DEP SPECIFICATION

STRUCTURAL DESIGN AND ENGINEERING OF ONSHORE STRUCTURES

DEP 34.00.01.30-Gen.

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DESIGN AND ENGINEERING PRACTICE

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1. INTRODUCTION

1.1 SCOPE

This DEP specifies requirements and gives recommendations for the design of onshore structural assets (structures).

In this DEP, safety is established as the primary consideration for structural design.

This DEP is a revision of the DEP with the same number dated December 2007; see (1.5) regarding the 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. Any authorised access to DEPs does not for that reason constitute an authorization to any documents, data or information to which the DEPs may refer.

This DEP is intended for use in facilities related to oil and gas production, gas handling oil refining, chemical processing, gasification, distribution and supply/marketing. 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 could 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 regards 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

1.3.1 General 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 it. The Principal may also include an agent or consultant authorised to act for, and on behalf of, the Principal.

The word **shall** indicates a requirement.

The word **should** indicates a recommendation.

1.4 CROSS-REFERENCES

Where cross-references to other parts of this DEP are made, the referenced section number is shown in brackets ( ). Other documents referenced by this DEP are listed in (6).

1.5 SUMMARY OF MAIN CHANGES

This DEP is a revision of the DEP of the same number dated December 2007. There were major changes to the content of this DEP. All changes are the result of segregation of requirements, and harmonization of local technical standards.

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Content that was background information, explanation and guidance, and therefore not required to be communicated to the Contractor, has been moved into the companion DEP Informative document.

The following are the main, non-editorial changes.

Old section	New section	Change
	3.1	Added applicable specifications for design loads (Table 3.1)
	3.13-14, 3.16-17	Added fluid loads, fluid surge, test loads, and buoyancy and hydrostatic pressures
3.16	3.20	Updated load combinations
3	5	Separated design criteria from the design loads (3)
	5.1	Added applicable specifications for design criteria
	5.7	Added module structural design
5	6	Updated the table of references for the applicable codes, standards and practices

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://sww.shell.com/standards and on the main page of the DEPs DVD-ROM.

1.7 DUAL UNITS

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.

1.8 PROJECT DOCUMENTATION REQUIREMENTS

For projects to ensure compliance with this DEP, proper documentation is required in the Definition and Execution phases of the project.

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2. DESIGN PROCESS AND DELIVERABLES

2.1 APPLICABLE DESIGN SPECIFICATIONS

The design of structures shall comply with the project specifications specified by the Principal and/or other project contract statements, and applicable code(s), standard(s), and practice(s) listed in Table 3.1 for design loads and Table 5.1 for design criteria.

Each code, standard or practice for design load shall be used in combination with the corresponding code, standard or practice for design criteria. If not, it shall be demonstrated that at least the same safety level is achieved.

Note: The latest edition in effect on the date of contract award shall be used except as otherwise noted. Full titles of the applicable codes, standards and practices are listed in (6).

2.2 DESIGN STAGE AND REQUIREMENTS

The structural design shall be carried out in stages with corresponding deliverables; see (Appendix A). Module structural design shall be in accordance with (2.3).

2.3 MODULE STRUCTURAL DESIGN

2.3.1 General

The structural design for modules shall comply with all other requirements within this DEP, with the following additional provisions:

a) The module and materials shall be designed for all forms of loadout, transportation and installation in accordance with applicable codes or standards (Table 3.1) and Table (5.1) as appropriate. The design criteria shall be supplemented by the requirements of ISO 19901, ISO 19902 and local standards, specifications, codes and regulations.

b) Investigation shall be carried out to examine various load-out/load-in methods, such as lifting, skidding, trailers or self propelled modular transporters (SPMTs). Decision on the module load-out / load–in method, shall be made early in the project development to direct the design of structural module frame.

c) Studies shall be carried out in early phases of the project (Select/Define) prior to detail engineering to identify all:

- personnel access and egress requirements
- human factors engineering requirements.
- Material handling studies for operations and maintenance (bridge cranes, monorails, davits).
- Elevated floor areas designed for maintenance loading
- Grating thickness requirements to allow for heavier load movement for maintenance equipment.
- Clearances for equipment removal and replacement.
- Identify drop zones

d) Studies shall be performed to demonstrate the module strength and structural capacity for the most onerous transport conditions.

e) For sea transportation, studies shall be performed for several module positions on transport vessels/barges e.g., centre, fore and aft port, fore and aft centre, fore and aft starboard in order to determine the most onerous acceleration loadings.

f) The design of lifting/supporting points shall be optimised to facilitate efficient transportation and placing of modules.

