

DEP SPECIFICATION

PIPELAY SURVEY, POSITIONING AND AS-BUILT REPORTINGS FOR OFFSHORE PIPELINES

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DESIGN AND ENGINEERING PRACTICE



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TABLE OF CONTENTS

1.	INTRODUCTION	5
1.1	SCOPE.....	5
1.2	DISTRIBUTION, INTENDED USE AND REGULATORY CONSIDERATIONS	5
1.3	DEFINITIONS	5
1.4	CROSS-REFERENCES	7
1.5	SUMMARY OF MAIN CHANGES.....	7
1.6	COMMENTS ON THIS DEP	7
2.	GENERAL REQUIREMENTS	8
3	GEODETIC CONTROL	9
3.1	HORIZONTAL DATUM AND PROJECTIONS.....	9
3.2	VERTICAL DATUM.....	9
3.3	TIME DATUM.....	9
4	SURVEY EQUIPMENT	10
4.1	SURFACE POSITIONING – DGNSS	10
4.2	TOUCHDOWN MONITORING	10
4.3	SUBSEA ACOUSTIC POSITIONING – ULTRA SHORT BASELINE SYSTEM.....	10
4.4	SUBSEA ACOUSTIC POSITIONING – LONG BASELINE SYSTEM	10
4.5	SUBSEA MEASUREMENTS – ATTITUDE / ORIENTATION / HEIGHT.....	11
5	PERSONNEL	13
5.1	GENERAL	13
5.2	SURVEY OPERATIONS MANAGER	13
5.3	SURVEY PROJECT MANAGER	13
5.4	PARTY CHIEF/SENIOR SURVEYOR	13
5.5	SURVEY ENGINEER	13
5.6	ONLINE SURVEYOR	14
6	PRE-LAY SURVEY	15
7	AS-LAID SURVEY	16
8	EVENTING	18
8.1	FIELD JOINTS	18
8.2	PIPELINE CROSSINGS	18
8.3	PIPELINE LATERAL BUCKLE TRIGGERS	19
8.4	ANODES.....	19
8.5	BUCKLE ARRESTORS	20
8.6	WEIGHT COAT	20
8.7	GENERAL PIPELINE DAMAGE	21
8.8	FREE SPANS	21
8.9	PIPELINE BURIAL.....	21
8.10	DEBRIS.....	23
8.11	CATHODIC PROTECTION VALUES	23
9	AS-TRENCHED AND AS-BUILT SURVEYS	24
9.1	AS-TRENCHED SURVEY	24
9.2	AS-BUILT SURVEYS.....	24
10	DELIVERABLES	25
10.1	CHARTING	25
10.2	REPORTING.....	25
10.3	DIGITAL PIPELINE AS-BUILT POSITION DATA.....	26
11	REFERENCES	27

APPENDICES

APPENDIX A USBL ACOUSTIC POSITIONING 28

APPENDIX B GYROCOMPASS 30

APPENDIX C DGNSS HEALTH CHECK 32

APPENDIX D MEASUREMENT ACCURACY & INSTALLATION TOLERANCE 34

1. INTRODUCTION

1.1 SCOPE

This DEP specifies requirements and gives recommendations for surveys in support of pipeline construction, including at what stages they are to be performed, for what purpose, and by what means. It also includes the requirements for pre-lay surveys. Principal may elect to use portions of this DEP for specific in-service pipeline surveys, see (8).

This DEP precludes the early stage activity requirements prior to pre-lay survey, such as pre-planning, desktop studies, scouting, archaeological and pipeline route surveys (geophysical and geotechnical samplings) to determine the suitability of the selected route(s), and any mandatory surveys required by the national and/ or local regulations. For these early stage activities, Principal's Geomatics group is recommended.

This new DEP-Gen. is a revision of the former deep water projects standard of the same number dated May 2008; 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 offshore oil and gas production (pipeline, flowline, umbilical riser projects) Application in other facilities may also apply.

