

DEP SPECIFICATION

RISER DESIGN

DEP 31.40.10.10-Gen.

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DESIGN AND ENGINEERING PRACTICE

DEM1



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1. INTRODUCTION

1.1 SCOPE

This DEP specifies requirements and gives recommendations for the design of offshore pipeline riser systems, which include the piping, riser clamp supports and any expansion spool or anchoring system at the base of the platform. This DEP identifies a broad approach to the design including:

- a. definition of riser system and interfaces;
- b. potential riser concepts;
- c. riser routing;
- d. analysis requirements;
- e. support design;
- f. J-tube design;
- g. fittings and materials.

This DEP does not present a methodology, but is intended to act as a checklist of design activities for consideration by an experienced engineer.

This DEP is based on riser design meeting the requirements of DEP 31.40.00.10-Gen.

The scope of this DEP covers rigid metallic risers typically used in non-deepwater applications and attached to fixed structures. Flexible metallic and non-metallic risers are excluded from the scope of the 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 February 2015; see (1.5) regarding the changes.

1.2 DISTRIBUTION, INTENDED USE AND REGULATORY CONSIDERATIONS

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This DEP is intended for use in facilities related to offshore flowline and pipeline risers in exploration and production facilities. 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 capitalised term **SHALL [PS]** indicates a process safety requirement.

The word **should** indicates a recommendation.

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

1.3.2 Specific definitions

Term	Definition
Deep Water	Unless specified otherwise by Principal in the Project Specifications, deep water is a water depth in excess of 300 m (984 ft).
J-Tube	J-shaped conduit installed on a platform, through which a pipeline can be pulled to form a riser. The pipeline is plastically deformed in the J-tube as it is pulled into position.
Non Deep Water	Water depth less than 300 m (984 ft).
Piping components	Items integrated in the pipeline riser such as flanges, tees, bends, reducers and valves.
Riser support	Structure intended for fixing the riser to the platform or for local or continuous guidance of the riser assembly.
Riser system	Riser pipe, supports, integrated piping components and corrosion prevention system.
Sub-structure	Fixed structure (fabricated from steel or concrete) that is founded on the sea-bed and designed to support platform topsides.

1.3.3 Abbreviations

Term	Definition
ASCE	American Society of Civil Engineers
EPDM	Ethylene Propylene Diene Monomer
ESD	Emergency Shutdown
GBS	Gravity Base Structure
HAT	Highest Astronomical Tide
LAT	Lowest Astronomical Tide
QRA	Quantified Risk Assessment
RTJ	Ring Type Joint
SMYS	Specified Minimum Yield Stress
SSIV	Sub Sea Isolation Valve
VIV	Vortex-Induced Vibration

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 (15).

1.5 SUMMARY OF MAIN CHANGES

This DEP is a full revision of the DEP of the same number dated February 2015. 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.
3, item 2	SHALL [PS] requirement revised and restructured.
4.2, item 4	SHALL [PS] requirement restructured and non-Process Safety requirements moved to item 5.
4.2, item 7	SHALL [PS] requirement revised to include pipeline expansion.
6.1, item 1	SHALL [PS] requirement revised to enforce requirement.
6.2, item 1	SHALL [PS] requirement restructured and non-Process Safety requirements moved to item 2.
6.3, item 1	SHALL [PS] requirement revised and restructured.
6.5.3, item 1	SHALL [PS] requirement revised and restructured to make more specific.
6.9, item 3	SHALL [PS] requirement revised and restructured to make it standalone.
7.3, item 1	SHALL [PS] requirement revised and restructured and non-Process Safety requirements moved to item 2.
11.2, item 1	SHALL [PS] requirement restructured to make it standalone.

1.6 COMMENTS ON THIS DEP

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

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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.

2. SYSTEM DEFINITION AND INTERFACES

2.1 GENERAL

1. The riser system shall be designed as a part of the total offshore pipeline system.
 - a. Refer to DEP 31.40.00.10-Gen. for pipeline engineering requirements.

For design purposes, it is necessary to define the extent of the riser assembly and to establish the interfaces between the riser system and adjacent systems. The interfaces provide a point where loading and/or displacement, and the requirements of the various systems can be defined and reconciled.
2. The riser interface points can be summarised as follows:
 - a. topside and supports;
 - b. sub-structure and supports;
 - c. pipeline/tie-in spool.
3. A riser analysis model shall be developed and take into account the effects of the interface points as detailed in (2.2, 2.3 and 2.4).

