

DEP SPECIFICATION

DESIGN OF PIPELINE PIG TRAP SYSTEMS

DEP 31.40.10.13-Gen.

February 2017

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 pig trap systems for onshore and offshore pipelines having a diameter of 100 mm (4 in) to 1400 mm (56 in). It is written with particular reference to liquid, gas and multi-phase hydrocarbon fluids, but may be applicable to other fluids.

The following components or topics are not specifically covered by this DEP:

- a. criteria for deciding whether permanent or temporary pig traps are required;
- b. applicability of the requirements and recommendations in this DEP to temporary pig traps, as used for pre-commissioning purposes;
- c. subsea pig launchers and receivers;
- d. pig launcher valves (i.e., valves where pigs can be loaded into the side of the valve).

This DEP is intended for design purposes only and not for material procurement. Design aspects relating to procurement are given in (5). The design could result in either the purchase of prefabricated traps or the purchase of individual components for field fabrication.

This DEP may be applied to the design of temporary pig traps, when specified by the Principal (see 2.2, item 4).

This DEP contains mandatory requirements to mitigate process safety risks in accordance with Design Engineering Manual (DEM) 1 – Application of Technical Standards.

As pig traps are part of a pipeline system, this DEP is based on ISO 13623:2009 in line with DEP 31.40.00.10-Gen.

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 pipelines in oil and gas production and distribution. 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.

Where national legislation requires the use of a standard other than ISO 13623, this DEP identifies the minimum requirements that shall be applied for the safe design, installation and operation of a pig traps, as part of a pipeline system.

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
Balance Line	Small-bore line which allows pressurisation of the barrel on both sides of a pig at the same time (see Figures 1 and 2).
Barred Tee	Tee-piece provided with bars across the internal bore of the branch pipe to prevent entry of a pig.
Bypass Line	Piping between the pipeline and associated plant or facility through which fluid flows under normal operational conditions (see Figures 1 and 2).
Catch Pit or Tray (or Drip Pan, Door Pit)	Draining facility underneath an end closure door.
Cold Bend	Bend made from line pipe at ambient temperature, normally on the construction site, using a mechanical bending machine.
Drain Line	Small-bore line used to drain fluid from the barrel (see Figure 1).
End Closure	Fitting, including a removable part or assembly, which provides quick and easy access to the major barrel when open and seals the bore when closed.
Kicker Line (or Bridle Line)	Piping from the major barrel to the bypass line used to control the launch or receipt of a pig (see Figures 1 and 2).
Launching Pins	Retractable pins, used in pig launchers to release a sphere from a cassette holding multiple spheres.
Major Barrel	Enlarged pipe section of a pig trap used for loading or retrieval of pigs (see Figures 1 and 2).
Main Line	Major portion of a pipeline, between pig traps (see Figure 1).

Term	Definition
Minor Barrel	Pipe section of a pig trap between the reducer and the pig trap valve, of the same diameter as the pipeline (see Figures 1 and 2).
Pig trap	An ancillary item of pipeline equipment, comprising a barrel, end closure and instruments, for introducing a pig into a pipeline or removing a pig from a pipeline. Pig traps are further described in DEP 31.40.10.13-Gen.
Pig Trap System	Pig trap together with all associated piping, valves, supports and instruments.
Pig	Device which can be propelled through a pipeline by fluid flow and is normally used for various internal activities such as separating fluids, cleaning the pipeline, or inspecting the pipeline.
Pig Launcher	Pig trap for launching pigs.
Pig Receiver	Device set onto or into a pipe, which gives an indication of the passage of a pig.
Pig Signaller	Device set onto or into a pipe, which gives an indication of the passage of a pig.
Piping	Pipework associated with the pipeline but not part of the main line.
Piping Class	A collection of piping components that are suitable for a defined service and design limits in a piping system. Piping classes are compiled in DEP 31.38.01.12-Gen. and DEP 31.38.01.15-Gen.
Pressure Safety Device (or Tell-tale Vent)	Safety device provided as part of the end closure door locking mechanism to safeguard personnel during door opening.
Pressurising Line	Small-bore line with valves to allow equalisation of pressure across a larger valve, avoiding damage to the seats of the larger valve (see Figure 1).
Requisition	Data/requisition sheet(s) DEP 31.40.10.93-Gen. and DEP 31.40.21.94-Gen., to be used by Principal and completed by Contractor.
Sphere Tee (or Radial Flow Tee)	Jacketed tee-piece with a perforated inner pipe allowing flow to enter the side branch but preventing entry of a sphere, foam or poly pig into the side branch with a minimum pressure drop.
Sphere	A spherically shaped pig.
Tight Shut-off Valve	Valve with leakage rate not exceeding ISO 5208 Rate A (no visible leakage).
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).

1.3.3 Abbreviations

Term	Definition
ESD	Emergency Shutdown
HIC	Hydrogen Induced Cracking
ID	Inside diameter
MESC	Materials and Equipment Standards and Code

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 full 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 and separation of requirements.
2.5.4	Separation of Shall [PS] and should into two separate requirements to clarify that a flanged purge connection Shall [PS] be provided on very toxic – acute systems should be provided on all systems.
4.1 General	Modification of Shall [PS] requirement around pig trap orientation to remove ambiguity of the term “critical” and to clarify that use of physical barriers as an alternative requires Principal approval.

