of the conversion principles - Design 2/2

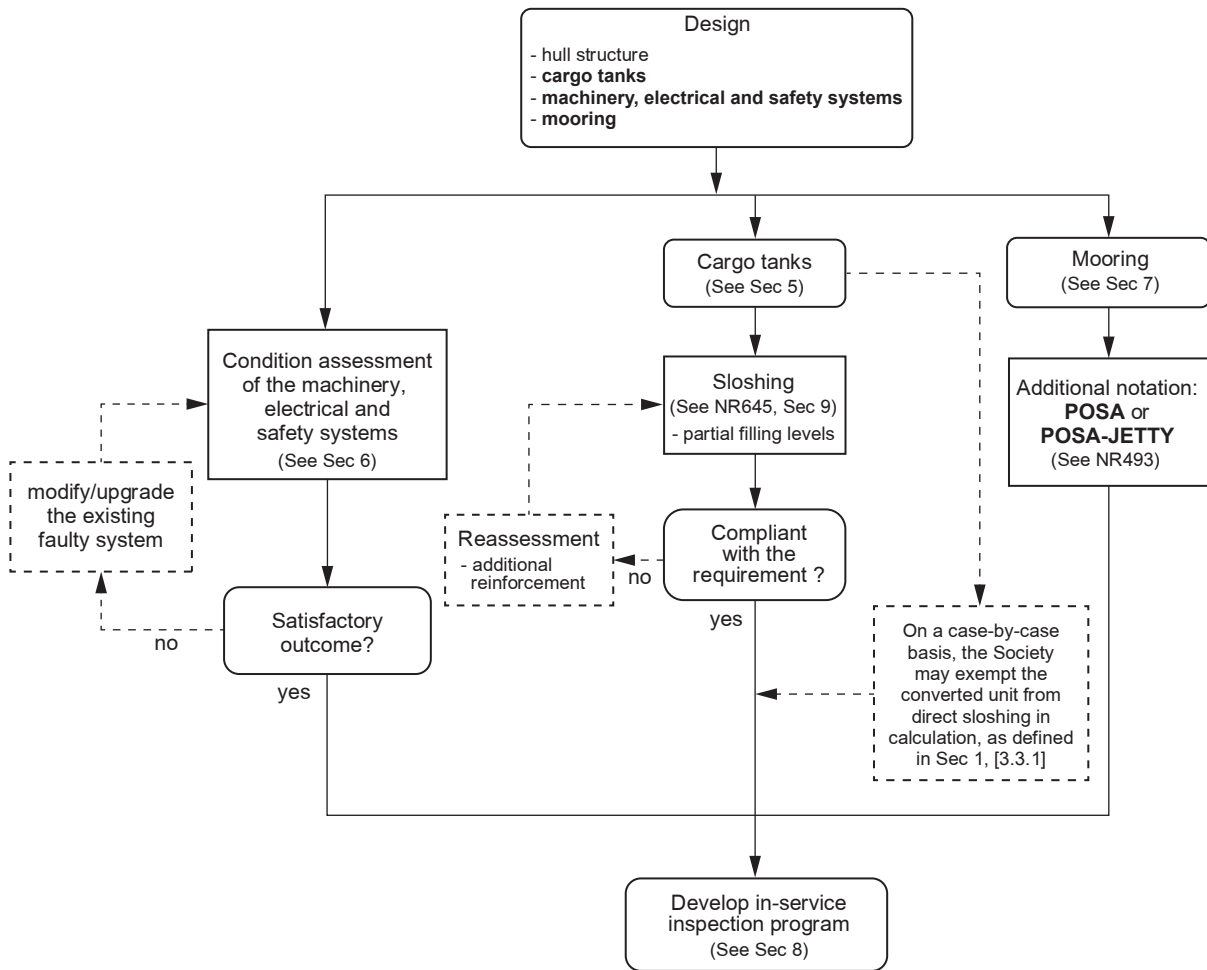
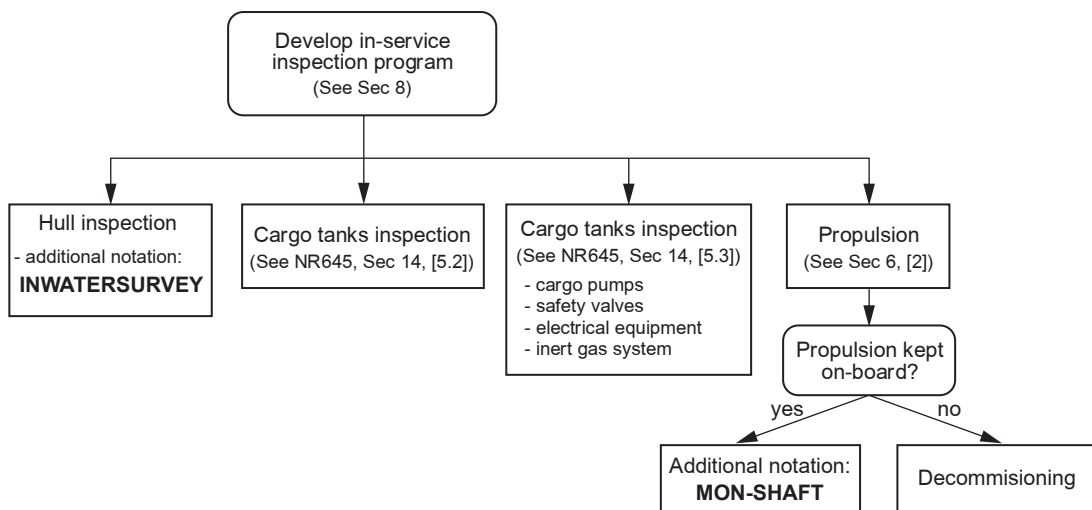


