

DEP SPECIFICATION

**PIPELINE ENGINEERING
(AMENDMENTS/SUPPLEMENTS TO ISO 13623:2009)**

DEP 31.40.00.10-Gen.

February 2011
(DEP Circular 35/11 has been incorporated)

DESIGN AND ENGINEERING PRACTICE

DEM1



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PART I INTRODUCTION

1.1 SCOPE

This DEP specifies minimum technical requirements and gives recommendations for the design, material procurement, construction, testing, operation, maintenance and abandonment of rigid steel pipelines (both onshore and offshore) used for the transport of hydrocarbons and other fluids.

This DEP is based on ISO 13623:2009. Part III of this DEP amends, supplements and deletes various clauses of ISO 13623. Part III follows the clause numbering of ISO 13623 for easy reference.

For some fluids, in particular those of an unstable or very toxic nature (see DEP 01.00.01.30-Gen.), additional requirements not covered in this DEP may be appropriate.

Further guidance on the design and operation of CO₂ pipelines can be found in DNV-RP-J202: Design and Operation of CO₂ pipelines (April 2010).

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 with the same number dated January 2010; 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 capitalised term **SHALL [PS]** indicates a Process Safety requirement. Derogations from these requirements have to be approved by the Delegated Technical Authority.

The word **should** indicates a recommendation.

1.3.2 Specific definitions

A **Delegated Technical Authority** is a person who has received delegated authority to approve Derogations from the Process Safety requirements from the Head of Shell P&T.

A **Derogation** is an authorised variance or exemption from a Process Safety requirement, with specified conditions.

Process Safety is the management of hazards that can give rise to major accidents involving the release of potentially dangerous materials, release of energy (such as fire or explosion) or both.

Barred tee	Tee-piece provided with bars across the internal bore of the branch pipe to prevent entry of a pig.
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Branch pipe	Pipe connected to a pipeline of equal or larger diameter, using a tee-piece or welded branch connection.
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Cold bend	A bend made from line pipe at ambient temperature, normally on the construction site, using a mechanical bending machine.
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Conceptual design	The stage in the design where a high level definition of the systems is given to allow an early assessment of technical and economical feasibility of a project.
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Deep Water	Unless specified otherwise by Principal in the Project Specifications, deep water is a water depth in excess of 300 m.
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Emergency shutdown valve	Valve for isolating a pipeline from a plant in case of emergency situations within the plant.
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Front End Engineering and Design (FEED)	Engineering and design activities, following the conceptual design, where a project is given further technical definition and where a job specification can be drawn for the preparation of and tender documents.
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Amended per
Circular 35/11

Flowline	An in-field pipeline transporting untreated hydrocarbons and other reservoir fluids, or a pipeline used to inject gas into a reservoir (gas injection flowline) or a pipeline to inject water into a reservoir (water injection flowline).
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Flow assurance	The measures to be taken to ensure that a pipeline can operate within the specified operating window during its lifetime. Such measures are to be addressed during the design stage to prevent e.g. hydrate formation, formation of wax etc. Flow assurance is an exercise requiring input from various disciplines such as process, hydraulic and pipeline design to ensure that all aspects are fully considered and to develop an integrated solution.
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Induction (hot) bend	A bend made under factory conditions by hot working pipes.
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Incidental pressure	Pressure occurring in a pipeline with limited frequency and during limited periods of time. Incidental pressures include surge pressures, and thermal pressures if not occurring routinely or for a significant period.
Integrity	The (technical) integrity of a facility is achieved when, under specified operating conditions, the pipeline can operate in accordance with the design intent.
Isolation (or block) valve	Valve used to interrupt the flow or to isolate one section of a pipeline from an adjacent section or a facility connected to the pipeline. An isolation valve is normally either fully opened or fully closed. Also referred to as a block valve.
Jumper	A short subsea section of pipe provided with mechanical connectors for the diverless connecting of e.g. a wellhead to the end of a pipeline.
Line pack	In a gas transmission system, the line pack is the quantity of gas in excess of the minimum gas inventory in the system required to meet deliveries. The line pack is used to continue deliveries for some period following interruption of supply upstream.
Liquid hold-up	Quantity of liquids present in a multi-phase pipeline.
Maximum operating temperature	The maximum temperature to which the pipeline or section of pipeline is expected to be exposed during planned operational activities, including start-up and shut-down operations, but excluding abnormal situations, e.g. fires.
Operating envelope	A defined set of key parameters or parameter ranges which must be adhered to during operation of the pipeline in order to prevent loss of technical integrity and maintain flow.
Pig	A device which can be propelled through a pipeline by fluid flow and is normally used for cleaning, batching, inspection or other activities.
Pig trap	An ancillary item of pipeline equipment, with associated pipework and valves, for inserting and launching a pig into a pipeline or receiving and removing a pig from a pipeline.
Pipe-in-Pipe (PIP)	A single flow line, provided with an outer steel carrier pipe. Used to improve insulation of the flowline for reasons of flow assurance.
Pipeline leak	An uncontrolled fluid release from a pipeline.
Plant	An installation such as a well-head, processing facility, pressure boosting station, storage tank, offshore platform, refinery, etc., with defined boundaries and which is not normally accessible to the public.
Pre-commissioning	A series of activities, including cleaning and possibly drying and inerting, executed to prepare the pipeline for commissioning.