2.2 TOPSIDE INTERFACE

1. The design of the riser system requires detailed interfacing with the platform topsides.
 - a. The location for the interface point between the top sides and riser system, (e.g., the code break), shall be such that the riser system:
 - i. extends up to and includes the pig trap (including associated pipework and valves) or;
 - ii. if no pig trap is fitted, extends up to and includes the first isolation valve off the riser.
 - b. DEP 31.40.10.13-Gen. provides guidance on the location of code breaks associated with pig traps.
2. The riser supports, except where directly welded onto the riser, are considered structural elements and fall outside the riser system (e.g., code break).
3. The following design issues shall be addressed:
 - a. design responsibility;
 - b. exact location of code breaks marked on Process Engineering Flow Schemes (PEFS);
 - c. piping layouts;
 - d. structural layouts;
 - e. instrument connections;
 - f. electrical isolation;
 - g. overlap of riser and piping analyses;
 - h. support locations;
 - i. access for pigging operations;
 - j. access for valve overhaul;
 - k. access for inspection of riser pipe under riser clamps;
 - l. selection of coating applied to riser pipe under riser clamps.

2.3 SUB-STRUCTURE INTERFACE

1. The design of the riser system requires detailed interfacing with the sub-structure.
2. The following design issues shall be addressed:
 - a. design responsibility;
 - b. code breaks;
 - c. details of the structural layout and dimensions of the sub-structure members;
 - d. platform deflections;
 - e. sub-structure settlement (short and long term);
 - f. scouring;
 - g. riser routing;
 - h. riser support locations and type, for load carrying capacity and minimization of VIV (vortex-induced vibration);
 - i. electrical isolation and access to take periodic readings;
 - j. riser loadings on riser supports;
 - k. ESD (emergency shutdown) valve location;
 - l. structural protection;
 - m. installation and connections at base of riser (tie-in method);
 - n. hook-up to top section of riser;
 - o. splash zone riser coatings;
 - p. location of clamps with respect to splash zone;
 - q. riser guards and protection against damage by boats.

2.4 PIPELINE/EXPANSION SPOOL INTERFACE

1. The design of the riser system requires detailed interfacing with the pipeline/expansion spool.
 - a. The interface between the riser and the submarine pipeline depends on the method of connection, geometry and type of riser and should be agreed in each case.
2. The following design issues shall be addressed:
 - a. design responsibility;
 - b. location of code breaks;
 - c. riser routing;
 - d. pipeline approach;
 - e. expansion spool layout;
 - f. scour and settlement;
 - g. overlap of riser and expansion spool structural analysis;
(often performed in one analysis from pipeline to pig trap)
 - h. the tie-in method.

3. HEALTH, SAFETY AND THE ENVIRONMENT

DEP 31.40.00.10-Gen. provides guidance to the management of HSE associated with the design, construction, testing, operation, maintenance and abandonment. Additional specific requirements and recommendations for the design of offshore pipeline riser systems are listed in (3, items 1 through 4):

1. The design shall include a safety assessment which quantifies the effect of the risers on platform safety.
 - a. The safety assessment shall include the use of risk analysis to determine the need for additional protective measures.
2. Any risk analysis performed SHALL [PS] take into account analysis of the risk from both natural and man-made hazards including the following:
 - a. natural hazards due to corrosion attack, marine life attack, extremes of temperature and environmental conditions;
 - b. man-made hazards due to platform loading and off-loading operations, vessel activities, dragged anchors, trawl gear, abrasion by cables and chains, impact by vessels, planned future installation activities, and dropped objects.

This is not an exhaustive list.
3. A cost-benefit analysis to assess the relative merits of different protective measures should be provided.
4. The requirement for and location of ESD and SSIV valves SHALL [PS] be addressed as part of the development of the platform specific safety case.

4. RISER ROUTING AND LOCATION

4.1 BASIC ROUTING REQUIREMENTS

1. Refer to DEP 80.00.10.12-Gen. for requirements for the location of the riser and riser ESD valve
2. Selection of riser routing and location on a platform should ensure accessibility for inspection and maintenance.
 - a. In meeting the accessibility requirements, gas risers shall have precedence over oil risers.
3. The selection of riser routing and location shall also evaluate the following:
 - a. safe installation;
 - b. supply boat mooring area locations;
 - c. location of planned future risers and pipelines;
 - d. topsides piping run length and pig trap area;
 - e. minimisation of risk of damage by vessel collisions, by positioning risers within the structure above a depth of 20 m (65 ft) below LAT or by providing riser guards;
 - f. location of ESD and SSIV valves, and their maintenance and inspection;
 - g. minimisation of risk of interference with future construction, drilling, workover or platform maintenance or repair operations, including jack-up footprints;
 - h. access for subsea and topsides hook-up.
4. Environmental loading conditions, particularly in the splash zone (5.3.3), should be evaluated.
 - a. In the splash zone, riser lengths and horizontal routing should be minimised.
5. Sub-structure bracing layout should be considered as this will determine the possible support locations and thus influence riser span lengths.