Figure 4 : Overview of the conversion principles - Develop in-service inspection program



9 Documents to be submitted

9.1 General

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

- NR467, Pt D, Ch 9, Sec 1, Tab 2, (NR467, Rules for the Classification of Steel Ships)
- NR645, Sec 2, [5], and
- in [9.2] to [9.3], as applicable.

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

9.2 Documentation of the existing ship

9.2.1 Required documentation of the ship 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
- cathodic protection
- trading routes history
- on membrane units, the reports of testing and inspections done to primary and secondary membranes.

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.

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 histories are provided, adequate assumptions on navigation coefficient are to be considered as stated in Sec 4, [5.2].

9.3 Documentation for conversion

9.3.1 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
 - corrosion addition considered, if relevant
 - structure fatigue damage calculations
 - hull structural drawings showing reinforced or modified details
 - drawings of new and modified superstructure and topsides.
- b) conversion work specification including:
 - foreseen steel renewal and structure reinforcements
 - lightship estimate and weight distribution
 - 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.
 - revised electrical power balance
 - revised short-circuit current calculations.
- d) local Authority requirements, if any
- e) flag administration requirements, if any.

9.3.2 Reference is also made to data and documents which are to be provided as required in NR645, and in particular::

- a) design criteria and data:
 - design data defined in Sec 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).
- b) hydrodynamic analysis for site 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.
- d) in Service Inspection Program.

SECTION 2

OPERATION AND SITE HYPOTHESIS

1 General

1.1 Application

1.1.1 The present Section provides requirements for operation and site hypotheses applied for the conversion of the unit.

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 be issued by the Society, based on the information provided by the party applying for classification.

The Design Criteria Statement is to be referred to on the unit's Classification Certificates.

The Design Criteria Statement is to be incorporated in the Operating Manual, as stated in NR645, Sec 1, [8.1.1].

3 Site condition

3.1 General

3.1.1 Units with the service notation **FSRU** or **FSU-LNG** are to be granted with a site notation, consisting in the name of field and/or geographical area and/or the most unfavourable sea conditions where the unit is intended to operate.