Risk	The product of the probability of an event occurring and the consequences of the event when it has occurred.
Amended per Circular 35/11	
Shore approach	That section of a pipeline which crosses the sea shore, or major river/estuary shores. The shore approach includes the area of breaking waves and extends from the lowest to the highest water mark.
Slug catcher	A device located at the downstream end of a multi-phase pipeline, for the primary separation of the liquid and gas phases, and the temporary storage of liquids generated by pigging and transient flow conditions. There are two types of slug catchers: the vessel type and the finger type.
Sphere	A spherical shape pig that may be used for batching and liquid hold-up removal in two-phase pipelines.
Sphere tee	A jacketed tee-piece with a perforated inner pipe to prevent entry of a sphere into the branch pipe.
Surge pressure	Pressure due to mass flow velocity changes, caused by operational activities, e.g. valve closures, pump shut-down or start-up.
Very toxic (substances)	substances that are very hazardous for the environment or human health, as specified in DEP 01.00.01.30-Gen. (which also identifies "toxic" substances by reference to chemical substances databases)
	NOTE: ISO 13623 uses the term "toxic" without further definition. All instances of the term "toxic" in ISO 13623 shall be considered to be the same as the term "very toxic" as defined in DEP 01.00.01.30-Gen.

1.3.3 Abbreviations

Amended per
Circular 35/11

CP	Cathodic Protection
DN	Diameter nominal
DP	Dynamically Positioned
EIA	Environmental impact assessment
ESD	Emergency shutdown
GRE	Glass reinforced epoxy
GRP	Glass reinforced plastic
HFW	High frequency welded
HIA	Health impact assessment
HIC	Hydrogen induced cracking
HSAW	Helical Submerged Arc Welded
HTHP	High Temperature High Pressure
IPF	Instrumented Protective Function

MAIP	Maximum Allowable Incidental Pressure
MAOP	Maximum Allowable Operating Pressure
MESC	Materials and Equipment Standards and Code
MOP	Maximum Operating Pressure (used in some regions instead of MAOP)
MSP	Maximum Source Pressure
PLEM	Pipeline End manifold
PN	Nominal pressure rating
QRA	Quantitative risk assessment
RTP	Reinforced thermoplastic
SAW	Submerged arc welded
SIA	Social impact assessment
SMYS	Specified minimum yield strength
SSCC	Sulphide stress corrosion cracking

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 (Part IV).

1.5 SUMMARY OF MAIN CHANGES

This DEP is a revision of the DEP of the same number dated January 2010. The following are the main, non-editorial changes.

Old section	New section	Change
1.1&1.2	1.1&1.2	Reference to DNV-RP-J202, API RP 111, DNV-OS-F101 included.
5.4	5.4	All requirements from DEP 31.40.10.14-Gen. Pipeline Overpressure Protection have now been included in this DEP.
6.4.1.1	6.4.1.1	Hoop Stress Due to Fluid Pressure –Principal may approve use of API RP 1111 or DNV-OS-F101 for pressure design of deepwater projects.
6.4.1.2	6.4.1.2	Other Stresses: An equation is added to address Von Mises stress in presence of significant radial stress (for low D/t pipe).
6.4.2.2	6.4.2.2	Strength Criteria: Table for Mid-Wall equivalent stress design factors based for low D/t ratios added.
6.7.3	6.7.3	Pressure Levels and Test Durations: Clauses have been added to address deep water hydrostatic test pressure.
Part IV		Section describing the Differences between ISO 13623 and ASME B31.4/B31.8 has been moved to the DEP Informative.

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

1.7 DUAL UNITS

**Amended per
Circular 35/11**

Dual units have been incorporated throughout this DEP.

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.

PART II GENERAL

Part III of this DEP is written as amendments and supplements to ISO 13623:2009. Wherever reference is made to ISO 13623, it shall be understood to mean ISO 13623:2009 as amended/supplemented by this DEP.

