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GUIDELINES ON
HULL SCANTLINGS ASSESSMENT FOR CONVERSION OF OIL TANKERS TO FLOATING OFFSHORE UNITS

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Guidelines

Hull Scantlings Assessment for Conversion of Oil Tankers to Floating Offshore Units

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Contents

Sections

Introduction

Floating Offshore Units (FOU)s may also be constructed by conversion of existing Oil Tankers to that role. The IRS *Rules for Construction and Classification of Floating Offshore Units* (hereinafter referred to as “FOU Rules”) permit such conversions of Oil Tanker to FOUs. However, it is important to assess the scantlings of Oil Tankers being converted to FOUs, in order to take in to account the structural health of the existing ship, and to consider the requirements of FOU to withstand loads corresponding to a different return period and different environment, operational and functional conditions.

This document provides guidance on various aspects to be considered when performing the assessment of scantlings of existing Oil Tankers which are planned for conversions to FOUs.

Section 1

General

1.1 Scope and Objective

1.1.1 These Guidelines are applicable to the assessment of scantlings of cargo areas of existing Oil Tankers which are planned for conversion to Floating Offshore Units (FOUs).

1.2 General Principles

1.2.1 The Oil Tanker planned to be converted to FOU should be under IRS Classification or classed with a Member of the International Association of Classification Societies (IACS).

1.2.2 The Oil Tanker planned to be converted to FOU should be of an age not exceeding 15 years. Conversion of Oil Tankers with age exceeding 15 years, will be considered by IRS on a case to case basis.

1.2.3 The scantlings of the selected Oil tanker should be assessed to confirm its adequacy for the FOU operations at the selected site(s) for the envisaged period of operation. The return period to be considered for the environmental loads is not to be less than that specified in the FOU Rules.

1.2.4 Renewal scantlings should be determined based upon the assessed scantlings of the hull structure of the FOU.

1.3 Pre-Conversion Surveys

1.3.1 Surveys of the as-built Oil Tanker cargo area prior to conversion should be performed to establish the current structural health and condition of the hull. The following activities should be performed during the survey but not limited to:

- Survey of the Oil Tanker Hull to detect any visible cracks, wastage, deformations, dents/damages and/or deterioration
- Thickness measurements of all structural members
- Close-up inspection of critical areas (these should be identified from a review of drawings of the existing Oil Tanker as well as from the records of periodical surveys of the Oil Tanker)
- NDT of critical areas (these are to be agreed with IRS)
- Inspection of the Ship's bottom

1.3.2 Surveys in accordance with 1.3.1 should be carried out for locations outside the cargo area where new process equipment or utility modules are envisaged to be fitted (e.g. helideck, crane installations, flare tower etc.).

1.3.3 An inspection plan covering the items mentioned in 1.3.1 and 1.3.2 should be submitted to IRS for review. This plan should be developed, taking into account the items in accordance with the age of the Oil Tanker as indicated in the IRS *Rules for Bulk Carriers and Oil Tankers*, Part 1, Chapter 3, Section 2.

1.3.4 Survey of the structures other than those mentioned in 1.3.1 and 1.3.2 should be performed in accordance with the relevant requirements for Oil Tankers as stipulated in Part 1, Chapter 2 of the IRS Rules for Construction and Classification of Steel Ships.

1.3.5 Pitting and Grooving Corrosion within the cargo area, where detected during the pre-conversion survey should be recommended for repair in accordance with IRS *Rules for Bulk Carriers and Oil Tankers*, Part 1, Chapter 3, Section 2.

1.4 Assessment of Scantlings

1.4.1 The scantlings of the cargo area of the FOU hull should be assessed. Renewal scantlings should also be determined. Please refer Section 2 for further details.

1.4.2 The Renewal scantlings will be applied in accordance with 1.4.1. Post renewal, survey(s) will be performed by IRS to confirm the renewal has been carried out in accordance with the determined renewal scantlings.