For units with the notation **liquefied gas carrier - FSRU** or **liquefied gas carrier - FSU**, the site notation is not mandatory.

In both cases, the data, limitations and assumptions used for the assessment of the unit on site are stated in the Design Criteria Statement, as defined in NR645, Sec 1, [8.1].

4 Towing/Transit condition for units with FSRU or FSU-LNG notation

4.1 General

4.1.1 The towing or transit between the conversion shipyard and the intended site is covered by classification requirements.

To flag the unit is:

- recommended for the towing
- mandatory in international waters and when people are onboard.

Attention is to be paid to the compliance with international codes and standards as required by National Authorities.

The Society may issue a provisional classification certificate when completion of the hull is deemed acceptable by the society, with design criteria for towing/transit condition clearly identified.

4.1.2 Fatigue strength during towing/transit

The Society reserves the right to require, for structural members, a direct fatigue analysis resulting from the towing/transit.

Such fatigue analysis is to be combined with the overall fatigue verification of the unit in operation at intended site.

4.1.3 Temporary mooring during towing/transit

The unit is to be equipped with temporary mooring (anchoring) equipment during the towing/transit operation. This equipment may be removed when the unit is permanently moored at the operation site.

5 Regasification system

5.1 General

5.1.1 Regasification System arrangement is to be defined (e.g local loads, equipment ...) in order to identify how new systems and operations may affect overall design and safety and to perform the risk assessment required in Sec 1, [6.1].

Note 1: This article is not applicable for FSU units.

SECTION 3

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 NR645, Section 5.

1.2 Documentation to be submitted

1.2.1 The documentation to be submitted is listed in Sec 1, [9].

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.

2 Design loads

2.1 General

2.1.1 Loading conditions

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

Loading conditions are to be separated into five categories:

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

2.1.2 Load cases

For each loading condition the load cases defined in NR645, Section 5 are to be considered.

2.1.3 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 regasification equipment and new equipment, in above conditions, as relevant
- flooding loads
- collision loads.

2.1.4 Fatigue calculations

Loading conditions and load cases to be considered for fatigue assessment are described in Sec 4, [5] and in NR645.

3 Hydrodynamic analysis

3.1 Principle

3.1.1 Application

Hydrodynamics analysis is to be performed for site conditions.

Hydrodynamic calculations are to be conducted as specified in NR645, Section 4.

3.1.2 Objectives

The purpose of hydrodynamic analysis is to obtain the parameters related to wave loading for on-site 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 NR645, Section 5.

3.1.3 On a case-by-case basis, the Society may exempt the converted or redeployed unit from hydrodynamic analysis provided the site conditions are considered less severe than the navigation notation conditions previously assigned to the LNGC.

SECTION 4 STRUCTURAL STRENGTH

1 General

1.1 Application

1.1.1 The present Section provides requirements for the structural assessment of FSRU or FSU units when converted from ships.

1.2 Principles

1.2.1 Re-assessment of the structural strength of the unit is necessary to covers the new condition of operation, with for example:

- the site condition
- the additional loads (regasification system and new equipment).

An evaluation of in-service accumulated fatigue damage is also necessary and is to be combined with the fatigue damage on site in order to ensure that the unit may be used safely during the new service life times.

2 Corrosion

2.1 General

2.1.1 On a case-by-case basis and depending on the outcomes of the scantling measurement required in Sec 1, [8.1.1], the Society may require additional calculations taking into account actual measured thickness.

3 Structural assessment

3.1 Methodology

3.1.1 The structural assessment is to include the following structural checks:

- a) local structural assessment:
 - yielding check
 - buckling check.
- b) hull girder strength:
 - hull girder yielding check
 - ultimate strength check.
- 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) Local structural improvements, in accordance with risk analysis results:

- protection to explosion
- minor collision
- dropped objects.