For ease of reference, the clause numbering of ISO 13623 has been used throughout Part III of this DEP.

Clauses in ISO 13623, which are not mentioned in this DEP, shall remain valid as written.

Where national legislation requires the use of a standard other than ISO 13623, this DEP shall be read as providing the minimal Shell requirements that shall be applied for the safe design, installation and operation of a pipeline system. In case of conflicts between this DEP and national and/or local regulations, refer to (Part I - 1.2).

NOTE: Rules and codes do not always derive from the same theoretical background or approach. During the preparation of the basis for design in the FEED phase of a project a review shall be conducted of the standards and specifications that shall apply to the project also taking into account the requirements of National and/or local Authorities.

Clear guidance on the application of standards, guidelines and specifications shall be defined in a design basis document approved by the Principal.

This DEP allows use of alternative pressure design calculations as per API RP 1111 for deepwater projects, as an alternative to pressure design calculations as per ISO 13623. A detailed gaps analysis has been performed to document justification.

DNV-OS-F101 is a widely used design code for offshore pipelines and compulsory in some countries. A detailed gaps analysis will have to be performed adopting DNV-OS-F101 as primary Code and gaps identified shall be clearly documented.

PART III AMENDMENTS/SUPPLEMENTS TO ISO 13623

1. SCOPE

Add to this clause:

A pipeline extends from pig trap to pig trap (including the pig traps and associated pipework and valves), or, if no pig trap is fitted, to the first isolation valve within the onshore plant or the offshore installation as applicable. Slugcatchers including associated pipework and valves are deemed to be part of a pipeline, unless otherwise specified by the Principal.

3. TERMS AND DEFINITIONS

Add to this clause:

Definitions in (I-1.3) of this DEP shall also apply.

4. GENERAL

4.1 HEALTH, SAFETY AND THE ENVIRONMENT

Add to this clause:

HSE associated with the design, construction, testing, operation, maintenance and abandonment of the pipeline system shall be managed in accordance with the requirements of the Principal's HSE Management System.

An assessment shall be carried out of the potential environmental, social and health impact of the proposed pipeline and where appropriate alternative routes and/or designs shall be evaluated. Mitigation, management, and monitoring measures shall also be addressed.

5. PIPELINE SYSTEM DESIGN

5.2 CATEGORIZATION OF FLUIDS

Add to this clause:

The term "toxic" as used above shall be understood to mean the same as the classification "very toxic" in DEP 01.00.01.30-Gen.

5.3 HYDRAULIC ANALYSIS

Add to this clause:

The hydraulic analysis shall take full account of possible changes in flowrates and operational modes, over the complete operational life of the pipeline.

**Amended per
Circular 35/11**

The hydraulic analysis shall also consider:

- surge pressure during shut-down of a liquid line;
- turn-down limitations and inhibition or insulation requirements to prevent wax or hydrates deposition;
- flow conditions, to allow their effect on the efficiency of corrosion inhibitors to be determined;
- benefit of internal coating after allowing for possible deterioration in coating during operational lifetime e.g. as a result of routine pigging;
- liquid catching and slug control requirements at the downstream end of two phase lines.

The following requirements shall be complied with:

- Pipelines conveying a liquid shall be sized so that the normal range of flow velocities is 1 m/s to 2 m/s (3.3 to 6.6 ft/s). Continuous operations above 4 m/s (13 ft/s) should be avoided.
- Unlined carbon steel pipelines transporting category B liquids containing a separate water phase, even in a small quantity (e.g. 1 % water cut), should not be operated at too low velocities (typically below 1.5 m/s (5 ft/s)). This is to prevent water

dropout, which may lead to a corrosive environment.

NOTE: When transporting light crude oils or condensate, a minimum velocity of 1.5 m/s (5 ft/s) in crude (higher in lighter fluids and gas) may not be sufficient to prevent water dropout. Specialist advice should be obtained on the required minimum velocity or alternative corrosion mitigation measures to be applied.

At water cuts higher than 20 %, flow velocity is no longer an issue as water wetting of the pipe wall will always occur, and alternative means of corrosion mitigation shall be considered. However, a minimum velocity of around 1 m/s is preferred for intelligent pigging operations. If the minimum velocity cannot be achieved in a cost effective way (e.g. high pump station costs), a corrosion management strategy shall be developed based on the expected water drop-out in the pipeline during low flow conditions.

It may sometimes be advantageous to adjust the design pressure along the route, depending on the patterns of the hydrostatic pressure and the friction pressure loss. Where this is applied, great care should be applied in the design to ensure that under all operating scenarios, over-pressurisation of one section by the adjacent sections is not possible.

