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Guidance on Practice for Pigging, Pig Launchers, and Receivers

GP 43-50

BP GROUP
ENGINEERING TECHNICAL PRACTICES

Foreword

This is the first issue of Engineering Technical Practice (ETP) BP GP 43-50. This Guidance on Practice (GP) is newly created and is not based on heritage documents from the merged BP companies.

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1. Scope

- a. This GP provides guidance on:
 1. Pigging practice.
 2. Pipeline design to accommodate pigging.
 3. Selection and design of pig traps, end closures, and appurtenances.
- b. Guidance on the need for pig traps and the locations within facilities is given in GP 43-20, GP 43-21, and GP 43-22.
- c. The scope of this GP includes:
 1. Onshore, offshore, and subsea pipeline systems.
 2. Horizontal and vertical launcher and receiver pig traps.
 3. Oil, gas, chemical, and LPG service conditions.
 4. All pig types, i.e. utility pigs, intelligent pigs, and spheres.
 5. New and existing facilities.
- d. It is written primarily for the Pipeline Technical Authority (TA) and for design, installation, and operations personnel.

2. Normative references

The following normative documents contain requirements that, through reference in this text, constitute requirements of this technical practice. For dated references, subsequent amendments to, or revisions of, any of these publications do not apply. However, parties to agreements based on this technical practice are encouraged to investigate the possibility of applying the most recent editions of the normative documents indicated below. For undated references, the latest edition of the normative document referred to applies.

BP

GP 06-20	Guidance on Practice for Materials for Sour Service.
GP 43-20	Guidance on Practice for Onshore Pipeline Design.
GP 43-21	Guidance on Practice for Offshore Pipeline Design and Construction.
GP 43-22	Guidance on Practice for Above Ground Pipeline Facilities.
GP 43-35	Guidance on Practice for Valves for Pipelines.
GIS 43-351	Guidance on Industry Standard for ISO 14313 (API 6D) Pipeline Valves (Non-Subsea).
GIS 43-352	Guidance on Industry Standard for EN ISO 14723 Subsea Pipeline Valves.
GP 46-01	Guidance on Practice for Pressure Vessels.
GIS 46-010	Guidance on Industry Standards for New Pressure Vessels.

American Society of Mechanical Engineers (ASME)

ASME BPVC,	Boiler and Pressure Vessel Code (ASME Code)
Sec VIII, Div 1	Section VIII, Division 1, Rules for Construction of Pressure Vessels.
ASME B16.9	Factory-Made Wrought Butt welding Fittings.
ASME B31.3	Process Piping.



American Petroleum Institute (API)

API Spec 6D Specification for Pipeline Valves.

British Standards Institution (BSI)

PD 5500 Specification for unfired fusion welded pressure vessels.

International Standards Organization (ISO)

ISO 13628 Petroleum and natural gas industries — Design and operation of subsea production systems —
Part 1: General requirements and recommendations.
Part 8: Remotely operated vehicle (ROV) interfaces on subsea production systems.

Manufacturers Standardization Society of the Valves and Fittings Industry (MSS)

MSS SP-44 Steel Pipeline Flanges.
MSS SP-75 Specification for High Test, Wrought, Butt Welding Fittings.

3. Symbols and abbreviations

For the purpose of this GP, the following symbols and abbreviations apply:

D	Diameter
DRA	Drag Reducing Agent
GIS	Geographical Information System
ID	Internal diameter
ILI	In-Line Inspection
LEL	Lower Explosive Limit
LPG	Liquid petroleum gas
MFL	Magnetic flux leakage
OD	Outer diameter
TA	Technical Authority
UT	Ultrasonic technique

4. Pigging overview**4.1. Reasons to pig**

- a. Pipelines shall be pigged for:
 1. Commissioning and decommissioning.
 2. Inventory management (sweeping out liquids, batching products, etc.).
 3. Cleaning or wax removal.