3.1.2 On a case-by-case basis, the Society may exempt the existing structure of the unit from structural assessment, provided the following conditions are fulfilled:

- the new scantling draught is equal to or lower than the actual one
- the new still water hull girder loads are within the actual allowable limit curves
- the new wave loads are considered less severe than unrestricted navigation (or actual navigation notation) or less severe than the previous site conditions

3.1.3 The added new structure and its interface with the existing hull are to be submitted to the structural assessment given in [3.1.1].

4 Structural strength

4.1 General

4.1.1 For on-site conditions, the structural strength is to comply with the requirements given in NR645, Section 7 with the design loads defined in Sec 3.

5 Fatigue

5.1 General

5.1.1 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_{towr} , 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_{LU} , when deemed necessary,
- e) evaluate fatigue criteria combining above damages, as defined in [5.5].

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

5.1.2 For units intended to be granted the additional class notation **Spectral Fatigue** (), as defined in NR467, Part A, 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 NR467, Pt B, Ch 7, Sec 4 for past life conditions NR645, Section 7 for on-site conditions.

5.1.3 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 NR467, Pt B, Ch 11, App 2 and Pt D, Ch 9, Sec 4, [5.6].

In addition, depending on the cargo containment systems, relevant structural details defined in NR467, Pt D, Ch 9, Sec 4, [5.7] are to be checked.

5.1.4 Fatigue assessment exemption

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

5.2 Past life accumulated fatigue damage

5.2.1 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 [5.2.2] or on defaults assumption as defined in [5.2.3].

All the structural details for which the fatigue is to be assessed on site as per [5.3], are also to be assessed for the past life fatigue.

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.

5.2.2 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 the NI 593, Appendix 3 (Ship Conversion into Offshore Units – Redeployment and Life Extension of Offshore Units).

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.

5.2.3 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 NR467, Pt B, Ch 7, Sec 4.

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

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

5.2.4 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.

5.3 Fatigue damage during transit

5.3.1 Accumulated damage during transit D_{tow}

D_{tow} during transit phase may be to be evaluated when deemed necessary.

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.

5.4 Fatigue damage on site

5.4.1 Wave environment

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

5.4.2 On site damage calculations D_{site}

On-site damage D_{site} is to be assessed according to NR645, Sec 7, [4.3.3].

When calculating D_{site} , new requested design life 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 NI 611 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.

5.4.3 Loading/unloading damage calculation D_{LU}

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} .

5.5 Fatigue criteria

5.5.1 Checking criteria

The following criteria is to be fulfilled:

$$D_{past} + \left(SF_{tow} D_{tow} + SF_{site} D_{site} + SF_{LU} D_{LU} \right) \gamma_R \leq 1$$

where:

SF_{tow} , SF_{site} , SF_{LU} : 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.

Regular monitoring of the details may be accepted on a case by case basis by the Society instead of reinforcements when criteria above is not fulfilled. This may be accepted only if the concerned details have never experienced any crack in the past life of the unit and during the condition assessment survey of the unit before conversion.

Table 1 : Fatigue damage safety factors

Method	Deterministic analysis with navigation notation (1)	Deterministic analysis with hydrodynamic loads (2)	Spectral analysis (3)
Safety factor	1	2	
(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 2 : 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
Safety factor	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 5

CARGO CONTAINMENT SYSTEMS

1 General

1.1 Application

1.1.1 The present Section provides guidelines and requirements for the cargo containment systems of an existing ship intended to be converted into an FSRU or an FSU.

1.1.2 The provisions of this Section are complementary to those of NR645, which remain applicable, except where otherwise specified.

1.2 Principles

1.2.1 Filling limits

Many LNG carriers are built with filling limits in cargo tanks when in navigation conditions. For FSRU or FSU application, sloshing against partial filling is to be re-evaluated taking into account the condition at the intended operating site, as detailed in [3.1].

