

PETRONAS TECHNICAL STANDARDS

TECHNICAL SPECIFICATION

PIGS FOR USE IN

OPERATIONAL PIGGING

PTS 30.40.60.32

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This revision of PTS **30.40.60.32 - Pigs for Use in Operational Pigging (October 2011, Revision 1)** has been updated to incorporate PETRONAS Lessons Learnt, Best Practice and new information issued by relevant industry code and standards. All updates in the document are highlighted in *italic* font.

The previous version of this PTS **20.197, 20.198 and 20.199 (October 1994)** will be removed from PTS binder / e-repository from herein onwards.

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PART I INTRODUCTION

1.1 SCOPE

This Specification defines the minimum technical requirements for:

- *PART II Foam Pigs*
- *PART III - Mandrel (steel body) pigs*
- *PART IV - Solid cast polyurethane pigs*

The main characteristic for each tool:

- *PART II – The foam pig is designed to pass through restrictions, but if the restrictions or deposits become too heavy, the foam will break up relatively easily and pass through the pipeline without becoming stuck. These pigs may also be used in swabbing operations for gas pipelines. Foam pigs are often used as chaser pigs for stalled mandrel pigs. Foam pigs cannot be reused, must be discard when worn (throw away item)*
- *PART III – Mandrel pigs are most commonly used pig for operational pigging. The use of mandrel pigs in the pipelines includes to control internal corrosion in pipelines by removing water, sand, scales, iron oxides, wax and other debris, distribution of a film of corrosion inhibitors across the internal pipe wall and batching of different products. Alternatively, these pigs may be used in cleaning and commissioning operations for new pipelines.*
- *PART IV – The use of solid cast pigs in the pipelines is to control internal corrosion in pipelines by removing water, wax and other debris, distribution of a film of corrosion inhibitors across the internal pipe wall, and batching of different products. Solid cast pigs cannot be reused and must be discard when worn (throw away item).*

1.2 DISTRIBUTION, INTENDED USE, REGULATORY CONSIDERATIONS AND DEVIATION

Unless otherwise authorised by PETRONAS, the distribution of this PTS is confined to companies forming part of PETRONAS group and to Contractors nominated by them.

This PTS is intended for use in oil refineries, gas handling installations, chemical plants, oil and gas production facilities, and supply/marketing installations.

If national and/or local regulations exist in which some of the requirements may be more stringent than in this PTS the Contractor/*Manufacturer* shall determine by careful scrutiny which of the requirements are the more stringent and which combination of requirements will be acceptable as regards safety environmental, economic and legal aspects. In all cases the Contractor/*Manufacturer* shall inform the Principal of any deviation from the requirements of this PTS 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 with the object of obtaining agreement to follow this PTS as closely as possible.

Any deviation to the requirements of this PTS shall seek approval / endorsement from the appropriate Technical Authority (TA).

1.3 DEFINITIONS

The following definitions shall apply:

Bi-di pig – *Pigs which can move in two directions through a pipeline.*

Brush Pig - *A pig fitted with brushes that can be spring loaded pads, circular/circumferential or moulded into the fabric of Foam Pigs and/or attached to Mandrel Pig. The usual material is steel, but other materials are available to suit objectives.*

By-pass – *A facility which allows product to flow through the pig body or seals in order to provide a flushing action in front of the pig to keep debris in suspension and reduce the risk of debris build up in front of the pig.*

Company - PETRONAS (also referred to as the Principal) or any duly appointed Party authorized to act for, and on its behalf.

Conical Cup – A pig fitted with driving cups, which *is restricted to moving* in one direction through a pipeline.

Contractor - A Party to a Contract with the Company (Principal) that is responsible for the supply of all or part of any Facility, Product or Service to perform the duties specified by the Company (Principal). The Company (Principal) may undertake all or part of the duties of the Contractor.

