

DEP SPECIFICATION

DEEPWATER PIPELINE END TERMINATIONS AND MIDLINE SLEDS

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DESIGN AND ENGINEERING PRACTICE



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TABLE OF CONTENTS

1.	INTRODUCTION	4
1.1	SCOPE	4
1.2	DISTRIBUTION, INTENDED USE AND REGULATORY CONSIDERATIONS	4
1.3	DEFINITIONS	4
1.4	CROSS-REFERENCES	6
1.5	SUMMARY OF MAIN CHANGES.....	6
1.6	COMMENTS ON THIS DEP	6
1.7	DUAL UNITS.....	6
1.8	NON NORMATIVE TEXT (COMMENTARY).....	7
2.	GENERAL AND FUNCTIONAL REQUIREMENTS.....	8
2.1	GENERAL REQUIREMENTS.....	8
2.2	FUNCTIONAL REQUIREMENTS.....	11
2.3	MIDLINE SLED SPECIAL REQUIREMENTS	12
2.4	SUBSEA MARKINGS AND COLORING	13
2.5	ELECTRICAL HYDRAULIC DISTRIBUTION	13
2.6	PLET SUPPORT STRUCTURE	13
2.7	INSTALLATION, INSPECTION, MAINTENANCE AND REPAIR PHILOSOPHY	14
2.8	LOAD CRITERIA	15
3.	PLET COMPONENTS AND SPECIFIC REQUIREMENTS	16
3.1	PIPING MODULE	16
3.2	VALVES	17
3.3	PLET CONTROL SYSTEM	18
3.4	HYDRAULIC TUBING, ELECTRICAL CABLING AND COUPLINGS	19
3.5	SENSORS AND INSTRUMENTATION	19
3.6	FLOWLINE CONNECTIONS.....	20
3.7	INSTALLATION AND INTERFACE REQUIREMENTS.....	20
3.8	PAINTING, COATING, AND CATHODIC PROTECTION	21
3.9	THERMAL INSULATION	22
4.	DESIGN, FABRICATION, INSTALLATION AND TESTING REQUIREMENTS	22
4.1	GENERAL	22
4.2	DESIGN	23
4.3	MATERIALS.....	24
4.4	PIPING ANALYSIS	24
4.5	STACK-UP TOLERANCE ANALYSIS.....	24
4.6	STABILITY ANALYSIS	25
4.7	CATHODIC PROTECTION ANALYSIS.....	25
4.8	ROV ACCESSIBILITY ANALYSIS.....	25
4.9	FABRICATION REQUIREMENTS.....	25
4.10	TESTING	26
5.	REPORTS, RECORDS AND DOCUMENTATION	33
6.	REFERENCES	35

APPENDICES

APPENDIX A	EXAMPLE ARRANGEMENT DRAWING	37
APPENDIX B	TYPICAL DATA SHEET (PROJECT SPECIFIC)	38
APPENDIX C	EXAMPLE INTERFACE DRAWING AND RESPONSIBILITY MATRIX	43

1. INTRODUCTION

1.1 SCOPE

This DEP specifies requirements and gives recommendations for design, manufacturing, assembly, testing, and shipment of a deepwater subsea pipeline end termination, also referred to as a PLET, PLEM, sled, or FTA. This DEP also includes the requirements for midline sleds. Its purpose is to define functional, operational, testing and interface requirements.

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 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 subsea oil and gas production. 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.

1.3.2 Specific definitions

Term	Definition
Midline Sled	A structural and piping system installed as part of and inline with a pipeline and located along the pipeline rather than at either end that allows the connection to the flowline of wells, manifolds, jumpers, additional pipeline segments, or other flow connections as required.
Pipeline End Termination	In this document, Pipeline End Termination (PLET) includes the full system installed along with the pipeline at either the first or second end to provide a stable point for initiating or terminating the pipeline, and to allow the connection of wells, manifolds, jumpers, additional pipeline segments or other flow connections as required. It includes the pipe work, valves, connection hubs, structure, foundation, control and chemical tubing, sensors and instrumentation, and installation tools and rigging. Other common terminology sometimes applied to systems meeting this definition of PLET are FTA, PLEM, or sled.