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

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** is an option to be confirmed with Principal

The word **work** is used to define the work to be executed by the Contractor as defined in the Invitation to Tender or Contract Scope of Work.

1.3.2 Abbreviations

AUV	Autonomous Underwater Vehicle
BOEMRE	Bureau of Ocean Energy Management, Regulation and Enforcement (applicable for Gulf of Mexico operations only)
CP	Cathodic Protection
C-O	Computed minus Observed
CRP	Common Reference Point
CTD	Conductivity, Temperature, and Depth
DGNSS	Differential Global Navigational Satellite System
DHSS	Dual Head Scanning Sonar
DMA	Deadman Anchor
DP	Dynamic Positioning
EHF	Extra High Frequency
EPROM	Erasable Programmable Read Only Memory
FOG	Fibre Optic Gyro
FTA	Flowline Termination Assembly
GoM	Gulf of Mexico
GNSS	Global Navigation Satellite System
ITRF	International Terrestrial Reference Frame
KP	Kilometre Posts
LBL	Long Baseline Acoustic System
MF	Medium Frequency
MOC	Management of Change
MP	Mile Post
MSL	Mean Sea Level
NTL	Notice to Lessees
OOS	Out Of Straightness
RMS	Root Mean Square
RO	Reference Object
ROV	Remotely Operated Vehicle
SCR	Steel Catenary Riser
SSBL	Super Short Baseline System
SVP	Sound Velocity Profiler
USBL	Ultra Short Baseline Acoustic System
UTA	Umbilical Termination Assembly
UTC	Coordinated Universal Time
UTH	Umbilical Termination Head

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 (11).

1.5 SUMMARY OF MAIN CHANGES

This DEP-Gen. is a revision of the deep water projects standard of the same number dated May 2008. The following are the main, non-editorial changes.

Old section	New section	Change
		Revised Section numbering because of insertion of new Sections
NA	3.0	Added Section on Geodetic Control (from SES 95-3 (SSB – 2000) Positioning and Site Investigation for Offshore Engineering and Construction Work)
NA	5.0	Added Section on Personnel requirements (from SES 95-3)
App A	App A	A.2.3 Updated sound velocity accuracy and Echo Sounder error check (A.4.7)
App D	App D	Deleted Table D2 (Measurement Accuracy for Jumpers) – this is addressed in DEP 37.80.00.38-Gen.

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

2. GENERAL REQUIREMENTS

Pre-lay surveys may be required prior to any structure and pipelay installation operation. This requirement varies from project to project. This event may be necessary due to the time gap between the original survey performed during the design stage and the installation start date. In the event pre-lay survey is required by the project team or by the national and/or local regulations, this shall be carried out in close consultation with the project team such that its start date and completion do not impact the construction works.

The objectives of a pre-lay survey are:

- To confirm the location and pipeline route(s) are clear of obstructions that may impede the installation process
- To ensure that the anchoring corridors, in case an anchored barge is used during installation, are clearly mapped of seabed obstructions that may slow the structure/pipelay installation process.
- To confirm status of pre-lay intervention works

A pre-lay survey may consist of either:

- A remotely operated vehicle (ROV) survey
- A Geophysical survey - Towed sensor or autonomous underwater vehicle (AUV)

If the pre-lay survey results show debris/relics of historical or archaeological significance, the process of notification as described in (8.10) shall be followed.

Pipeline inspection surveys are required at various stages of installation, operations, and any subsequent inspection works. The stages during which a pipeline inspection survey would typically be required include the following:

- a) Pipeline installation support.
- b) As-Laid Surveys
- c) As-Trenched Surveys
- d) As-Built Surveys (after post-lay interventions such as trenching/rock dumping or remedial works such as span rectification).
- e) Periodic Inspection works

The objectives of a pipeline inspection survey are further defined as:

- 1) Confirmation of location and integrity of the pipeline.
- 2) Location of all pipelines, cables and any other under water structures that may affect the pipeline under inspection.
- 3) Confirmation of the seabed topography.
- 4) Establish and confirm the locations given in the referenced drawings for subsea structures and seabed features respectively.
- 5) Confirmation of the status of relevant third party installations.