Guide disc – *Guide disc has a shore hardness value of 85-90 and is thicker and harder than sealing disc. Guide disc is bi-directional, used to centre the pig in the pipeline and is one of the main components in the removal of debris.*

Magnetic Pig – *A Mandrel pig having magnets mounted on the body.*

Mandrel Pig – *Steel body pigs which are assembled from a number of different component parts generally consisting of a central tubular body connected to various cups, discs, brushes etc., allowing for interchangeable spare parts.*

Manufacturer/Supplier - *is the party which manufactures or supplies equipment and services to perform the duties specified by the Contractor.*

Principal - a Party, or an agent authorised to act for and on its behalf, that generally specifies the technical requirements, initiates the Work and ultimately pays for the execution of that Work. The Principal shall mean Company unless otherwise specified.

Progressive Pigging - *The process of running a series of pigs that are progressively harder or more aggressive in order to remove pipeline deposits in a series of runs, in a gradual manner, or to prove the pipeline is suitable for the passage of more aggressive pigs.*

Scale – *rust and corrosion products adhering to the inner surface of pipeline which decrease ability to transfer heat and increase the pressure drop for flowing fluids.*

Sealing Disc – *forms a seal with the pipe wall and provides the differential pressure to propel the pig in the pipeline.*

Solid Cast Pig - Pigs which have the same general shape and function of mandrel pigs (i.e. bi-di or conical cup pig) but are moulded in one piece, cast from polyurethane material. These pigs may be attached with wire brushes or blades.

Swabbing Pig – *Low density bare foam pigs used to mop up residual liquids following bulk de-watering in order to prepare the pipeline for a drying exercise. May also be used in gas pipelines to reduce condensates.*

Uni directional pig – *Pigs which move in one direction only through a pipeline.*

The words **Shall** and **Will** indicate a requirement.

The word **Should** indicates a recommendation.

The word **May** indicates an option.

1.4 CROSS-REFERENCES

Where cross-references to other parts of this document are made, the referenced section number is shown in brackets thus (-). Other documents referenced in this document are listed under References.

PART II FOAM PIGS FOR USE IN OPERATIONAL PIGGING

2.1 REQUIREMENTS

The *Manufacturer* shall furnish foam pigs that are able to fully comply with this Specification.

The *Manufacturer* shall ensure that the foam pigs to be supplied are able to perform the required service and are fit for use in the pipelines as described by the Company, based on the data as supplied by Company.

The Company shall specify the required functions of the foam pigs to be supplied. The Company shall describe the pipeline in which the pigs are intended to be run. The format for information to be supplied by the Company is shown in *Appendix A*.

2.1.1 Materials

The main body of the foam pig shall be constructed of polyurethane foam that has an open cell (porous) structure. The foam shall have a density of:

- approx. 32 kg/m³ (2 lb/ft³), if specified as low density.
- approx. 80 kg/m³ (5 lb/ft³), if specified as medium density.
- approx. 128 kg/m³ (8 lb/ft³), if specified as high density.

The outer surface of the foam pig *may be bare, or coated with solid polyurethane elastomer either covering 100% of the pig body or in strips in a spiral or criss-cross pattern*, to promote better contact between the pig and the pipe wall. The solid layer should strengthen and contain the pig structure. It should provide adequate abrasion resistance to withstand the specified pipeline travel length without wearing substantially or disbonding from the foam. Unless otherwise specified, the coated foam pigs should be capable of travelling at least 15 km.

2.1.2 General design

Typical uses for a foam pig include:

- *Batching*
- *Swabbing*
- *Water fill and removing*
- *Condensate removal*
- *Light debris removal*

It should be noted that foam pigs can safely pass restrictions that would prevent the passage of a mandrel pig. They should not be used to prove the pipeline for the passage of a mandrel pig.