4.2 APPROACH TO PLATFORMS

1. Detailed evaluation shall be given to the approach routes to the platform including:
 - a. potential crossings;
 - b. seabed obstruction;
 - c. existing platforms/seabed facilities in close proximity;
 - d. angle, elevation and allowable span length of pipeline approach;
 - e. pipeline installation method near platform;
 - f. pipeline expansion requirements;
 - g. routing to minimise risk of damage by dropped objects;
 - h. accessibility for future positioning of jack-up rig;
 - i. potential or planned field development including new platforms, risers and pipelines;
 - j. location of unused J-Tubes, risers and clamps;
 - k. location of flare.
2. Refer to DEP 80.00.10.12-Gen. for routing of pipelines and expansion spools.

The approach path and placement area for the legs for jack-up rigs, supply boat loading zone, anchor patterns of vessels (supply boats and construction vessels) and presence of adjoining pipelines are all factors that can influence route selection.
3. When pipelines have to approach the sub-structure with angles greater than 30° from the perpendicular to the sub-structure face, the spacing between the risers should be increased to allow more space between the pipelines on the sea bottom.
4. If the direct approach of a pipeline to the riser base intersects a jack-up rig approach corridor, the routing analysis SHALL [PS] assess the risk of damage to the pipelines during the approach and positioning of the jack-up.
5. Where the pipeline cannot take a direct approach, changes in route should be made at a sufficient distance from the platform to avoid tight approach curves.
 - a. Where this is not possible, doglegs should be used.
6. Optimising spool length requirements to facilitate pipeline installation should be evaluated.
 - a. Suction piles may be used for initiation activities, to allow the pipeline start-up head to be positioned in close proximity to the structure.
7. Routing of expansion spool-pieces and pipelines from the bottom riser clamp to the seabed SHALL [PS] take into account the effects of riser and pipeline expansion, platform movement and scour induced spans.

5. DESIGN DATA

5.1 RISER SYSTEM/PLATFORM DATA

5.1.1 Process data

1. The following process data are common to all elements of the riser system:
 - a. minimum bore requirement to meet throughput requirements;
 - b. fluid type and density - maximum and minimum;
 - c. design life;
 - d. design pressure;
 - e. maximum allowable operating pressure;
 - f. hydrostatic test pressure for testing in fabrication yard and for system test;
 - g. design temperature - maximum and minimum;
 - h. normal operating temperature - maximum and minimum;
 - i. internal corrosion allowance (if appropriate).

5.1.2 Riser data

1. The following riser data are required, as a minimum, for the riser design:
 - a. riser type – whether a conventional riser for steel platform, for gravity base structure, J-tube riser or caisson riser;
 - b. installation philosophy – whether pre-installed or retrofit;
 - c. method of pipelay initiation;
 - d. method of tie-in;
 - e. steel grade;
 - f. outside diameter;
 - g. wall thickness;
 - h. internal/external coating - type, thickness and density;
 - i. insulation - type, thickness and density;
 - j. field joint coating material - type, thickness and density;
 - k. valve, fitting and pig trap weight, rating and location;
 - l. bend radii, and thinning;
 - m. mechanical protection requirements.

5.1.3 Pipeline data

1. Steel grade.
2. Outside diameter.
3. Wall thickness.
4. Internal/external coating - type, thickness and density.
5. Insulation - type, thickness and density.
6. Field joint material - type, thickness and density.
7. Expansion movements at free end.
8. Degree of trenching, self-burial and/or rock dump.

5.1.4 Expansion tie-in spool data

1. Steel grade.
2. Outside diameter.
3. Wall thickness.
4. Internal/external coating – type, thickness and density.
5. Riser/spool connection type and allowable misalignment.
6. Geometry of expansion spool.
7. Mechanical protection requirements.
8. Bend radii and thinning.

5.1.5 Platform data

1. Substructure type and dimensions.
2. Details of other risers, caissons and/or J-tubes.
3. Possible support locations and load restrictions.
4. Immediate substructure settlement into seabed.
5. Long-term substructure settlement into seabed.
6. Anode or impressed current system – locations and details.
7. Riser breakaway loads (if required).
8. Platform displacements under 100-year design condition.

5.2 SOIL DATA

1. Soil data provides information regarding resistance of the soil to pipeline movement (lateral and longitudinal friction coefficients), soil strength deterioration due to cyclic wave loading, load bearing capacity of the soil and susceptibility of soil to scour.
 - a. Refer to DEP 37.81.10.15-Gen. for further information on geotechnical considerations and pipe-soil interaction models on a clay seabed.
 - b. For seabeds other than clay or specific soil conditions, specialist geotechnical advice should be obtained.
2. The following information should be obtained prior to start of design.
 - a. ASCE classification of soils and grain-size;
 - b. specific gravity of the soils;
 - c. soil friction angle for sands;
 - d. undisturbed shear strength of clay soils;
 - e. remoulded (disturbed) shear strength or sensitivity.