

DEP SPECIFICATION

STRUCTURAL DESIGN AND ENGINEERING OF ONSHORE STRUCTURES

DEP 34.00.01.30-Gen.

February 2017

ECCN EAR99

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 is a revision of the DEP of the same number dated February 2015; 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 authorized 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 shall 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.

The word **may** indicates a permitted option.

1.4 CROSS-REFERENCES

Where cross-references to other parts of this DEP are made, the referenced section or clause 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 February 2015. The changes followed a requirements quality review and were not a full technical update. The following are the main, non-editorial changes.

Section/Clause	Change
All	Restructured and clarified requirements, enforced use of shall/should/may for normative statements.

1.6 COMMENTS ON THIS DEP

Comments on this DEP may be submitted to the Administrator using one of the following options:

Shell DEPs Online (Users with access to Shell DEPs Online)	Enter the Shell DEPs Online system at https://www.shelldeps.com Select a DEP and then go to the details screen for that DEP. Click on the "Give feedback" link, fill in the online form and submit.
DEP Feedback System (Users with access to Shell Wide Web)	Enter comments directly in the DEP Feedback System which is accessible from the Technical Standards Portal http://www.shell.com/standards . Select "Submit DEP Feedback", fill in the online form and submit.
DEP Standard Form (other users)	Use DEP Standard Form 00.00.05.80-Gen. to record feedback and email the form to the Administrator at standards@shell.com .

Feedback that has been registered in the DEP Feedback System by using one of the above options will be reviewed by the DEP Custodian for potential improvements to the DEP.

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 NON NORMATIVE TEXT (COMMENTARY)

Text shown in italic style in this DEP indicates text that is non-normative and is provided as explanation or background information only.

Non-normative text is normally indented slightly to the right of the relevant DEP clause.

1.9 PROJECT DOCUMENTATION REQUIREMENTS

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

2. DESIGN PROCESS AND DELIVERABLES

2.1 APPLICABLE DESIGN SPECIFICATIONS

1. The Code, standard or practice for design load as specified in Table 3.1 shall be used in combination with the corresponding code, standard or practice for design criteria specified in Table 5.1.
 - a. The latest edition of the applicable code, standard or practice that is 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

1. Refer to (Appendix A) for requirements of engineering design documentation during various phases of structural design.
2. Refer to (Appendix B) for requirements of Structural engineering drawings.

2.3 MODULE STRUCTURAL DESIGN

2.3.1 General

1. The module and materials shall be designed for the proposed loadin and loadout, transportation and installation conditions in accordance with applicable codes or standards in Table 3.1 and Table 5.1, in line with project requirements.
 - a. Module structural members shall be strengthened where necessary.
2. A weight management plan and report shall be developed and updated throughout the project, and include the following:
 - a. module weight calculations including the following;
 - i. centre of gravity calculations for each step in transportation process;
 - ii. centre of gravity for lifting ,erection and installation (i.e., with all temporary transportation steel removed prior to lifting, and any additional ship loose item installed prior to lifting).
 - b. load out and Transportation support points;
 - c. lift points for lifting, erection and installation;
 - d. overall Module dimensions.
3. Sea fixings and localised structural reinforcement shall be provided where required to accommodate the intended transportation loads and designed to achieve stable transportation.
4. Lifting supporting points shall be designed to conform to the planned Module placement and Lifting schemes.
5. To perform the lifting analysis of the modules, the Contractor shall use approved weight and COG envelope based on weight control reports or as follows:
 - a. in the absence of COG envelope, a COG inaccuracy factor of 1.1 shall be applied on the lifted weight.
6. Where information is not available to determine the final lifting weight, a minimum contingency factor of 5% shall be applied to the lifted weight.
7. Effective moments on structure shall be considered due to possible shift of centre of gravity.
8. For lifting design, a nominal transverse load of 5% of the sling force shall be applied at the centre of the pinhole simultaneously with the sling force.

9. Lifting/jacking lugs/padeye and all structural members transmitting lifting forces within the structure and directly connected to the lifting/jacking lugs/padeye shall be designed for a minimum impact factor of 2.0.
10. All other structural members transmitting lifting forces shall be designed using impact factor of 1.3.
11. The design load for shackles and other rigging gear shall be based on a minimum impact factor of 1.3 on the working load.
12. All material used for fabrication of lifting lugs and padeyes shall be procured directly from steel mills approved by Principal with certification as follows:
 - a. original mill certificates supplied with the fittings;
 - b. original mill certificates included as part of project documentation and handed over to the Principal.
13. Full traceability of material used for lifting lugs and padeyes shall be ensured during the entire fabrication process.
14. Pad eye plates greater than 38 mm (1.5 in) thick shall be subject to through-thickness testing to ensure laminations do not exist.
 - a. This requirement for through-thickness testing shall be explicitly indicated in the drawings.
15. 100% non-destructive testing (NDT) shall be performed for all the welds of the padeye as follows:
 - a. ultrasonic testing (UT) for complete joint penetration welds;
 - b. either dye penetrant testing or magnetic particle testing (PT/MT) for fillet welds.
16. Requirements of material properties and weld inspection, shall be explicitly shown on structural design drawings.
17. Any damage to coating of permanent steel during loadout, transportation and lifting shall be locally rectified in accordance with an approved repair procedure, after all installation is completed.
18. Any subsequent lifting of the module requiring reuse of lifting lugs and padeyes shall be shall be subject to Principal's approval.
 - a. In case of reuse of lifting lugs and padeyes, all the welds of the lifting lugs and padeyes (including connections to the main structural steel) shall undergo close visual inspection and subsequent 100% NDT as (2.3.1, Item 15).