1.5 Documentation

1.5.1 The following documentation should be submitted:

- Design brief of the FOU – anticipated operations, functions and environment conditions
- As-built plans of the Oil Tanker
- Trim & Stability booklet of the Oil Tanker
- Periodical Survey records of the Oil Tanker
- Damage and Repair history of the Oil Tanker
- Trading history of the Oil Tanker
- Pre-conversion thickness measurement report of the hull
- Pre-conversion survey report
- Structural calculations and analyses reports of the Oil Tanker
- Structural calculations and analyses reports of the FOU subsequent to outcome of the pre-conversion survey

Section 2

Structural Assessment

2.1 General

2.1.1 Structural assessment of the scantlings for the primary structure of the cargo area of the FOU hull as well as those locations outside of the cargo area where new process and/or utilities are envisaged to be fitted should be performed in accordance with the guidance provided in this section.

2.2 Design Loads

2.2.1 The design loads to be considered for the assessment should be in accordance with IRS FOU Rules, Chapter 4. The design loads and loading conditions should be representative of those which are anticipated to be encountered by the FOU during it's service life.

2.2.2 Ultimate, Fatigue and Accident Limit States should be considered in accordance with IRS FOU Rules, Chapter 4 when deciding the design loads.

2.2.3 The return period to be considered for the environmental loads should be in accordance with IRS FOU Rules, Chapter 4.

2.2.4 The design loads should also consider navigation and transit conditions of the FOU in addition to the operation at site.

2.3 Terminology

2.3.1 t_{as_built}: The as-built thickness of the scantlings for the Oil Tanker

2.3.2 t_c: Corrosion margin required as per the IRS FOU Rules

2.3.3 t_c': Corrosion margins considered during design and construction of the Oil Tanker

2.3.4 t_{net_assess}: Net thickness required from assessment of scantlings as per the IRS FOU Rules

2.3.5 t_{ren}: Renewal thickness required

2.3.6 t_{exist}: Measured thickness during pre-conversion survey

2.4 Structural Assessment Methodology

2.4.1 The initial net thicknesses to be considered for scantling assessment should first be established using the as-built scantlings of the subject oil tanker and corrosion margins (t_c') which are deducted from the as-built scantlings as appropriate (i.e. depending upon the specific limit state which is to be evaluated). The corrosion additions should be considered in accordance with Section 2.5.

2.4.2 The structural assessment should undertake evaluation of the initial net scantlings obtained from 2.4.1 in accordance with the below-mentioned requirements. In case the initial net scantlings do not comply with the requirements in the following, then the net scantlings should be increased in steps so as to arrive at a final set of such net scantlings which comply with the below requirements.

- Longitudinal Strength (FOU Rules, Chapter 4, Section 12)
- Hull Girder Ultimate Strength (FOU Rules, Chapter 4, Section 19)
- Local Scantlings Evaluation (FOU Rules, Chapter 4, Sections 4, 13 – 18, 20, 23)
- Evaluation from Direct Strength Analysis (FOU Rules, Chapter 4, Section 21)
- Evaluation from Local Structural Strength Analysis

- Evaluation from Fatigue Analysis (FOU Rules, Chapter 4, Section 22). The accumulated fatigue damage during operation as tanker should also be considered to determine the balance fatigue life of the FOU. The balance fatigue life should not be less than that as specified in Chapter 4, Section 22.5 of the FOU Rules.
- Scantlings evaluation from other safety studies (e.g. collision analysis, dropped object analysis etc.) (FOU Rules, Chapter 4, Section 10)

2.4.3 The net scantling for a structural element obtained from the evaluation in 2.4.1 is termed as t_{net_assess}.

2.4.4 The gross assessed scantling (t_{gross_assess}) should then be obtained by combining the net assessed scantling in 2.4.2 with appropriate corrosion additions computed for the structural elements. The corrosion additions to be used for this purpose should be calculated using the below formula.

$$t_c = CR \times T$$

Where,
CR: corrosion rate in mm/year for each exposed side as shown in Table 2.4.4
T: Design Life of the FOU converted from Oil Tanker

Table 2.4.4: Corrosion rates for structural elements within the cargo area

Space	Corrosion rate (mm/year)
Cargo Tank and Fuel Oil Tank	0.0375
Ballast Tank	0.050
Bilge Tank	0.050
Exposed to Seawater	0.0375
Exposed to Atmosphere	0.025
Void Space/Dry Space	0.0125

Note 1: IRS may specially consider other values for corrosion rates if accompanied by data from field measurements and satisfactory technical justification.