1.2.2 Increase Admissible Cargo Tank Pressure pressure (IATP)

Many LNG carriers are designed and built with a maximum cargo tank design pressure of 25kPa.

The additional class notation **IATP**, as defined in NR467, Pt F, Ch 11, Sec 14, may be assigned to FSRU or FSU units whose maximum cargo tank design pressure does not exceed 70 kPa and that are designed and built so as to allow the pressure in the tanks to increase above 25 kPa.

2 Cargo tanks inspection at conversion yard

2.1 Membrane

2.1.1 For an existing LNG ship constructed with membrane type, an internal inspection is to be performed for the primary barrier and internal systems (e.g. pump tower including its base support and base plate, pumps,...). The secondary barrier is to be checked by adequate tests as recommended by designer.

2.2 Type B tanks

2.2.1 For an existing LNG ship constructed with Type B tanks, an inspection and test campaign (documented through an Inspection Test Plan) is to be carried out for the tank, the tank insulation and the internal systems (e.g. dome connections, pump tower, pump base plate, pumps, pipings and fittings, means of access). The Inspection Test Plan (ITP) is to be issued by designer / builder.

3 Sloshing on-site

3.1 Partly filled tanks on-site

3.1.1 As defined in NR645, Sec 9, [2], all cargo tanks are to be checked for several relevant partial filling levels.

Note 1: Subject to the agreement of the Society, direct sloshing calculation need not be performed for site areas where the extreme 100 years return period significant wave height is less than 1,5 m.

SECTION 6

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 FSRU or an FSU.

1.1.2 The provisions of this Section are complementary to those of NR645, which remain applicable, except where otherwise specified.

1.1.3 On a case-by-case basis and depending on the outcomes of the inspection work survey required in Sec 1 [8], the Society may require additional requirements.

1.2 Principles

1.2.1 All systems on-board are depending on the outcomes of the conversion work survey required in Sec 1 [8] and if existing faulty systems are detected, these systems are to be upgraded or modified.

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 Some additional requirements are necessary to covers the specific aspect of permanent FSRU or FSU units, paying particular attention to:

- sea water system
- preservation of propulsion, if any.

1.2.4 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.

1.2.5 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 and after the conversion as for an operating ship, meeting all requirements of the vessel's Flag Administration and international regulations for safe operation (see [2.1.2]).

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 is to 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 Preservation of propulsion machinery while permanently moored at site

Propulsion machinery, when intended to be preserved for future use after the FSRU or the FSU has been duly moored at site, is to be subject to a case-by-case approval, upon receipt of a detailed preservation plan, and the additional class notation **MON-SHAFT** is mandatory in this case, as defined in NR645.

The preservation philosophy is to be submitted for approval, whereas the plan is to be adequate with the operational philosophy of the FSRU or the FSU 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 program for the propulsion preservation is to be submitted for approval and monitored accordingly under the supervision of the Society while the FSRU or the FSU remains at site.

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

In such case, the accepted program is to be reflected in a memorandum attached to classification certificate.

2.1.3 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.

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 LNG carrier. 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.

4 Fire-fighting systems

4.1 General

4.1.1 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 regasification system.

4.1.2 Due to new regasification system, 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 regasification system.

SECTION 7

MOORING SYSTEMS

1 General

1.1 Application

1.1.1 The present Section provides guidelines and requirements for the mooring systems of an existing ship intended to be converted into an FSRU or an FSU.

1.1.2 The provisions of this Section are complementary to those given in NR645, which remain applicable, except where otherwise specified.

1.2 Principles

1.2.1 Mooring system is a critical system in particular in case of permanent installations (more than 5 years on site). Mooring systems traditionally used in a LNG carrier are not

intended for extended period. Re-assessment of the mooring systems may be required to ensure a sufficient level of safety.

2 Additional service features

2.1 General

2.1.1 As defined in NR645, Section 2, one of the additional service features **POSA** or **POSA-JETTY** is mandatory for permanent unit with the service notation **FSRU** or **FSU-LNG**.