4. Corrosion and scale control.
 5. Inspection.
- b. Pipelines should be pigged on a regular basis. The timing for inspection is dependent on the corrosion risk assessment and the effectiveness of detection.

Pig launcher and receiver traps may be removed after commissioning, if not required for normal operations.

Pigging may also be required to perform specialist functions, e.g. isolation for valve maintenance.

4.2. Pig types

4.2.1. Utility

Utility pigs perform gauging of the internal bore, cleaning and debris removal, batch separation of products, and sweeping of liquids from the line.

Pigs can either be uni- or bi-directional.

Utility pigs are of the following types:

- *Foam: moulded from polyurethane foam in various densities with various configurations of solid polyurethane strips and/or abrasive materials permanently bonded to their surface.*
- *Elastomer: moulded from solid elastomer.*
- *Mandrel: a central metal body with various components (cups, discs, wire brushes/scrapper blades, gauging plates) attached.*

Caution shall be applied with very soft foam pigs, which can be easily damaged and caught up on valves and side openings.

Utility pigs may be run as dual module to facilitate negotiation of tight bends or wye configurations. The coupling may be subject to high transient and fatigue loads.

Specialty pigs may be used for wax detection, to remove hard scale with a pin-wheel, magnetic cleaning, internal coating, leak detection, and other functions.

4.2.2. Gel

There are four main types of gel that are used in pipeline applications: batching, or separator gel, debris pickup gel, hydrocarbon gel, and dehydrating gel.

When used with conventional pigs (e.g. constrained between two utility pigs), gelled pigs can improve overall performance while almost eliminating the risk of a stuck pig.

Gel is normally a diesel based highly viscous product but can be made with water and a range of chemicals depending on chemical compatibility requirements. Gel pigs can be susceptible to dilution and gas mixing.

When designing a pig train that incorporates gel pigs, the design shall minimize fluid bypass of the pigs and shall place a conventional pig at the back of the train when displacing with gas.

4.2.3. Sphere

Sphere pigs are normally used to sweep liquids from gas lines. They are normally either made from foam throughout or comprise an elastomer skin inflated with glycol and/or water. See 4.4.1.n for more detailed guidance.



Soluble spheres are sometimes used in crude pipelines, made from a micro crystalline wax and amorphous polyethylene which acts as a paraffin inhibitor. They are broken up by the crude oil and do not require a receiver trap.

4.2.4. Inspection

Simple gauging plate and caliper type pigs are used to detect small and large scale geometric variations in pipeline cross-section, respectively.

An intelligent pig is able to detect the presence of metal loss, cracks, and pipeline features (valves, fittings, etc.) within the pipe wall, normally using either magnetic flux leakage (MFL) or ultrasonic techniques (UT).

Some pigs may require an umbilical or fibre optic cable for detailed inspection close to the facility. These are called tethered pigs.

Specialised pigs are also used to perform leak detection and mapping (GIS).

Eddy current and video based techniques are also available, e.g. for flexibles.

4.2.5. Isolation

Isolation pigs are used to temporarily plug the line and may require tethering back to the launching facility.

The differential pressure that can be resisted depends on the type of pig and some pigs are dual-module.

4.2.6. Dual or multi-diameter

A dual diameter pig functions in two distinct diameters, for example 8" and 10", and is able to negotiate both 8" and 10" pipe.

Negotiating the transition between two pipelines is an important issue and the configuration of the pig with respect to the reducer (i.e. sealing length against reducer length) is critical.

Excessive wear of components in the smaller diameter line section shall be considered.

4.3. Pig selection

4.3.1. General

- a. The selection and type of pig to be used and its optimum configuration for a particular task in a particular pipeline shall be determined based upon several criteria, which include:

1. The purpose (e.g. linefill, batching, cleaning, or inspection).
2. Type of information to be gathered (e.g. from an ILI pig run) and data requirements.
3. The line contents (e.g. gas, oil, or water), with/without contaminants (e.g. wax) that may need to be displaced/removed during conventional pigging operations.
4. Required driving pressure vs. available pressure.
5. Operating velocity range of the pig.