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.
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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.

1.9 ACTION ITEMS

Items requiring selection or a decision by the Principal are identified by the use of a (●) in the margin and summarised in Table I-1.

Table I-1 Summary of Principal actions

Section / Clause		Description
2.5.1	11	Define the type of Tees to be installed.
		Define if a drain connection on the tee is to be installed.
2.6.1	4	Specify the type of valve(s).
2.6.1	5	Specify the pre-commissioning method.
2.6.1	6	Specify the type of valve connection (weld-end / flanged).
2.6.1	9	Specify the type of actuator(s).
2.6.1	12	Specify the type of valve isolation.
2.6.2	1	Specify the type of valve(s).
2.6.3	1	Specify the type of valve(s).
2.6.5	1	Specify the type of valve(s).
2.6.6	2	Specify the type of valve(s).
2.6.6	3	Specify the type of valve(s).
2.6.7	1	Specify the type of valve(s).
2.6.8	1	Specify the type of valve(s).
2.6.9	1	Specify the type of valve(s).
2.7.1	7	Specify the position of the end closure(s).
2.7.3	4	Specify the type of interlocking.
3.1	1	Specify whether dual use of pig traps is required.
3.1	2	Specify the type of pigging operation.
3.1	3	Specify either horizontal or vertical position of the pig trap.
3.2	3	Specify design code break.
3.3	1	Specify the design factor.
3.4	2	Specify the pipeline design pressure & fitting class rating.
3.5	1	Specify the minimum and maximum design temperature.
3.5	3	Specify the minimum and maximum ambient temperature.
4.1	5	Specify provisions for the future maintenance.
4.4	2	Specify accessibility of the pig trap location(s).
5.1	1	Specify the nature of the transported fluid, including details of toxicity and corrosivity.

2. BASIC DESIGN

2.1 BACKGROUND

The boundaries of a pig trap system are defined as:

- *a point on the incoming/outgoing pipeline, on the pipeline side of the main tee but including the main line pig signaller (Figures 1 and 2); and*
- *the pipeline side of the isolation valve of connecting facilities (Figures 1 and 2).*

The main purpose of a pipeline pig trap system is to provide, in a safe manner and without flow interruption, the means to either:

- *insert and launch a pig into a pipeline; or*
- *receive and retrieve a pig from a pipeline.*

The barrel is the section of the pig trap, from the pig trap valve up to and including the end closure, which is required to launch and receive pigs.

It consists of four parts, as follows:

<i>End closure</i>	<i>A quick opening end closure welded to the major barrel allowing the insertion and removal of pigs.</i>
<i>Major barrel</i>	<i>An enlarged section of the barrel used for loading or retrieving pigs.</i>
<i>Reducer</i>	<i>A reducer between major and minor barrel.</i>
<i>Minor barrel</i>	<i>A section of the barrel between the pig trap valve and the reducer.</i>

2.2 GENERAL

1. Components and configuration of typical pig traps are shown in Figures 1 and 2.
2. The minimum required components for any launcher or receiver shall be as shown in Figure 3.

Depending on actual service conditions, this DEP might require additional components not shown in Figure 3.

3. Requirements for temporary pig traps shall be determined on a case-by-case basis by the Principal.
4. If pig launching / receiving operations are anticipated during the hours of darkness, the required illumination level should be 150 lux., measured at the working plane or 1000 mm (39 in) above the floor level in a horizontal plane, unless otherwise specified in national legislation.

2.3 BARREL

1. For pipelines with a nominal diameter smaller than DN 500 (NPS 20), the major barrel's nominal diameter should be 50 mm (2 in) larger than the pipeline's nominal diameter.
 - a. In determining the required oversize, account should also be taken of the actual internal diameter.

This may be particularly relevant if thick wall low-grade pipe is used for the major barrel and the pipeline is thin wall high-grade material.
 - b. Since pipe with a DN 300 (NPS 12) nominal diameter has an outside diameter of 324 mm (12-3/4 in), the major barrel's nominal diameter should be DN 400 (NPS 16) rather than DN 350 mm (NPS 14).
2. For pipelines with a nominal diameter of DN 500 (NPS 20) and larger the major barrel's nominal diameter should be 100 mm (4 in) larger than the pipeline's nominal diameter.

Typical sizes for the major barrel (using standard nominal sizes) are given in Table 1a and Table 1b.

3. For nominal pipe sizes based on inch units, the nominal diameters should be rounded to the nearest mm.
4. The Supplier should be consulted for sphere launchers utilising an automatic retractable flap system or where pigs are loaded into the launcher in a cartridge or cassette to determine if a larger oversize is necessary.
5. The internal diameter of the minor barrel should be the same as that of the main line.
6. Transitions in the internal diameter of the barrel due to wall thickness variations greater than 2.4 mm (0.10 in) shall be tapered to a maximum angle of 14 ° to the pipe axis to allow the smooth passage of a pig.
7. Pig traps shall be designed for the longest pig expected to be used (usually an intelligent pig) plus a margin of 10%.