Foam pigs shall be capable of withstanding a run in a pipeline along the specified length without breaking up or deteriorating substantially from excessive wear, unless encountering a major restriction. *The length of the run will be dependent upon the pipeline product, the condition of the internal surface (roughness), the presence of debris and the pig coating.*

The foam pig shall be capable of breaking up should it encounter a restriction which it cannot be squeezed through. The pig shall be capable of travelling through restrictions of up to 20% of the specified nominal internal diameter. The differential pressure under which the pig breaks up should not be more than 5 barg.

It is important that the foam pig only breaks up due to a major pipeline obstruction and not due to excessive abrasion during its run or at a tee branch. *For this reason, pig catcher should be used for all foam pig runs.*

Foam pigs should safely negotiate a 1D bend.

The foam pigs shall be able to remove a limited amount of soft wax and loose debris from the pipeline. The solid polyurethane elastomer coating *may* contain grooves, which provide a passage for fluid bypass which is adequate to ensure that debris does not accumulate in front of the pig and obstruct its passage.

All foam pigs to be used for pipelines shall be equipped with a polyethylene or polypropylene rope loop through the nose of the pig in order to enhance its retrieval from the pig traps. This rope should run through the inside length of the pig and be *embedded*/secured in the solid polyurethane elastomer forming the base of the pig.

2.1.3 Shape and dimensions

Foam pigs *may* have a bullet or cylindrical shape. The nose of the *bullet* foam pig shall be tapered and its front edges shall be rounded such that the pig will not snag on obstructions or side branches. A rounded nose tip is preferable. The rear end of the foam pig shall have a solid polyurethane elastomer sealed concave base. The recommended foam pig shape is depicted in [Figure 1](#).

All foam pigs shall be slightly oversized in relation to the internal diameter of the pipe, unless otherwise specified. The recommended range of foam pig outer diameters in relation to the nominal pipe diameters is tabulated in [Table 1](#). However, for each specific pig order, the *Manufacturer* shall ensure that the foam pig supplied can be used for the specified pipeline without affecting the integrity of the pig structure. The *Manufacturer* shall also ensure that the pig can perform the required function without the chance of becoming stuck.

Foam pigs shall have a sufficient length such that they do not experience excessive fluid bypass whilst negotiating tee branches or bends. The length of the foam pig body, which is in full contact with the pipe wall, shall be at least 1.5 times the nominal pipeline diameter.

If foam pigs are used for batching, pig profile should be cylindrical and not with conical nose.

2.1.4 Brush h foam pigs

If it is specified that foam pigs are to be supplied as brush pigs, these foam pigs shall be supplied with either wire brush bristles *embedded* in the foam or with silicon carbide chips moulded into the coating. The bristles shall be made of hardened tempered steel. Stainless steel brushes shall not be supplied unless specifically approved by the Company.

Design of the brush pig shall be such that bristles and chips cannot come loose during pigging runs.

The wire brush components shall be attached such that they provide a 360° coverage of the internal pipeline diameter. The wire brushes shall be wear-compensated such that they contact the pipe wall for the entire pipeline travel length.

Typical uses for a wire brush foam pig include:

- *Scraping – surface preparation for internal coatings of new pip*
- *Heavy scraping – but not suitable for hard/ heavy scale.*

2.1.5 Pig locators

There is no requirement for the foam pigs to be able to carry pig tracking or locating devices unless specified by the Company.

2.2 HANDLING, MAINTENANCE AND STORAGE

The *Manufacturer* shall furnish guidelines for cleaning, inspection and storage of the foam pigs. Attention should be given to the limitations of what the foam pig can be exposed to, such as temperatures, humidity, environment, etc.

2.2.1 Pig transport and storage

Horizontal transport and storage shall not be allowed. Polyurethane foam will take a permanent set if subjected to a constant load at one point.

After manufacture, polyurethane foam pigs shall be stored away from direct sunlight, at a temperature of 10 to 16°C, and a relative humidity not exceeding 60%. This shall require an air conditioned environment.

During transport, the *Manufacturer* shall ensure that the foam pigs are not exposed to direct sunlight.

2.2.2 Inspection of pigs

The pigs shall be provided with specification sheet.