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g) For sea transportation, sea fixings and localised structural reinforcement shall be provided to accommodate transportation loads; however these shall be optimized to reduce shipping weights, vessel/barge dimensions and removal works at site.

h) The structural steel shall be designed to include transportation bracing steel which can be easily removed for operational access purposes.

i) A weight management program shall be established, reports shall be published to project team on a regular basis. The program shall include:

- Module weight calculations including centre of gravity calculations for each step in transportation process. The center of gravity (COG) of each module shall be sufficiently low to enable stable transport of modules from yard to the installed location.
- Module weight calculations including centre of gravity for erection (i.e. all temporary steel removed prior to lifting, and any additional ship loose item installed prior to lifting)
- Forces at lift locations to be submitte to fabricator and heavy haul contractor
- Dimensions

j) The modules shall be weighed in the yard to confirm module weight calculations.

k) The dimensions and weights of modules shall be limited to ensure that these can be transported and installed at all envisaged locations within the plant footprint.

2.3.2 Lifting Operations

The following are minimum requirements for modules in lifting operations.

a) Lifting/jacking lugs shall be designed for a 2.0 impact factor. However, shackles and other rigging gear shall be selected with minimum 1.3 impact factor.

b) Pad eye connection details should avoid tension being applied through the thickness of a plate or other rolled element, as lamination faults (lamellar tearing) resulted from weld shrinkage could cause a failure. If this detail is unavoidable, through-thickness testing must be performed for plates greater than 38 mm (1.5 inches) thick to ensure laminations do not exist.

c) Pad eye main plates should be slotted through horizontal plates and welded flat against webs or stiffening plates below.

d) Align the padeye plate with the sling. Apply a nominal transverse load of five percent of the sling force at the center of the pinhole simultaneously with the sling force.

e) There should be no more than one cheek plate on each side of the main plate. The cheek plates should be circular with a radius equal to that of the main plate less the cheek plate thickness. The cheek plate thickness should be less than or equal to the main plate thickness.

f) The pinhole should be as small as practical and not more than 4 mm (1/8 in) larger than the shackle pin. They should be machined, not flame cut, and should be line-bored after welding the cheek plates to the main plate.

g) Total thickness of the padeye should be 6 mm (1/4 in) smaller than the minimum width of shackle.

h) Shackles should have a nominal factor of safety of 5:1.

i) Weld non-destructive testing (NDT) is required for welding and shall be shown on the design drawings. For complete joint penetration welds, ultrasonic testing (UT) shall be specified. For fillet welds, penetrant testing/magnetic particle testing (PT/MT) shall be specified.

j) Material used for fabrication of lifting lugs shall be traceable back to its Material Test Report. Design drawings shall specify this requirement.

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k) Padeyes should not be removed from the modules unless they are an obstruction.

2.4 DRAWINGS AND RELATED DOCUMENTS

Drawings shall conform to DEP 02.00.00.10-Gen. and (Appendix B).

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3. STRUCTURE DESIGN LOADS

3.1 GENERAL

The minimum loading design basis shall be as specified in the applicable codes, standards, specifications, practices and regulations (Table 3.1). Additional requirements are provided in the remainder of (3), or otherwise specified by the Principal.

Table 3.1 Applicable Codes, Standards and Practices for Structure Design Loads[1)]

Design Loads	European Codes and Standards	American Codes and Standards	Canadian Codes and Standards
Loads (in addition to those listed below) and Load Combination	EN 1991	ASCE/SEI 7-05 IBC [2)] ASCE Wind Loads and Anchor Bolt Design for Petrochemical Facilities	NBC[2)] CAN/CSA-S16-01
Crane and Hoist Loads	EN 1993-6 BS 6349-2 (for jetties)	OSHA 1910.179 AASHTO CMAA No. 70 CMAA No. 74	AASHTO CMAA No. 70 CMAA No. 74
Erection Loads	EN 1991-1.6	ASCE/SEI 37-02	ASCE/SEI 37-02
Impact Loads	EN 1991-1.7	AASHTO AREA	
Seismic Loads	EN 1998 EN 14620 (LNG Storage) PIANC guidelines (Port Structures)	ASCE Guidelines for Seismic Evaluation and Design of Petrochemical Facilities NFPA 59A (LNG Storage)	

NOTES: 1): If local standards, specifications, codes and regulations exist for loads, and test methods covered by this Specification that yield equivalent actions and effects, they may be substituted only with prior written approval by the Principal.

The edition in effect on the date of contract award shall be used, except as otherwise noted. Short titles will be used herein where appropriate.

2): Note that in Canada and the US, the States/ Provincial/Territorial governments building codes, acts, and regulations may supersede the national codes listed here.

3.2 STRUCTURE DEAD LOADS

Structure dead load is the weight of materials forming the structure and foundation.

The structure dead load shall also include the soil and water pressure, and all permanently attached appurtenances (e.g., lighting, instrumentation, HVAC, sprinkler and deluge systems, fireproofing, and insulation, etc.) except the empty weight of process equipment, vessels, tanks, piping, and cable trays) shall be considered part of the structure dead load.

For submerged structures the dry and submerged dead weight shall be calculated including or excluding any anticipated marine growth whichever is most unfavourable as part of the structure dead load.

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