Dimensions for pig traps designed for intelligent pigs are shown in Table 1a and 1b.

8. The reducer between the major and minor barrel should be eccentric for horizontal traps (with the bottom of the entire barrel at the same level) and concentric for vertical traps.
9. Concentric reducers may be appropriate for horizontal traps when fitted with internal trays (4.4).

For length of reducers, refer to ASME B16.9.

10. For horizontal receivers, the barrel should be sloped down towards the end closure to a maximum of 3 ° to improve draining of liquids from the barrel.
11. Horizontal launchers should be sloped down towards the pipeline to a maximum of 3 °.
12. For bi-directional traps the barrel should be level.

13. The barrel length for intelligent pigs shall be as specified in Table 2a and Table 2b.

The lengths in Table 2a and Table 2b are based on available data for magnetic flux and ultrasonic internal inspection tools and are considered conservative. The largest dimensions pertaining to any particular diameter tool have been plotted against diameter and then the curve has been generalised. The dimensions take into account the position of the pig driving cup(s) as well as the overall length of the pig, and this leads to very long receiver dimensions if the trap is to cater for all possible pigs. These conservative dimensions will be useful for conceptual design but the user should check the lengths of the latest available tools from various relevant Manufacturers when performing detailed design. There are significant variations between tools (particularly between magnetic flux (MFL) and ultrasonic (US) tools). It might be decided to design for only one specific type of tool. It is to be noted that inspection tools (MFL and US) are sometimes combined, resulting in an increased barrel length.

Table 1a Typical nominal diameters of major barrel and pipework

Pipeline [mm]	Bypass line [mm]	Kicker line [mm]	Balance line [mm]	Drain line [mm]	Major barrel [mm]
100	75	50	50	50	150
150	100	50	50	50	200
200	100 to 150	100	50	50	250
250	150	100	50	50	300
300	150 to 200	100	50	50	400
350	150 to 250	100	50	50	400
400	200 to 300	150	100	100	450
450	250 to 300	200	100	100	500
500	250 to 400	200	100	100	600
600	300 to 450	200	100	100	700
700	400 to 500	250	100	100	800
750	400 to 550	250	100	100	900
800	400 to 600	250	100	100	900
900	450 to 650	300	100	100	1000
950	500 to 650	300	100	100	1050
1000	500 to 800	300	100	100	1100
1050	500 to 900	400	100	100	1150
1200	600 to 900	450	100	100	1300
1400	800 to 1000	500	100	100	1500

Table 1b Typical nominal diameters of major barrel and pipework

Pipeline [in]	Bypass line [in]	Kicker line [in]	Balance line [in]	Drain line [in]	Major barrel [in]
4	3	2	2	2	6
6	4	2	2	2	8
8	4 to 6	4	2	2	10
10	6	4	2	2	12
12	6 to 8	4	2	2	16
14	6 to 10	4	2	2	16
16	8 to 12	6	4	4	18
18	10 to 12	8	4	4	20
20	10 to 16	8	4	4	24
24	12 to 18	8	4	4	28
28	16 to 20	10	4	4	32
30	16 to 22	10	4	4	36
32	16 to 24	10	4	4	36
36	18 to 26	12	4	4	40
38	20 to 26	12	4	4	42
40	20 to 32	12	4	4	44
42	20 to 36	16	4	4	46
48	24 to 36	18	4	4	52
56	32 to 40	20	4	4	60

Table 2a Barrel lengths for intelligent pigs

Pipeline diameter [mm]	Approx. maximum tool		Approx. minimum barrel length ^{1,2} [m]			
	length ² [m]	mass ³ [kg]	Launcher		Receiver	
			A _L	B _L	A _R	B _R
100	2.8	60	2.8	0.5	2.8	2.8
150	2.8	90	2.8	1.5	2.8	2.8
200	3.9	170	4.1	1.5	3.9	3.9
250	4.3	300	4.3	1.5	4.3	4.3
300	4.3	365	4.3	1.5	4.3	4.3
350	4.8	380	4.8	1.5	4.8	4.8
400	5.1	700	5.1	1.5	5.1	5.1
450	5.1	810	5.1	1.5	5.1	5.1
500	5.1	840	5.1	1.5	5.1	5.1
600	5.7	1600	5.7	1.5	5.7	5.7
650	5.8	2000	5.8	1.5	5.8	5.8
700	6.0	2000	6.0	1.5	6.0	6.0
750	6.6	2270	6.6	1.5	6.6	6.6
900	6.6	3560	6.6	1.5	5.3	6.6
950	6.6	3600	6.6	1.5	5.5	6.6
1000	6.6	4090	6.6	1.5	5.5	6.6
1050	6.6	4550	6.6	1.5	6.4	6.6
1200	6.6	⁴	6.6	1.5	6.6	6.6
1400	6.6	⁴	6.6	1.5	6.6	6.6
NOTES: 1 See Figure 6 for definition of dimensions A and B. 2 See (2.3 item 13). 3 The mass indicated excludes the mass of lifting/loading trolley or tray. 4 To be checked with Supplier.						