A darkening in the coloration of polyurethane can indicate material breakdown. The *Manufacturer* shall give guidelines on this.

The *Manufacturer* shall also give guidelines on a simple check, made by attempting to force a sharp object into the foam material. The *Manufacturer* shall indicate what amount of penetration can be associated with good foam material.

The Company shall make visual inspection according to the datasheet and specification assuring there are no cuts, tears, punctures or other damage which will affect the pig's ability to run in the pipeline.

2.2.3 Pig cleaning

Specification sheet shall indicate if steam cleaning is an acceptable option for cleaning the foam pigs.

Polyurethane components should not be exposed to temperatures above 80°C for long periods of time.

2.3 IDENTIFICATION AND INFORMATION

The density of each foam pig supplied shall be clearly indicated by the *Manufacturer* such that the density of each pig is easily recognisable to personnel conducting the pigging operations.

Manufacturing date shall be stencilled on the back end of the pig.

The *Manufacturer* shall indicate what the normal hardness of *polyurethane coating* of the pig should be.

TABLE 1 RECOMMENDED FOAM PIG OUTER DIAMETERS

Pipeline Nominal Diameter	Outside Diameter of Normal Foam Pig	Outside Diameter of Brush Foam Pig
168.3 mm (6")	165 mm (6.5")	160 mm (6.3")
219.1 mm (8")	215 mm (8.6")	210 mm (8.3")
273.1 mm (10")	270 mm (10.6")	265 mm (10.4")
323.9 mm (12")	320 mm (12.6")	315 mm (12.4")
355.6 mm (14")	350 mm (14.0")	350 mm (13.8")
406.4 mm (16")	400 mm (16.0")	395 mm (15.5")
457 mm (18")	450 mm (18.0")	460 mm (18.1")
508 mm (20")	500 mm (20.0")	510 mm (20.1")
610 mm (24")	600 mm (24.0")	615 mm (24.2")
762 mm (30")	775 mm (30.5")	775 mm (30.5")
813 mm (32")	825 mm (32.5")	825 mm (32.5")
914 mm (36")	925 mm (36.4")	925 mm (36.4")
1016 mm (40")	1020 mm (40.2")	1020 mm (40.2")

Note: These outside diameters are for guidance only. Per pipeline, they should be checked for their suitability.

FIGURE 1 FOAM PIG SHAPE



PART III MANDREL (STEEL BODY) PIGS FOR USE IN OPERATIONAL PIGGING

3.1 MANDREL PIG REQUIREMENTS

The *Manufacturer* shall furnish mandrel (steel body) pigs that are able to fully comply with this specification.

The *Manufacturer* shall ensure that the mandrel pigs to be supplied are fit for use in the pipelines as described by the Company, based on the data as supplied by the Company. The *Manufacturer* shall also confirm that the pigs supplied are the optimum selection for the purpose specified by the Company.

The Company shall specify the purpose of the mandrel pigs to be supplied. The Company shall describe the pipeline in which the pigs are intended to be run. The format for information to be supplied by the Company is shown in *Appendix B*.

This Specification addresses components that are commonly available. If the *Manufacturer* has any products (i.e. different / proprietary design of disc or cup) which offers similar functions as required by the Company, this alternative may be presented and used subject to Company approval.

3.1.1 Type of mandrel pigs

3.1.1.1 Bi-di pigs

Bi-di pigs shall be able to remove dislodged iron oxides, *loosely-adhered* scales, soft wax and loose debris from a pipeline, as well as sweep stagnant liquids out of a pipeline. Pluggable bypass holes *should* be provided through the body *and/or* discs of the pig, *if specified by the Company*. The bypass holes will provide a passage for fluid bypass, which is adequate to ensure that debris does not accumulate in front of the pig and obstruct its passage.