Pipelines conveying gas should be sized so that the normal range of flow velocities is 5 m/s to 10 m/s (16 to 32 ft/s). Continuous operations above 20 m/s (65 ft/s) should be avoided.

Sections of decreasing design pressure should not be incorporated in pipelines conveying gas, because the slight cost benefit is unlikely to outweigh the lost advantage of line packing and the associated reduction of system availability.

For pipelines conveying fluids containing solid particles, the maximum velocity shall take into account the potential for erosion. Conditions which may cause pipewall erosion shall be avoided.

5.4 PRESSURE CONTROL AND OVERPRESSURE PROTECTION

Add to this clause:

The maximum allowable incidental pressure (MAIP) is 1.1 times MAOP for both liquid and gas lines except in the case of:

- a) Pipelines designed in accordance with ISO 13623 conveying category C and D fluids that have been pressure tested at a reduced test pressure of 1.20 times MAOP – for such pipelines the MAIP is limited to 1.05 times MAOP.

**Amended per
Circular 35/11**

- b) Gas pipelines designed in accordance with ASME B31.8 and operating at or below a hoop stress of 72 % of the SMYS - for such pipelines the MAIP is also limited to a pressure which results in a hoop stress not exceeding 75 % of SMYS.
- c) Gas pipelines designed in accordance with ASME B31.8 and operating over a hoop stress of 72 % of the SMYS – for such pipelines the MAIP is limited to 1.04 times MAOP.

Pressures in excess of MAOP shall be recorded with duration and pressure value.

In case overpressure protection is provided by relief valves, the design SHALL [PS] comply with DEP 80.36.00.30-Gen. The relief valve set pressure SHALL [PS] be equal to or less than the pipeline MAOP.

In case overpressure protection is provided by source-isolation valves, the design SHALL [PS] comply with DEP 32.80.10.10-Gen. The set point of this Instrumented Protection Function SHALL [PS] be equal or less than 107% of the pipeline MAOP.

When existing pipeline systems are extended, e.g. by adding a new branch line, the whole pipeline system SHALL [PS] be subject to a design review to ensure that overpressurisation of the system from the new branch line is not possible.

5.5 REQUIREMENTS FOR OPERATION AND MAINTENANCE

Add to this clause:

Requirements for operations and maintenance shall be consistent with existing operations philosophies, policies and procedures.

Add to sub-bullet 12:

e.g. the requirement to depressurise a gas pipeline using the adjoining plant facilities and the associated impact on these facilities.

5.6 PUBLIC SAFETY AND PROTECTION OF THE ENVIRONMENT

Add to this clause:

**Amended per
Circular 35/11**

The factors which are critical to public safety and the protection of the environment SHALL [PS] be analysed over the entire life of the pipeline, including abandonment, and shall take into account any change in the level of risk over time. The risk should be reduced to as low as reasonably practicable (ALARP), with the definite objective of preventing leaks. The risk reduction measures and ALARP achievement shall be fully documented, implemented and maintained.

NOTE: For further guidance on safety design aspects reference should be made to the latest EP Business HSE Standards.

6. PIPELINE DESIGN

6.1 DESIGN PRINCIPLES

Add to this clause:

DEP 31.40.10.18-Gen. applies to any application of (reliability-based) limit states design methods. Such methods should only be used to confirm the safety of a design when no established (e.g. deterministic) guidance is available. Such cases may include:

- unusual extreme loads, such as external pressure in deep water, seismic loads (e.g. at a fault crossing), ice loads (e.g. by impact from ice keels);
- situations where strain based criteria may be appropriate because the loads depend on the compliance of the pipe, but the actual strains the pipe will experience depend on uncertain parameters (e.g. wall thickness variations, strength of the pipe material)

Where use is made of reliability-based limit state design principles, the impact on welding and materials should be evaluated at an early stage and appropriate allowance made for development and testing of welds.

Reliability-based limit state design methods should not be used to circumvent or recalibrate functional and deterministic requirements specified in this standard such as hoop stress, burial depth, pressure testing, NDE during construction, etc.

6.2 ROUTE SELECTION

6.2.1 Considerations

6.2.1.1 General

Add to this clause:

For pipelines on land, location classes SHALL [PS] be identified along the pipeline route for pipelines transporting category D and E fluids. These shall be in accordance with Annex B unless some other classification is specified in national regulations.

When optimising the route selection due regard shall be given to the cost impact of relocating pipeline sections to a lower location class i.e. the cost of additional pipeline length versus reduction in wall thickness.

6.2.1.2 Public safety

Replace second paragraph 2 with: