

DEP SPECIFICATION

**FIXED STEEL OFFSHORE STRUCTURES
(AMENDMENTS/SUPPLEMENTS TO ISO 19902:2007)**

DEP 37.19.00.30-Gen.

February 2011

(DEP Circular 31/12 has been incorporated)

DESIGN AND ENGINEERING PRACTICE

DEM1



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TABLE OF CONTENTS

PART I	INTRODUCTION AND GENERAL REQUIREMENTS.....	4
1.	INTRODUCTION	4
1.1	SCOPE.....	4
1.2	DISTRIBUTION, INTENDED USE AND REGULATORY CONSIDERATIONS	4
1.3	DEFINITIONS	4
1.4	CROSS-REFERENCES	5
1.5	SUMMARY OF CHANGES.....	5
1.6	COMMENTS ON THIS DEP	5
1.7	DUAL UNITS.....	5
2.	GENERAL REQUIREMENTS.....	5
2.1	GENERAL	5
2.2	INTERNATIONAL STANDARD ADOPTED FOR USE.....	5
PART II	AMENDMENTS/SUPPLEMENTS TO ISO 19902:2007	6
3.	TERMS AND DEFINITIONS.....	6
5.	ABBREVIATED TERMS	6
6.	OVERALL CONSIDERATIONS.....	6
8.	ACTIONS FOR PRE-SERVICE AND REMOVAL SITUATION	7
9.	ACTIONS FOR IN-PLACE SITUATION	9
10.	ACCIDENTAL SITUATIONS.....	10
12.	STRUCTURAL MODELLING AND ANALYSIS	10
13.	STRENGTH OF TUBULAR MEMBERS	10
14.	STRENGTH OF TUBULAR JOINTS	10
15.	STRENGTH AND FATIGUE RESISTANCE OF OTHER STRUCTURAL COMPONENTS	11
16.	FATIGUE.....	12
17.	FOUNDATION DESIGN	13
18.	CORROSION CONTROL	18
19.	MATERIALS.....	18
20.	WELDING, FABRICATION AND WELD INSPECTION.....	19
21.	QUALITY CONTROL, QUALITY ASSURANCE AND DOCUMENTATION	20
22.	LOADOUT, TRANSPORTATION AND INSTALLATION.....	20
23.	IN-SERVICE INSPECTION AND STRUCTURAL INTEGRITY MANAGEMENT	23
24.	ASSESSMENT OF EXISTING STRUCTURES.....	23
26.	STANDARD DETAILS	23
ANNEX A	ADDITIONAL INFORMATION AND GUIDANCE	24
ANNEX C	MATERIAL CATEGORY APPROACH	29
ANNEX D	DESIGN CLASS APPROACH	33
ANNEX G	FABRICATION TOLERANCES	33
PART III	REFERENCES	34

PART I INTRODUCTION AND GENERAL REQUIREMENTS

1. INTRODUCTION

1.1 SCOPE

This DEP specifies requirements and gives recommendations for the design of fixed steel offshore structures for the petroleum and natural gas industries. It also covers issues relating to planning and construction where these are relevant to design.

This DEP is based on ISO 19902:2007. Part II of this DEP amends, supplements and replaces various clauses of ISO 19902:2007.

This DEP does not cover design of the topsides structure.

In certain situations (e.g. where extensive good historical performance is known), and if approved by the Principal, fixed offshore structures may be designed in accordance with API-WSD instead of ISO 19902:2007 and this DEP.

This DEP contains mandatory requirements to mitigate process safety risks in accordance with Design Engineering Manual DEM 1 – Application of Technical Standards

This is a revision of the DEP of the same number dated January 2010; see (1.5) regarding the main changes.

1.2 DISTRIBUTION, INTENDED USE AND REGULATORY CONSIDERATIONS

Unless otherwise authorised by Shell GSI, the distribution of this DEP is confined to Shell companies and, where necessary, to Contractors and Manufacturers/Suppliers nominated by them.

This DEP is intended for use in offshore exploration and production facilities. This DEP may also be applied in other similar facilities.

When DEPs are applied, a Management of Change (MOC) process should be implemented; this is of particular importance when existing facilities are to be modified.

If national and/or local regulations exist in which some of the requirements may be more stringent than in this DEP, the Contractor shall determine by careful scrutiny which of the requirements are the more stringent and which combination of requirements will be acceptable with regard to the safety, environmental, economic and legal aspects. In all cases the Contractor shall inform the Principal of any deviation from the requirements of this DEP which is considered to be necessary in order to comply with national and/or local regulations. The Principal may then negotiate with the Authorities concerned, the objective being to obtain agreement to follow this DEP as closely as possible.