1.3.3 Abbreviations

Term	Definition
A&R	Abandonment and Recovery
AFC	Approved for Construction
API	American Petroleum Institute
ASME	American Society of Mechanical Engineers
CFR	Code of Federal Regulations
CG	Center of Gravity
CRA	Corrosion Resistant Alloy
FTA	Flowline Termination Assembly
HSE	Health, Safety and Environmental
IMR	Inspection, Maintenance and Repair
ISO	International Standards Organization
ITP	Inspection and Test Plan
JSA	Job Safety Analysis
MAOP	Maximum Allowable Operating Pressure
MQC	Multiple Quick Connect
NDE	Non Destructive Examination
OGP	International Association of Oil and Gas Producers
PLEM	Pipeline End Manifold

Term	Definition
PLET	Pipeline End Termination
ROV	Remotely Operated Vehicle
SCM	Subsea Control Module
SIT	System Integration Testing

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 minor 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.

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.

2. GENERAL AND FUNCTIONAL REQUIREMENTS

2.1 GENERAL REQUIREMENTS

2.1.1 Project Specification

1. The Principal shall provide a detailed project specification.

The project specification includes all relevant information required to design, fabricate, test and loadout the PLET. The project specification will typically include a data sheet that tabulates the relevant data. An example of a typical data sheet is given in Appendix B.

2.1.2 Equipment Selection

1. All equipment shall have a proven subsea service record for similar applications and be suitable for the selected method of installation (e.g., J-lay or S-lay).
 - a. The Contractor shall provide a fully detailed list of previous projects utilizing the equipment proposed for the scope of work.
 - b. The proposed equipment shall be subject to approval by the Principal.
 - c. For non-proven equipment, refer to (4.10.2) for requirements.

2.1.3 Design analysis

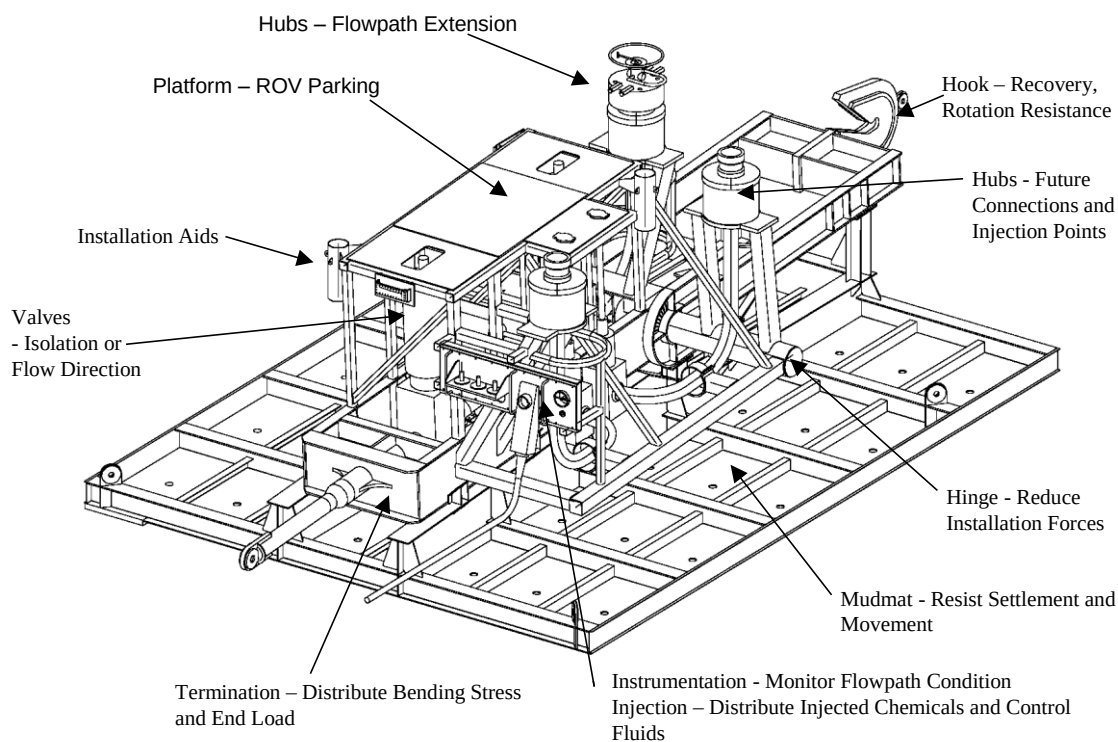
1. The PLET design analysis can be divided into two major categories:
 - a. pressure piping;
 - b. steel structure.