Some pigs are fitted with bypass ports that enable the speed of the pig to be reduced below that of the pipeline fluid velocity. See 5.1.f for more detailed guidance.

6. Maximum temperature and/or fluid pressure permitted.

Due to onboard electronics the maximum temperature for the UT and MFL inspection vehicles is about 60°C (140°F), MFL vehicle may tolerate higher temperatures (~80°C (176°F)) for short periods and can be launched in a batch of cold fluid.



7. Requirements to track or communicate with the pig.

Pigs can be fitted with transponders to enable external tracking of the pig and sensors to detect external electro-magnetic or radioactive systems to improve positional accuracy for inspection pigs and to trigger setting and un-setting of isolation pigs.

b. The following characteristics of the pipeline shall also be considered:

1. The minimum and maximum internal diameter.
 2. The presence of tee's and wye's that may require a longer pig to ensure that the pressure driving force is maintained as the pig traverses the connection.
 3. The distance the pig must travel and the internal condition of the pipe, with regard to the wear on the cups or discs.
 4. Minimum bend radius, bend angles, and position of back-to-back bends.
 5. Pipeline components, e.g. valves, barred or sphere tees.
 6. Elevation profile (e.g. pig acceleration during linefill).
 7. Ability to drive the pig in the reverse direction (e.g. for a bi-directional pig).
- c. Some pigs should be run in combination with other pigs, e.g. cleaning pig ahead of a batch pig.
- d. To determine wax quantities and the number of cleaning runs required.
- e. Before inspection a geometric sizing pig run shall be utilised.

4.3.2. Inspection pigs

The main technologies for detecting pipe wall loss defects and circumferential cracks are:

- *Magnetic Flux Leakage (MFL).*
- *Ultrasonic (UT).*

Factors that affect choice of technology include:

- *Accuracy of result: UT provides a direct measurement whilst MFL readings require processing and interpretation.*
- *Pipeline product: UT generally requires to be run in a liquid to provide an acoustic couplant. This is less convenient for gas and multi-phase lines in which arrangements have to be made to enable the pig to run within a slug of liquid. MFL is unaffected.*
- *Cleanliness of line: UT requires a higher level of pipe wall cleanliness than MFL.*
- *Pig speed: MFL technology may be run at higher speeds compared to UT.*
- *Wall thickness: The magnets of MFL pigs may be unable to fully saturate heavy wall thickness pipes with magnetic flux resulting in incomplete pipe-wall inspection. Heavy wall thickness pipelines can reduce the reflection time of UT signals causing data loss.*

Thick wall, small diameter pipes are most affected because of the small volumetric space which limits the size of the magnets. Thick wall lines may require a separate run to magnetise the pipe wall.

Specialised inspection pigs are required to detect axially orientated cracks or defects.



4.4. Pigging operations**4.4.1. General**

- a. Pigging operations shall require a suitably documented operating and risk assessment to ensure that personnel safety and pipeline integrity/function are not jeopardised.
Factors to consider include purging of H₂S, flammability of sulphide deposits, radioactive scale, operation of trap end closures/ doors, risk of a stuck pig, etc.
- b. If lines have not been recently pigged or there is uncertainty about the condition of the line, e.g. known restriction, the requirements of clause 4.4.3 shall apply.
- c. Flushing and purging may be required to meet requirements of:
 1. Toxicity and contaminants.
 2. Flammability.
 3. Cleaning.
- d. The trap design shall comply with the requirements given in clause 6.
- e. If the trap does not comply with clause 6, for example has a bolted external clamp type of enclosure, the following actions shall be considered:
 1. Replacement of trap or components, e.g. door closure mechanism.
 2. Perform a risk assessment for using the existing trap.
E.g. low pressure liquid lines pose less risk than high pressure gas lines.
 3. Review of the operating procedures to minimise risk to personnel using the existing trap.
Determine whether pressurisation of the pig traps can be achieved safely without having to operate valves in the immediate vicinity of the closure.
 4. To enable valves to be operated at a safe distance from the closure the practicability of modifications to the pressurising system shall be evaluated.
- f. The design of the pig handling facilities shall be addressed as given in clause 6.9.
- g. Spare end closure seal materials and gaskets shall be available at the start of pigging operations.