Note 2: For tanks cladded with stainless steel, the corrosion rate for the stainless steel side can be taken as 0.

Note 3: For the zone within 1.5m of the top of the Cargo Tank and Fuel Tank, the corrosion rate should be taken as 0.05 mm/year.

Note 4: For the zone within 1.5 of the top of the Ballast Tank, the corrosion rate should be taken as 0.0625 mm/year.

2.4.5 For a structural element which shares boundary with two different types of spaces, the corrosion additions corresponding to each space should be computed and added for obtaining the corrosion addition for that structural element. For a structural element not sharing a boundary with any other space (i.e. an internal member for the space), the corrosion addition is twice the value obtained by using the formula in 2.4.4. This is given by the formulae as indicated below:

1) For a member sharing boundary with two spaces:

$$t_c = t_{c1} + t_{c2}$$

Where,
t_{c1},t_{c2}: Corrosion addition, in mm, on one side of the considered structural member, as defined in Table 2.4.4

2) For an internal member within a space:

$$t_c = 2t_{c1}$$

Where,
t_{c1},t_{c2}: Corrosion addition, in mm, on one side of the considered structural member, as defined in Table 2.4.4

2.4.6 The gross assessed thickness is obtained by combination of the net assessed thickness (2.4.3) and the corrosion margins (2.4.4).

$$t_{gross-assess} = t_{net-assess} + t_c$$

2.4.7 The assessed gross thickness should be further used to determine the renewal scantlings as described in Section 3. (It may be noted that the process described in this sub-section would require several iterations so as to establish the minimum required assessed gross scantlings)

2.5 Corrosion margins to be considered for structural assessment of the oil tanker for conversion to FOU

2.5.1 Corrosion margins which should be considered during the structural assessment for evaluating the initial net thicknesses of the oil tanker for conversion to FOU from the as-built scantlings are elaborated in this sub-section.

2.5.2 For Double Hull Oil Tankers of length 150 m and above, contracted for construction on or after 1st April 2006, the corrosion margins should be considered as indicated in Table 2.5.2.

2.5.3 For Double Hull Oil Tankers of length 150 m and above, contracted for construction on or after 1st January 2014, the corrosion margins should be considered in accordance with the IRS Rules for Bulk Carriers and Oil Tankers

2.5.4 For Oil Tankers which do not fall in the categories as mentioned in 2.5.2 – 2.5.3, the corrosion margins will be specially considered and agreed by IRS. The designer of the FOU should propose corrosion margins to be considered followed with due technical justification.