For units, with the service notation **liquefied gas carrier - FSRU** or **liquefied gas carrier - FSU** considered as permanent installations, **POSA-JETTY** may be assigned. If the unit is permanently moored at sea then **POSA** is mandatory.

SECTION 8

IN SERVICE INSPECTION PROGRAM

1 General

1.1 Application

1.1.1 The present Section provides guidelines and requirements for the development of a in-service inspection program of an existing ship intended to be converted into an FSRU or an FSU.

1.1.2 The provisions of this Section are complementary to NR645, Section 14, which remain applicable, except where otherwise specified.

1.2 Principles

1.2.1 LNG carriers are to go in dry-docking every 5 years which may not be in line with the operation principle of typical FSRU or FSU operated at a single location for an extended period.

In order to consider the possibility of an inspection on site without dry-docking, the unit is to be adapted to the on-site constraints to ensure the same level of safety as during a classic dry-docking , by compliance with the requirements of Article [2].

1.2.2 Preparation studies to allow in-service inspection of cargo tanks and handling equipment on-site are described in Fig 1.

1.2.3 Flag and coastal state agreement and their additional requirements, if any, are to be carefully considered

2 In-service inspection

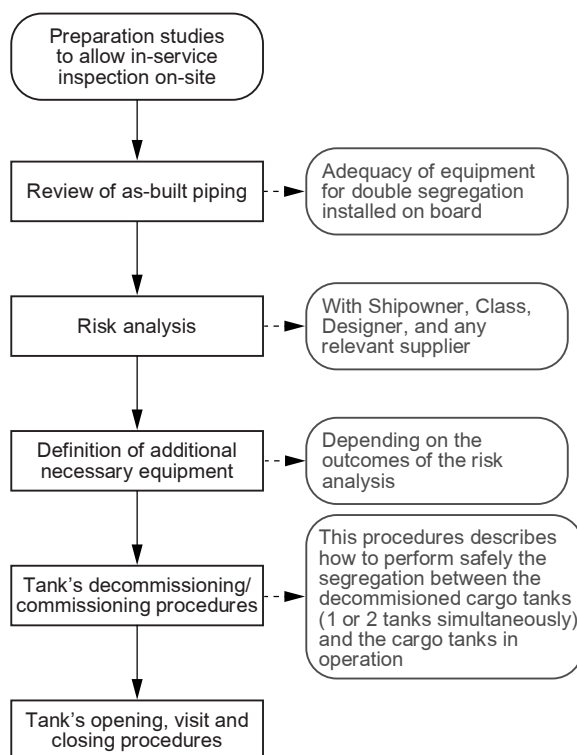
2.1 General

2.1.1 In Service Inspection Program is to be submitted to the society for review. When validated, it is reflected in a memorandum attached to classification certificate.

2.2 Hull inspection

2.2.1 For permanent installations and for other units where drydocking is impracticable, the examination of the outside of the unit's underwater parts and related items may be carried out during an in-water survey, subject to the notation **INWATERSURVEY** having been assigned and subject to the agreement of the Society and as authorised by Flag Administration and, when relevant, by the coastal state.

Figure 1 : Preparation studies to allow in-service inspection of cargo tanks and handling equipment on-site



2.3 Cargo tanks inspection

2.3.1 As defined in NR645, arrangements are to be set out to allow safe inspection of a single or more cargo tanks with the unit in operation. Double shut off arrangement for all interconnections between tanks and equipment and piping to be fitted.

2.4 Cargo handling equipment

2.4.1 As defined in NR645, when it is intended to have the intermediate and/or renewal survey performed while the unit is in continuous operation, the unit shall be adequately prepared to allow the relevant surveys and tests to be safely undertaken to the required extent, paying particular attention to:

- safety valves
- cargo pumps
- regasification plant
- electrical equipment in hazardous area
- inert gas system
- ESD systems.



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