1.3 DEFINITIONS

The **Contractor** is the party that carries out all or part of the design, engineering, procurement, construction, commissioning or management of a project or operation of a facility. The Principal may undertake all or part of the duties of the Contractor.

The **Manufacturer/Supplier** is the party that manufactures or supplies equipment and services to perform the duties specified by the Contractor.

The **Principal** is the party that initiates the project and ultimately pays for its design and construction. The Principal will generally specify the technical requirements. The Principal may also include an agent or consultant authorised to act for, and on behalf of, the Principal.

The lower-case word **shall** indicates a requirement.

The capitalised term **SHALL [PS]** indicates a process safety requirement.

The word **should** indicates a recommendation.

1.4 CROSS-REFERENCES

The clause numbering used in Part II of this DEP corresponds with that used in ISO 19902:2007. Other documents referenced by this DEP are listed in (Part III).

1.5 SUMMARY OF CHANGES

This is a revision of the DEP of the same number dated January 2010. Content of the previous version that was background information, explanation and tutorial has been removed.

1.6 COMMENTS ON THIS DEP

Comments on this DEP may be sent to the Administrator at standards@shell.com, using the DEP Feedback Form. The DEP Feedback Form can be found on the main page of "DEPs on the Web", available through the Global Technical Standards web portal <http://www.shell.com/standards> and on the main page of the DEPs DVD-ROM.

1.7 DUAL UNITS

Amended per

Circular 31/12

Dual units have been incorporated throughout this DEP.

This DEP contains both the International System (SI) units, as well as the corresponding US Customary (USC) units, which are given following the SI units in brackets. When agreed by the Principal, the indicated USC values/units may be used.

2. GENERAL REQUIREMENTS

2.1 GENERAL

Part II of this DEP amends, supplements and deletes various clauses/paragraphs of ISO 19902:2007. Wherever reference is made to ISO 19902, it shall be understood to mean ISO 19902:2007 as amended/supplemented by this DEP.

For ease of reference, the clause numbering of ISO 19902 has been used throughout Part II of this DEP. Clauses of ISO 19902 that are not mentioned in this DEP shall remain applicable as written.

2.2 INTERNATIONAL STANDARD ADOPTED FOR USE

ISO 19902:2007 SHALL [PS] be adopted for use with amendments as described in Part II of this DEP.

PART II AMENDMENTS/SUPPLEMENTS TO ISO 19902:2007

3. TERMS AND DEFINITIONS

Add new clauses:

3.57 **barge**

simple floating vessel, normally non-propelled, on which a structure can be transported

3.58 **vessel**

self-propelled ship-shaped unit, on which a structure can be transported.

5. ABBREVIATED TERMS

Add:

CoG centre of gravity

FMEA failure modes and effects analysis

GRP glass-reinforced plastic

6. OVERALL CONSIDERATIONS

6.1 **Types of fixed steel offshore structure**

6.1.1 General

Add:

All calculations, dimensions and weights shall be in SI units (see DEP 00.00.20.10-Gen.).

6.1 **Service and operational considerations**

6.3.3.2 Deck elevation

Add:

For a structure with exposure level L1 (manned non-evacuated or high consequence, see Table 6.6.1) the abnormal water level should have a return period of 10 000 years and should incorporate the associated storm surge and astronomical tide, in addition to allowances for water depth uncertainty, seabed penetration and subsidence. For a structure with exposure level L2 (manned evacuated or unmanned and medium consequence, see Table 6.6.1) the abnormal water level should have a return period of 1 000 years and should incorporate the associated storm surge and astronomical tide, in addition to allowances for water depth uncertainty, seabed penetration and subsidence.

Add to last paragraph:

The durability, corrosion protection and fatigue characteristics of such equipment and support members shall also receive detailed attention in design.

6.6.3 Consequence categories

Add before last paragraph:

A structure with exposure level L1 should achieve a target reliability equivalent to an annual probability of failure of 3×10^{-5} / year (ref. ISO 19902:2007 A.9.9.3 and EP 97-5050) This target reliability can be achieved by using the 100-year return period environmental actions in conjunction with the action factors given in ISO 19902:2007 Table 9.10.1 and Clause A.9.9.3. A structure with exposure level L2 should achieve a target reliability equivalent to an annual probability of failure of 5×10^{-4} / year (ISO 19902:2007 A.9.9.3 and EP 97-5050).

This target reliability can be achieved by using the 100-year return period environmental actions in conjunction with the action factors given in ISO 19902:2007 Table A.9.9.2.

8. ACTIONS FOR PRE-SERVICE AND REMOVAL SITUATION

8.3 Actions associated with lifting

8.3.2 Dynamic effects

Correction – change list number j) to b) and list number k) to c).

Replace a) and b) by the following:

a) for lifts in air, performed offshore, in sheltered waters or onshore the DAF is given in Table 8.3-1.