Pigs may need to run in a sequential and progressive manner to build a picture of the pipeline conditions and minimise the risk to the pipeline operations and the possibility of a stuck pig.

Examples of a pigging sequence are:

- *A foam pig may be run before a gauging pig.*
 - *An additional gauge plate larger than the initial gauge plate can subsequently be run on one of the cleaning pigs to further increase the known bore of the pipeline.*
 - *There could be a requirement for multiple cleaning runs and possible special procedures to achieve a successful inspection. Debris collected, and/or damaged pigs/gauge plates should be evaluated as an on-going process and the pigging programme adjusted to achieve the best results.*
- h. A calliper pig shall be run before an ILI pig (this is a normal requirement).
 - i. Only one pig shall be permitted in the pipeline (or a pipeline section between pig traps) at any time and this pig shall be received and evaluated before running the next pig.



- j. A notable exception would be a pig train of several pigs in the pipeline simultaneously during batching operations or pipeline commissioning. This shall only be permitted after proving the bore is clear and free of any obstruction.

Multiple pigs in the line may be necessary on long lines for inventory control.

These may also be used in drying operations in which pigs are released every few hours to help sweep out liquids.

- k. Multiple pigs shall only be used if there is confidence in the line bore.
- l. If two pigs including a dual module pig are run in the line at the same time, the second pig shall be capable of driving the first pig in the event of seal failure of the first pig.

A cup pig is less likely to become stuck than a bi-directional pig.

- m. Cleaning and brush/scrapper pigs shall be configured to limit the amount of material that can be removed in a single pass to the amount that can be contained in the receiver.

The use of by-pass ports to help clear the build up of material in front of the pig and keep it in suspension are commonly used.. Otherwise there is a risk of blocking the line or preventing entry of the pig into the receiver trap due to the overfilling of the pig trap with solids.

- n. Inflatable spheres shall be:

1. Filled with a water/glycol mix (typically 50:50/60:40) and ring-gauged to ensure that they are of the correct diameter, typically 1 – 3% greater than the ID, according to the manufacturer's recommendations.

Allow sufficient glycol in the mix to avoid hydrate formation, should the sphere rupture. However, use of 100% glycol may deteriorate the sphere material.

2. Inspected to ensure that the filling plugs do not leak and be replaced, if necessary.

Leaking plugs have resulted in safety incidents, see clause 4.5.i.

- o. The pipeline inlet and outlet pressures and flows shall be monitored and recorded throughout the pigging operation.
- p. Transponders shall be fitted to a pig to aid detection and subsequent removal, if there is a risk of it becoming stuck.

This is preferable on early pig runs and when there is a change in pig size.

- q. Due consideration shall be given to the safety and environmental hazards associated with:

1. Handling and disposing of waste from the pipeline found in the receiver pig trap, e.g. radioactive scale, wax, etc.
2. Handling the pig and any associated materials and fluids, e.g. inhibitor slugs.

Some pigging activities require additional liquids handling facilities for:

- *Batch processes, e.g. introduction of methanol, biocide, and inhibitor slugs.*
- *Product separation with buffers (e.g. nitrogen).*
- *Immersion of ultrasonic inspection tools in a water slug to provide an acoustic couplant in gas lines.*

- r. The type and quantity of material shall be recorded in accordance with the Facility Integrity Management System.

- s. Possible contingencies available in the event of a stuck pig include:

1. Increasing the driving pressure, (this shall not exceed the MAOP) and/or reducing the downstream pressure in order to place a higher differential pressure across the pig.