2.1.4 Steel structure primary components

1. The steel structure of the PLET can be divided into the following primary components, as illustrated in Figure 1:
 - a. foundation (mud mat – may be hinged depending on installation requirements);
 - b. yoke;
 - c. pipe support frame;
 - d. hub support frame;
 - e. end termination – stress joint transition to pipeline or flowline.

2.1.5 Other design requirements

1. The quantity and complexity of components installed subsea should be minimized.
Simple solutions offer enhanced reliability and reduce the need for maintenance and repair throughout field life.
2. There are several key considerations that should be addressed in the design of the PLET which include but are not limited to, the following:
 - a. interface of the PLET to the installation vessel and lay system;
 - b. keeping size and weight of equipment to a level consistent with use of conventional installation techniques;
 - c. keeping size and profile of equipment compact to reduce the effects of hydrodynamic forces in the splash zone, in the water column, and on bottom;
 - d. ensure equipment has sufficient structural strength and profile to protect piping and critical components during launch operations, travel through the water column, and landing operations;
 - e. ensure all installation, and IMR activities can be completed by ROV, without assistance of divers;
 - f. access area and grab bars are designed to withstand all the forces developed by ROV's in the course of their operational activities;
 - g. equipment, especially seal surfaces, are designed to minimize the probability of impact damage due to construction activities (e.g., landing of jumpers) and construction hazards (e.g. dropped objects);
 - h. potential use of supplemental buoyancy to reduce submerged weight and/or provide means to prevent undesired rotation during installation.
3. The Principal shall specify the design criteria, installation criteria, applicable codes and standards, and functionality for the intended purpose in the project specification.
The design may take different shapes and sizes depending on the specific requirements.

Figure 1 Typical PLET Components and Functionality

2.2 FUNCTIONAL REQUIREMENTS

A PLET provides the stable terminating or initiating point at the end of a subsea pipeline, and provides a mechanism to join the pipeline with other subsea equipment such as a subsea tree, manifold, or another pipeline end termination.

1. The PLET shall:
 - a. facilitate safe deployment with the pipeline/flowline to the seafloor;
 - b. allow recovery of the pipeline/flowline to the surface with the line in the flooded condition;
 - c. provide sufficient bearing surface to limit soil penetration, resist torsion imparted by the pipeline or jumper, and accommodate flowline loads due to thermal or pressure expansion as specified in the project specification;
Typically accommodation of flowline loads requires a slide mechanism between piping and mudmat.
 - d. provide an interface and a means to commingle or isolate produced fluids from individual subsea flowlines or wells connected to it;
 - e. ensure it remains in an upright position through the water column during deployment;
 - f. provide lifting points for handling onshore, load out, installation and retrieval;
 - g. provide a parking platform for ROV activities during installation and interventions;
 - h. provide distribution and control of fluid pressure to actuated valves;
 - i. provide location and mounting for pipeline instrumentation (e.g., pressure, temperature or pig signal devices);
 - j. provide distribution of electrical power and control signal for sensors or other devices as required;
 - k. provide location aids, guidance, and mounting for any retrievable components that may be located on the PLET (e.g., chokes or flowmeters).