A pipeline inspection survey may consist of either:

- i. A Geophysical survey - Towed sensor or AUV
- ii. An ROV investigation of pipeline condition, crossings and any peripheral pipeline assemblies.
- iii. Alternatively, a combination of both ROV and Geophysical surveys.

3 **GEODETIC CONTROL**

The selection of coordinates system and any survey control points used in any aspect of the work (either onshore or offshore), shall be approved by Principal before use. Principal (with the assistance of local Shell Geomatics group) shall provide details of geodetic parameters for the proposed work site, Contractor will review geodetic details, and immediately advise of any discrepancies or if unable to achieve required configuration with contractor's navigation software system. Principal may accept alternate geodetic algorithms that would yield similar results, after review and approval from the local Shell's Geomatics group.

Details of geodetic system and survey control used during the work shall be properly documented and included in the final report to Principal.

3.1 **HORIZONTAL DATUM AND PROJECTIONS**

Typical navigation systems will receive differential global navigation satellite system (DGNSS) position information based on WGS 84 Geographic Coordinate Reference System and undergo coordinate transformation to the appropriate local system required for the work site. Details of the local projection parameters and transformation method shall be shown in all project planning and reporting. Field operating units must be clearly indicated in all work packages, and angular units should be displayed in Grid degrees (°), in the absence of project specific requirements.

3.2 **VERTICAL DATUM**

Depth information displayed or reported in all work packages, shall include details of the tidal datum, any local reference stations, and/or any models used for work. Mean Sea Level (MSL) shall be used as vertical datum in the absence of project specific requirements.

3.3 **TIME DATUM**

Time information displayed or reported in all work packages, shall include details of the time zone used for work. Time zone details shall include offset references to Coordinated Universal Time (UTC).

4 SURVEY EQUIPMENT

4.1 SURFACE POSITIONING – DGNSS

Surface positioning of the installation or survey vessel shall utilize DGNSS. This shall include continuous, real-time output of navigation data to the vessel dynamic positioning (DP) computer. A minimum of two (2) independent sources of differential corrections shall be provided and 100% redundancy in DGNSS positioning equipment shall be provided. The vessel shall use a true-north seeking gyrocompass or a global navigation satellite system (GNSS) based attitude & heading sensor for orientation (Ref: Appendix B for Gyro operational information). Where applicable, input from a heave, pitch, roll sensor shall also be used to make real-time corrections to the positioning data. The accuracy of DGNSS shall be better than 3 m, in the absence of any project specific requirements.

During pipelay, the navigation software shall display the installation vessel's real-time location relative to the proposed route. The display must also include seafloor facilities, hazards, and any proposed installation critical positions. Navigation data/display shall include touchdown, distance downline [stations such as kilometre posts (KP), mile post (MP), etc.], and cross track information during pipelay.

Demonstration of the proper setup of the online navigation shall be performed by the survey contractor prior to the commencement of the positioning activities and shall include the following:

- Proper geodetic parameter application.
- Correct inputs from the DGNSS equipment and gyrocompass.
- Correct application of the antennae offsets.

(See Appendix C for DGNSS Health check guidelines)

The proposed Barge Track route must show where the vessel should be during pipelay to maintain the pipeline's touch down point based on lay table information (i.e. Pipelay vessel's offset along curves).

The monitors displaying the vessel's position shall be located (at a minimum) on the bridge, at the DP operator's station, and at the ROV pilot's station.

4.2 TOUCHDOWN MONITORING

Actual touchdown data may be obtained by positioning the ROV at the touchdown of the pipeline. The ROV based touchdown data shall be relayed from the Survey/ROV vessel through a real-time data transmission link. Subsea positioning requirements are given in (4.3) and (4.4).