Table 8.3-1 DAF for a single crane on a vessel

Gross lift weight [kN]	k_{DAF}			
	Offshore	Lifts in air, onshore or in sheltered waters	Onshore*)	
			Moving	Static
<1000	1.30	1.15	1.15	1.00
1 000 to 10 000	1.20	1.10	1.10	1.00
10 000 to 25 000	1.15	1.05	1.05	1.00
>25 000	1.10	1.05	1.05	1.00

*) Lifts by land based cranes concern marine operations such as loadouts.

Change c) to b).

8.6 Actions associated with transportation

8.6.3 Determination of actions

Add:

In lieu of a full motion analysis the values given in Table 8.6-1 may be used for design. The partial action factor for environmental, permanent and variable actions may be taken as 1.20.

Table 8.6-1 Default values of motion responses for standard transportation analyses

		Roll amplitude degrees	Pitch amplitude degrees	Heave acceleration m/s ² (ft/s ²)
Large vessels	$L_{OA} \geq 140$ (460) and $B \geq 30$ (98)	20	10	0.2 g (0.66g)
Medium vessels	$L_{OA} \geq 76$ (250) and $B \geq 23$ (75)	20	12.5	0.2 g (0.66g)
Small vessels	$L_{OA} < 76$ (250) or $B < 23$ (75)	30	15	0.2 g (0.66g)
Large cargo barges	$L_{OA} \geq 76$ (250) and $B \geq 23$ (75)	20	12.5	0.2 g (0.66g)
Small cargo barges	$L_{OA} < 76$ (250) or $B < 23$ (75)	25	15	0.2 g (0.66g)
L_{OA} = Length over all, in metres (feet) and B = Breadth, in metres (feet)				
The default motion criteria shown above should be applied in accordance with the following points. a) The roll and pitch values listed above should be assumed to apply for a 10 s full cycle period of motion for vessels and barges $B \geq 23$ m (75 ft). For vessel and barges $B < 23$ m (75 ft) the roll period can be smaller. b) The roll and pitch axes should be assumed to pass through the centre of floatation. c) The phasing considered should be assumed to combine, as separate load cases, the most severe combinations of: ▪ roll and heave; ▪ pitch and heave. d) For inland and sheltered water transportation, the greatest effect of the following cases should be taken into account: ▪ the static loads caused by an acceleration of 0.1 g applied parallel to the deck in both directions; ▪ the static inclination caused by the design wind; ▪ the most severe inclination in the one-compartment damage condition. e) The additional heel or trim caused by the design wind should be considered. For many transports, however, it is permissible to omit the effects of direct wind action when calculating the actions on the cargo. f) The direction of the heave component shall be taken to act along the global vertical axis. Therefore components of heave actions parallel to the deck should be added to the roll or pitch loads in the same direction.				

Additionally, a maximum allowable angle of heel shall be determined in order to account for structural design limitations of, for instance, topsides modules and the sea fastening. It is clearly irrelevant that the structure may be allowed to heel 15° if the integrity of modules or sea fastening is already compromised at 10°.

9. ACTIONS FOR IN-PLACE SITUATION

9.2 Permanent actions (G) and variable actions (Q)

9.2.7 Carry down factors

Add:

The carry down factors for variable actions on open areas may be taken in accordance with the table below. Normal operating actions shall be taken as 100 % fluid content for all analyses. Test weights of pipes and vessels shall not be considered in global structure and foundation design. Test weights do need to be considered in local design.

Area	Local design	Primary topsides structure design	Global design (structure and foundation)
	Apply factor given	Apply factor given	Apply factor given
Storage areas	1.0	1.0	1.0
Laydown areas	1.0	f	f
Lifeboat platforms	1.0	1.0	may be ignored
Area between equipment	1.0	f	"
Walkways, staircases and platforms	1.0	f	"
Walkways and staircases for inspection and repair only	1.0	f	"
Roofs, accessible for inspection and repair only	1.0	1.0	"

NOTES: 1. The factor f in the table is the minimum of 1.0 and $(0.5 + 3/\sqrt{A})$, where A is the area over which the variable action acts in m^2 .

Add new clause:

9.2.10 Drill cuttings

A build-up of drill cuttings on the sea floor adjacent to and on top of the lower level plan bracing may lead to overstressing of members. Where this can occur the lowest plan bracing level shall be designed for potential build up of cuttings including the effects of corrosion or, for example, SRB activity. The problem of drill cuttings affecting the platform installation should also be addressed where template drilling has been carried out prior to installation of the substructure.

9.5 Extreme quasi-static action caused by waves only (E_{we}) or by waves and currents (E_{wce})

9.5.3 Drag and inertia coefficients

Add after last sentence:

A minimum increase of 7 % on the C_d shall be applied to account for anodes, unless a lower number can be justified by calculations.