2.3 MIDLINE SLED SPECIAL REQUIREMENTS

In general, the requirements for a PLET also apply to midline sleds. A few provisions, mainly related to the PLET support structure and installation methods are not applicable. A midline sled requires a few special design considerations that are not applicable to first or second end PLETs. Figure 2 illustrates typical midline sled features.

1. Special design requirements that apply to midline sleds include:

- a. for an S-lay installation, the midline sled shall;
 - i. fit through the pipeline assembly line, and
 - ii. fit through the stinger of the pipelay vessel.

Hinged mud mats or other features such as detachable mud mats can be provided to allow passage of the midline sled through the stinger.

- b. for a J-lay installation, the midline sled shall fit through the pipeline assembly tower;

Hinged mud mats or other features such as detachable mud mats can be provided to allow passage of the midline sled through the pipeline assembly tower.

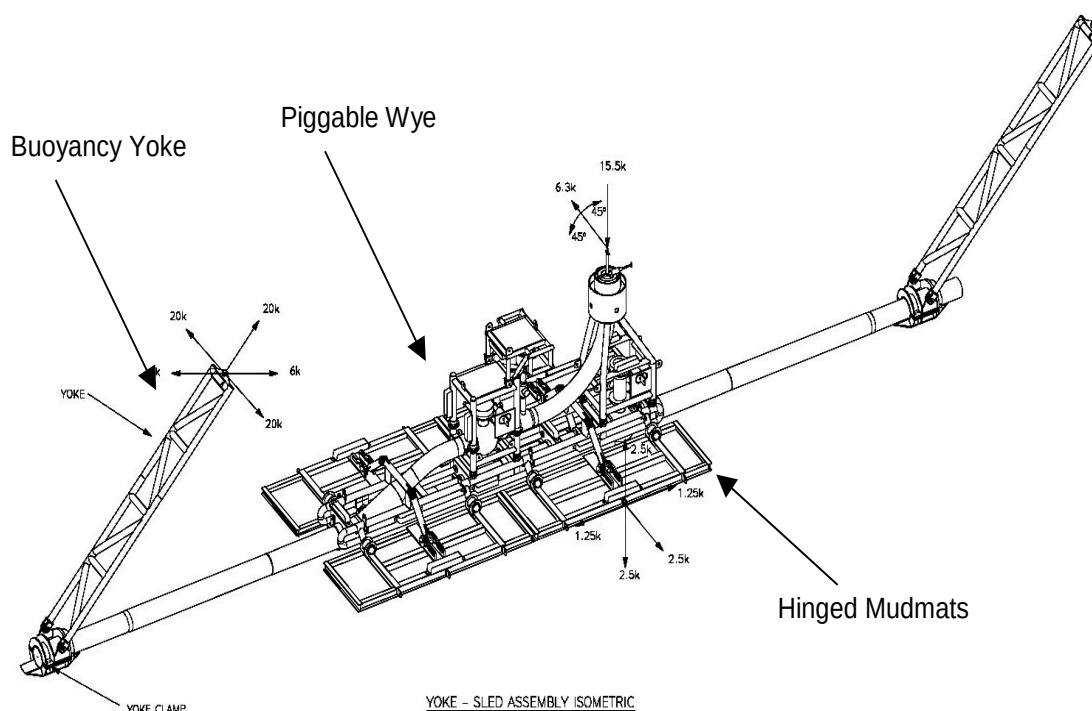
- c. for S-lay installation, additional analysis of the sled frame shall be provided;
 - i. this analysis shall be done in conjunction with the pipeline analysis to ensure the sled does not overstress the pipeline.