2.3.2 Module Layout

1. The layout, size, column spacing and weight of the module should be determined accounting for all of the following:
 - a. personnel access and egress requirements;
 - b. human factors engineering requirements;
 - c. material handling studies including provision of suitable lifting and handling device;
 - d. elevated floor areas designed for maintenance and loading;
 - e. grating thickness requirements to allow for heavier load movement for maintenance equipment;
 - f. clearances for equipment removal and replacement;
 - g. identify the fall zones of tools/equipment being lifted and the need for dropped object protection;
 - h. alignment of the module structural support columns spacing and location of support points with the intended foundation philosophy (e.g., pile foundation, footing);
 - i. height of module with respect to ground level based on bottom clearances, footing height, installation philosophy;
 - j. logistic constraints such as height, length, breadth and weight limitations existing along the proposed route of module transportation from the fabrication yard to the final location of the module at the project site.

2.3.3 Transportation

1. For sea transportation, studies should be performed to determine the most onerous acceleration loadings, based on the intended location(s) of the module on the barge (e.g., centre, fore and aft port, fore and aft centre, fore and aft starboard).
2. The centre of gravity (COG) of each module should be kept low to enable stable transport of modules from yard to the installed location.
3. Seafastener design should be optimized to reduce shipping weights, vessel/barge dimensions and removal works at site.
4. The structural steel (e.g., transportation bracing) should be designed for easy removal after module installation.
5. Before leaving the yard, the module should be weighed in the yard using calibrated jacks to confirm the module weight and COG calculations.
 - a. Weighing procedures should be submitted in advance for review and actual weighing should be witnessed by the Principal or its nominated agency.

2.3.4 Lifting operations

1. Pad eye connection details should avoid tension being applied through the thickness of a plate or other rolled element.
Lamination faults (lamellar tearing) resulted from weld shrinkage could cause a failure.
2. Pad eye main plates should be slotted through the horizontal plates and welded flat against webs or stiffening plates below.
3. Pad eye plate should be aligned with the direction of the sling as per the proposed lifting plan.
4. There should be no more than one cheek plate on each side of the main plate:
 - a. the cheek plates should be circular with a radius equal to that of the main plate less the cheek plate thickness;
 - b. the cheek plate thickness should be less than or equal to the main plate thickness.
5. The pinhole should meet the following:
 - a. not be more than 4 mm (1/8 in) larger than the shackle pin;
 - b. machined, not flame cut;
 - c. line-bored after welding the cheek plates to the main plate.
6. The total thickness of the padeye should be 6 mm (1/4 in) smaller than the minimum width of the shackle.
7. Shackles should have a nominal factor of safety of 5:1 being the Minimum Breaking Load (MBL) : Working Load Limit (WLL).
8. Padeyes should not be removed from the modules unless they are interfering with the rest of the functionality of the module.

3. STRUCTURE DESIGN LOADS**3.1 GENERAL**

1. The loading design basis shall be as specified in the applicable codes, standards, specifications, practices referred in Table 3.1 below unless otherwise specified by the Principal.

Table 3.1 Applicable Codes, Standards and Practices for Structure Design Loads¹⁾

Design Loads	European Codes and Standards	American Codes and Standards ²⁾	Canadian Codes and Standards ²⁾
General Loads and Load Combination	EN 1991	ASCE/SEI 7-05 IBC ¹⁾ ASCE Wind Loads and Anchor Bolt Design for Petrochemical Facilities	NBC CAN/CSA-S16-01
Crane and Hoist Loads	EN 1993-6 ³⁾ BS 6349-2 (for jetties)	OSHA 1910.179 ³⁾ AASHTO CMAA No. 70 CMAA No. 74	AASHTO ³⁾ 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 ³⁾	
Seismic Loads	EN 1998 (for all other onshore structures) 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. 2): Note that in Canada and the US, the States/ Provincial/Territorial governments building codes, acts, and regulations can govern the national codes listed here. 3): If similar requirements exist in these codes, the most onerous loadings apply.			

2. The return period of wind, wave and current loads defined in Table 3.2 shall be used in accordance with the appropriate load combination