Table 2.5.2 Corrosion Additions			
Item			**Corrosion Margin t_c' (mm)**
Internal members and plate boundary between spaces with the same category of contents			
In and between ballast water tanks	Face plate of PSM	Within 3m below top of tank	4.5
		Elsewhere	3.5
	Other members	Within 3m below top of tank	4
		Elsewhere	3
In and between cargo oil tanks	Face plate of PSM	Within 3m below top of tank	4
		Elsewhere	3.5
	Other members	Within 3m below top of tank	4
		Elsewhere	2.5
In and between heated cargo oil tanks	Face plate of PSM	Within 3m below top of tank	4.5
		Elsewhere	4
	Other members	Within 3m below top of tank	4.5
		Elsewhere	3.5
Exposed to atmosphere on both sides	Support members on deck		2.5
In and between void spaces	Spaces not normally accessed, e.g. access only via bolted manhole openings, pipe tunnels, etc		2
In and between dry spaces	Internals of deckhouses, machinery spaces, pump room, store-rooms, steering gear space, etc.		1.5
Plate boundary between spaces having a different category			
Boundary between ballast tank and cargo oil tank	Unheated Cargo oil	Within 3m below top of tank	4
		Inner Bottom Plating	4
		Elsewhere	3
	Cargo oil	Within 3m below top of tank	4.5
		Inner Bottom Plating	4.5
		Elsewhere	3
Boundary between ballast tank and atmosphere or sea	Weather deck plating		4
	Other members	Within 3m below top of tank	3.5
		Elsewhere	3
Boundary between ballast tank and void or dry space	Within 3m below top of tank		3
	Elsewhere		2.5
Boundary between Cargo Tank and atmosphere	Unheated Cargo Oil	Weather deck plating	4
	Heated Cargo Oil	Weather deck plating	4.5
Boundary between cargo tank and void spaces	Unheated Cargo Oil	Within 3m below top of tank	3
		Elsewhere	2.5
	Heated Cargo Oil	Within 3m below top of tank	3.5
		Elsewhere	2.5
Boundary between cargo tank and dry spaces	Unheated Cargo Oil	Within 3m below top of tank	3
		Elsewhere	2
	Heated Cargo Oil	Within 3m below top of tank	3
		Elsewhere	2.5

Section 3

Determination of Renewal Scantlings

3.1 General

3.1.1 This section provides the methodology for determination of the renewal scantlings. The renewal scantlings should be determined for the structural elements as indicated in Section 2.1.1

3.2 Definitions

3.2.1 Renewal thickness (t_{renew}): Gross thickness evaluated to determine whether a structural element can be accepted after the FOU assessment.

3.2.2 Minimum acceptable thickness (t_{min}): Minimum acceptable thickness for structural elements which have been subject to corrosion wastage.

3.2.3 Substantial wastage thickness ($t\_{substantial}$): Thickness at 75% wastage levels.

3.2.4 Wastage (w): Corrosion (average) of the structural element expressed as percentage of the as-built thickness. As default, *w* should be considered as 0.2. Higher values of *w* should be accompanied by appropriate technical justification.

3.2.5 Measured thickness ($t\_{measured}$): Thickness obtained from actual measurements/ thickness gauging during the pre-conversion survey.

3.3 Criteria for Renewal

3.3.1 Renewal thickness (t_{renew}) is determined from the equation as shown below:

$$t_{renew} = t_{substantial} + t_c$$

Where,
t_c is to be calculated in accordance with Section 2.4.4

3.3.2 Minimum acceptable thickness (t_{min}) is determined from the equation as shown below:

$$t_{min} = (1 - w)t_{gross-assess}$$

Where,
$t_{gross-assess}$ should be evaluated in accordance with 2.4.6 and w should be evaluated in accordance with 3.2.4

3.3.3 Substantial thickness ($t\_{substantial}$) is determined from the equation as shown below:

$$t_{substantial} = (1 - 0.75w)t_{gross-assess}$$

Where,
$t_{gross-assess}$ should be evaluated in accordance with 2.4.6 and w should be evaluated in accordance with 3.2.4

3.3.4 The renewal of scantlings should be decided evaluating the criteria as shown below:

i. If $t\_{measured} > t\_{renew}$ – renewal of scantlings is not considered to be necessary.
ii. If $t\_{measured} < t\_{renew}$ – renewal of scantlings should be undertaken. The thickness of the structural element should not be less than the gross renewed thickness ($t\_{gross-assess}$)

3.4 Verification of Renewal

3.4.1 The following assessments should be performed using the renewal scantlings as calculated from Section 3.3:

- Longitudinal strength check (for all transverse sections in the cargo area)
- Hull Girder ultimate strength check (for all transverse sections in the cargo area)
- Buckling check (should be performed using net thickness t_{min}) for the cargo area

End of the Guidelines