4.3 SUBSEA ACOUSTIC POSITIONING – ULTRA SHORT BASELINE SYSTEM

Based on installation tolerances, a calibrated Ultra-Short Baseline System (USBL) may be required for subsea positioning. USBL systems shall utilize a motion sensor and real-time gyrocompass input to correct for the vessel's attitude. The absolute accuracy of USBL shall be better than 0.5% of the slant range.

Reference (Appendix A) for USBL operational information.

Any subsea equipment requiring USBL positioning shall follow the displaying requirements detailed in (3.1). Acoustically positioned hardware must be shown relative to any existing seafloor features, on the navigation screen.

4.4 SUBSEA ACOUSTIC POSITIONING – LONG BASELINE SYSTEM

Based on installation tolerances, a calibrated long baseline system (LBL) may be required for subsea positioning. Precise positioning applications may require an LBL array of transponders installed on the seafloor.

The operating frequency and signal architecture of the LBL system must be appropriate to the water depth, environment and positioning requirement. The distribution of transponders on the seabed must be planned to provide positional coverage within the area encompassed by the resulting network with sufficient redundancy and adequate fix geometry over the entire area of interest. Typically a medium frequency system (18-36 kHz) should be used to establish positioning with a relative accuracy of better than 1 meter. Extra high frequency (EHF) (50-110 kHz) is typically used to establish positioning with relative accuracy better than 10 centimetres. However, modern developments in signal processing and architecture mean that positional accuracy is no longer related solely to operational frequency.

The methods used to install transponders on the seabed must be consistent with the most efficient utilisation of vessel time and facilitate the installation and removal of transponders by ROV where appropriate. Design and fabrication of the transponder frames must comply with the field's requirement for either short-term or long-term utilization, where the size and mass incorporates the appropriate stability and cathodic protection.

The geometry of the transponder network and the equipment and methodology employed to conduct the calibration must support calibration with an accuracy that is consistent with the end requirement for positioning. In particular the instrumentation used to determine the speed of sound in water and the relative depths of the array transponders must be selected and deployed in a manner that is consistent with the expected variation in sound speed at array depth and the horizontal separation between transponders. The calibration process must yield sufficient redundant observations to enable the computation of statistical estimates of the calibration quality and also include appropriate QC checks to identify gross error in the resulting transponder coordinates. Where the magnitude of the variation in tidal height at the work site may result in a significant impact on the accuracy of subsequent positioning operations the seabed equipment should include instrumentation to enable the accurate real-time measurement of tidal height during those operations.

Contractor utilizing the array shall maintain all relevant information of the calibration (if applicable) or positioned LBL targets (i.e. baseline, sound velocity, logged positioning files, range measurements, transponder locations, offsets, etc...). Contractor shall also ensure that sufficient redundant measurements are taken to ensure a high level of confidence in any final reported positions [i.e. four (4) or greater range fix, multiple observations on target transponder, acceptable statistical values for computed position, Low Root Mean Square (RMS), etc.]

Contractor must demonstrate the effective control of error in the positioning solution through rigorous operational procedures consistent with industry best practice. Sufficient redundancy must be provided in equipment to identify bias in the derived values for the speed of sound in seawater and the depths of objects being positioned within the network. The level of redundancy during positioning must be consistent with the accuracy requirement and provide appropriate statistical measures of the quality of the computed positions.

4.5 SUBSEA MEASUREMENTS – ATTITUDE / ORIENTATION / HEIGHT

Attitude of subsea hardware shall be measured using appropriate instrumentation and methods.

The orientation of subsea hardware shall be measured using a calibrated underwater gyrocompass. The gyro shall be deployed in suitable pressure housings and be capable of real-time monitoring and reporting through a hardwire link or through an acoustic link. Orientation may also be computed from the position of two (2) transponders mounted at known locations on the subsea hardware if it can be shown that this method will provide sufficient accuracy.

Subsea height/depth measurements shall be made using high precision depth sensors capable of measuring to the required accuracy. At each subsea location, a reference point must be established on a piece of hardware that can be defined as the local relative datum. Heights of other points in the immediate vicinity shall be referenced to this local datum.