9.10.2 Demonstrating sufficient RSR

Add to paragraph at the end:

EP 97-5050 provides guidance on determining the RSR value. The RSR is dependent on the probability of failure and the local environmental conditions.

10. ACCIDENTAL SITUATIONS

10.1.6.2 Assessment of structures following damage

Add after last paragraph:

A push-over analysis to confirm the residual strength after damage and to determine any reduction of the intact RSR is mandatory for L1 structures.

10.2 Vessel collisions

10.2.2 Collision events

Add after last paragraph:

Risers and conductors SHALL [PS] be positioned to minimise exposure to accidental damage. Sufficient clearance SHALL [PS] be provided in the impact zone to alleviate contact forces from deforming structural elements.

10.3 Dropped objects

Add before first paragraph:

A dropped objects study SHALL [PS] be undertaken to evaluate the impact energy and potential damage caused by objects dropped, based on crane usage and objects lifted during rig workover and platform activities. Resistance to dropped objects should be provided by indirect means, such as using redundant framing patterns and materials with sufficient ductility and toughness in vulnerable areas.

12. STRUCTURAL MODELLING AND ANALYSIS

12.4 Analysis requirements

12.4.4.6 Analysis for reserve strength

Correction - the last sentence of b) does not belong to b) and should become a new paragraph:

- b) where foundation failure occurs before structural failure, structural failure should be determined by assuming a foundation capacity based on upper bound estimates of soil properties.

The upper bound approach, b) above, provides an assessment of the steel structure strength.

13. STRENGTH OF TUBULAR MEMBERS

13.2 Tubular members subjected to tension, compression, bending, shear or hydrostatic pressure

13.2.6.2 Hoop buckling

Correction - Equation (13.2-28) should read:

$$C_h = 0,44 \frac{t}{D} + 0,21 \left(\frac{D}{t}\right)^3 \mu^4 \quad \text{for } 0,825 \frac{D}{t} \leq \mu < 1,6 \frac{D}{t} \quad (13.2-28)$$

14. STRENGTH OF TUBULAR JOINTS

14.2 Design considerations

14.2.5 Detailing practice

5th paragraph, replace the first sentence with:

The nominal gap (i.e. excluding weld toes) between adjacent braces, whether in-plane or out-of-plane, should not be less than 75 mm (3 in). Alternatively the joint gap may be taken as 50 mm (2 in) between weld toes.

5th paragraph; add the following sentence at the end of the paragraph:

Partially overlapped braces are not allowed in the ship impact zone.

Figure 14.2-4:

Correction - The two requirements for details on the left referring to the lower brace should read:

$\geq d_2$ and ≥ 600 ;

$\geq d_2/4$ and ≥ 150

Add new clause:

14.11 Bolted connections

Bolted connections are permitted, but should only be used for the attachment of non-primary items where use of bolted connections is either more cost-effective or offers operational advantages (e.g. post-installed risers) over welded connections.

Particular attention should be paid to the following:

- avoidance of corrosion in bolted assemblies;
- interaction of bolting material with the CP system (e.g. potential for hydrogen embrittlement)
- methods for tensioning bolts (if required) and clearances for tensioning tools;
- avoidance of secondary stresses (e.g. bending due to non-parallel flanges).

15. STRENGTH AND FATIGUE RESISTANCE OF OTHER STRUCTURAL COMPONENTS

Add new clause:

15.4 Conductors

15.4.1 General

Forced displacements and any consequent actions on the conductor due to the relative movement between the structure and a drilling jack-up, where applicable, shall be considered in an Ultimate Limit State (ULS) check.

Deterioration of surface soil strength can result from conductor/casing cementing operations. Such effects shall be considered in the foundation design of conductors. Details of top hole construction practice are defined in the DEP supplement to A.15.4.1.

Welded or threaded conductors may be used as foundation piles provided a rigorous technical analysis of the static strength and fatigue endurance due to driving stresses and in-situ axial and lateral actions is performed to demonstrate robustness and long-term integrity.

It is important that at the design stage all expected actions on the conductor are well defined. In all cases, the conductor shall be able to support its own weight plus the weight of any equipment to be placed on top of it and/or casings to be hung off it. A partial action factor of 1.3 shall be applied.

The axial capacity of the conductor shall be calculated using the methods described in Clause 17 and a partial resistance factor of 1.5 shall be applied to the representative value of the axial capacity of the conductor. No end bearing on the conductor shall be allowed.

The conductor tip should preferably be located in a cohesive soil rather than in a non-cohesive soil such as sand or silt.

15.4.2 Conductor guides

The conductor guide stubs and stub support members shall be included in the respective analysis models. They shall be checked for both extreme and abnormal in-place actions,