The sled is subject to bending loads when the sled traverses the stinger.

- d. detailed analysis of the pipeline wye component;
- e. detailed analysis of the rotation of the sled during installation;

Buoyancy modules and yokes can be provided to prevent rotation of the pipeline and sled as it is laid.

Figure 2 Typical Midline Sled Components



2.4 SUBSEA MARKINGS AND COLORING

1. Unless otherwise specified in the project specification, refer to ISO 13628-1 Annex B for markings and coloring requirements.

2.5 ELECTRICAL HYDRAULIC DISTRIBUTION

1. If specified in the project specification, the electro-hydraulic system shall be capable of accommodating the following functions:
 - a. control for valve actuation;
 - b. control for choke actuation;
 - c. monitoring of sensors (e.g., temperature, pressure, flow meter, pig signals, erosion detector, sand detector, choke position indicator).
2. The Subsea Control Module (SCM) should be mounted on an adjacent tree or distribution skid and not on the PLET.
 - a. If the SCM is mounted on the PLET, controls and chemical distribution shall be integrated into the PLET.

2.6 PLET SUPPORT STRUCTURE

1. If specified in the project specification, the PLET structure shall be supported on the seabed by a foundation system.

This is to prevent excessive settling of the PLET on the seabed.

 - a. Refer to DEP 37.81.10.31-Gen. for structural requirements for the PLET.

Guidance on pipe/soil interaction on a soft clay seabed can be found in DEP 37.81.10.15-Gen.
2. The pipe support structure on the PLET shall be designed to slide when the pipeline load exceeds the friction resistance between the pipe support structure and the foundation (mud mat) beams on the sled.
 - a. The friction resistance shall be calculated based on the submerged weight and the friction coefficient between the pipe support structure and the foundation beams.
3. The foundation design shall limit vertical movement from the installed position within the amount of settlement allowance determined in the foundation and jumper design calculations.

2.7 INSTALLATION, INSPECTION, MAINTENANCE AND REPAIR PHILOSOPHY

1. All installation and intervention operations shall be performed with the assistance of standard deepwater work class ROVs.
 - a. The PLET shall be designed so that no routine maintenance is required over the design life specified by the project specification.
2. The PLET shall be designed for transportation, flooded deployment, and flooded recovery.
3. The following additional requirements should apply to the design:
 - a. axial and transverse (considering 90° longitudinal rotation) load profiles;
 - b. levelling;
 - c. ROV access;
 - d. jumper measurement;
 - e. jumper installation;
 - f. coating colors and markings;
 - g. ballast;
 - h. level and orientation instrumentation;
 - i. alignment aids.
4. Requirements related to installation and IMR activities are as follows:
 - a. consideration should be given to equipment transportation, handling and installation;
 - i. If necessary, additional temporary protection should be provided, and designed to minimize the risk of damage to equipment.
 - b. the PLET should be designed to best balance the equipment installation time while retaining maximum reliability of installation;
 - i. For all pieces of installable equipment, the Contractor shall provide the expected installation windows (e.g., limiting sea states, currents, wind speeds), and size/weight envelopes as a separate report.
 - ii. The sensitivity of equipment during installation or retrieval to adverse weather conditions, vessel motions and reduced seabed visibility should be minimized.
 - c. all rigging equipment used for handling of the structures at the onshore fabrication site shall be supplied by the Contractor;
 - i. The Contractor should liaise with the Principal to ensure that the rigging set up for the offshore deployment operations is fully integrated and checked prior to release of the PLET to the Principal.
 - d. use of counterweights, buoyancy, and temporary balance weights should be minimized;
 - e. all subsea valves, whether manually or hydraulically actuated shall have the capability of ROV operation and/or override;
 - f. replaceable PLET components shall be designed to be interchangeable.
 - i. Interchangeability may be demonstrated by the use of jigs and/or fixtures where the delivery schedule does not permit direct confirmation prior to delivery.