Bi-di pigs shall consist of:

- a metal cylindrical body which is capable of holding various removable sealing and guide discs, *wire brushes, magnets, scraper blades, pig tracking devices and aluminium gauging plate*.
- sealing discs, with two fitted both at the front and back of the pig, *although this is often varied to suit circumstances. The number of seals is variable and will depend upon the space and number of accessories to be mounted on a standard body*.
- guide discs, with one fitted both at the front and back of the pig.

See [Figure 5](#) for a typical arrangement of the bi-di pig. *However, such is the versatility of a mandrel, many variations are possible to suit conditions and pigging objectives.*

The *Manufacturer* shall advise if more discs are required to negotiate the bends in the pipeline (based on the radius advised) or to improve performance.

The guide discs *may* be positioned outboard of the sealing discs, *unless specified by the Company*.

A standard bi-di pig should not be used for the removal of hard or heavy scales as they will be ineffective. Specialised pigs should be used in such cases.

A standard bi-di pig can be fitted with gauging plate and is called gauging pig. Gauging pig is used to prove pipe roundness and to ensure excessive weld penetration or debris does not exist in pipeline, as well as, proving minimum bend radius prior to intelligent pig runs. Gauging plate O.D.'s range anywhere from 90% to 95% of the internal diameter of the pipeline and can also have slots cut into the circumferential perimeter for easier deformation identification. Depending on the size of the pig, the thickness of the gauging plate can be 1/8", 1/4", 3/8" and 1/2" thick. The standard construction material for gauging plates is aluminium, but steel can also be used.

Bi-di pigs are recommended for pre-commissioning work i.e. batching between products, hydrostatic testing; and in operation for chemical batching and removal of loose deposits, debris and relatively soft paraffin.

Gauging pigs are also recommended during pre-commissioning work as well as in operation for the reasons mentioned above.

3.1.1.2 Conical cup pigs

It shall be possible to use conical cup pigs, without the various additions, as batching pigs, which separate fluids in front and at the back of the pig with minimal bypass.

Pluggable bypass holes *should* be provided through the body *and/or* disc of the pig, *if specified by the Company*. The bypass holes will provide a passage for fluid bypass, if required. Bypass holes through the back cups of the pig do not have to be plugged.

The pluggable bypass holes shall be plugged on delivery of the pig.

Conical cup pigs shall consist of:

- a metal cylindrical body capable of holding various removable cups as well as aluminium gauge plate.
- conical cups, with one cup minimum fitted at the front, and one cup minimum at the back of the pig.

See [Figure 6](#) for a typical arrangement of the conical cup pig.

The *Manufacturer* shall advise if more cups are required to negotiate the bends in the pipelines (based on the radius specified), or to reduce wear on the front cup, or to improve performance.

Unidirectional cup pigs can be used for the same functions as bi-directional pigs. There are two types of cups used which are standard and conical. If a unidirectional pig is to be used for batching, standard cups should be used.

Conical cups have advantages in which the most significant is the fact that they will allow approximately 20% reductions in ID to be negotiated. This makes them very useful when combined with a narrow body and gauge plate for assessing dents on a pipeline since standard cup will only negotiate 9 – 11% only.

Typical uses for a conical cup pig include:

- *Batching*
- *Water fill/ removal*
- *Condensate removal*
- *Light debris removal (if used with brush)*

Conical cup pigs are recommended to be used as mentioned above only when the users are sure on conditions of the pipeline i.e. no restriction (dent, ovality, buckle etc.) as well as sufficient pressure and flow from start until the completion of pigging activities to ensure smooth pigging operation.

3.1.1.3 Brush pigs

The brush pigs shall be capable of dislodging iron oxides, *loosely-adhered* scales and loose debris from the pipeline wall.

Brush pigs *should* be either cup pigs or bi-di pigs fitted with a set of spring loaded brushes. *Pigs fitted with circular brushes are just as effective as spring loaded brushes.*

The shape and stiffness of brush bristles plays an important part. Soft densely packed brushes should not be used as they will clog very easily. Bristles should be slightly oversize and have built in spring in order for pits and grooves can be cleaned.