

PETRONAS TECHNICAL STANDARDS

DESIGN AND ENGINEERING PRACTICE

TECHNICAL SPECIFICATION

DESIGN OF PIPELINE PIG TRAP SYSTEMS

PTS 31.40.10.13

NOVEMBER 2010



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PTS Updates/Review

This revision of **PTS 31.40.10.13 - Design of Pipeline Pig Trap Systems (November 2010, 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 31.40.10.13 - Design of Pipeline Pig Trap Systems (December 1998)** and **PTS 20.200 - Design of Pipeline Pig Trap Systems (September 1994)** and **PTS 20.145 – Pipeline Launching and Receiving Facilities (February 1992)** will be removed from PTS binder / e-repository from herein onwards.

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PREFACE

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The information set forth in these publications is provided to users for their consideration and decision to implement. This is of particular importance where PTS may not cover every requirement or diversity of condition at each locality. The system of PTS is expected to be sufficiently flexible to allow individual operating units to adapt the information set forth in PTS to their own environment and requirements.

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1. INTRODUCTION

1.1 SCOPE

This PTS specifies requirements and gives recommendations for the design of pig trap systems for onshore and offshore pipelines having a diameter of 100 mm to 1400 mm. 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* covered by this PTS:

- criteria for deciding whether pig traps are required;
- applicability of the requirements and recommendations in this PTS to temporary pig traps;
- subsea pig launchers and receivers;
- Pig valves (i.e. valves where pigs can be loaded into the side of the valve).

NOTE: 1. The applicability of this PTS to temporary pig traps shall be determined on a case-by-case basis by the Principal.

2. Although this PTS excludes specific requirements for subsea pig traps, many aspects will still be relevant for such applications.

This PTS 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 PTS is a revision of the PTS of the same number dated December 1998.

1.2 DISTRIBUTION, INTENDED USE AND REGULATORY CONSIDERATIONS

Unless otherwise authorised by PETRONAS, the distribution of this PTS is confined to companies forming part of the PETRONAS Group or managed by a Group company.

This PTS is intended for use in oil refineries, chemical plants, gas plants, onshore and offshore oil and gas production facilities, loading and unloading terminals, LNG Export and Import Terminals, 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 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 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.

1.3 DEFINITIONS

1.3.1 General definitions

The **Contractor** is the party that carries out all or part of the design, engineering, procurement, installation, and commissioning or management of a project or operation of a facility. The Principal may sometimes 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 its design and construction. The Principal will generally specify the technical requirements. The Principal may also include an agent or consultant authorised to act for and on behalf of the Principal.

The word **shall** indicate a requirement.

The word **should** indicate a recommendation.

1.3.2 Specific definitions

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 side branch 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).
cold bend	bend made from linepipe at ambient temperature, normally on the construction site, by 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.
main line	major portion of a pipeline, between pig traps (see Figure 1).
major barrel	enlarged pipe section of a pig trap used for loading or retrieval of pigs (see Figures 1 and 2).
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	device which can be propelled through a pipeline by fluid flow and is normally used for various internal activities such as separating fluids, cleaning and inspecting the pipeline. (A sphere is a spherically shaped pig).
pig launcher /scraper launcher	pig trap for launching pigs.
pig receiver /scraper receiver	pig trap for receiving pigs.
pig signaller	device set onto or into a pipe, which gives an indication of the passage of a pig.
pig trap / scraper trap	ancillary item of pipeline equipment, comprising of <i>major/minor</i> barrel, end closure and instruments, for introducing a pig into a pipeline or removing a pig from a pipeline.
Pig trap/ scraper trap system	pig trap together with all associated piping, valves, supports and instruments.
pig valve	<i>valves where pigs (foam and sphere type) can be loaded into the side of the valve</i>
piping	pipework associated with the pipeline but not part of the main line.
piping classes	standardised piping assemblies contained in PTS 31.38.01.12. and PTS 31.38.01.15.
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) PTS 31.40.10.93. and PTS 31.40.21.94., to be used by the Principal and completed by the 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, <i>foam or poly pig</i> into the side branch with a minimum pressure drop.
tight shut-off valve	Valve with leakage rate not exceeding ISO 5208 Rate A (no visually detectable leakage for the duration of the test).
catch pit or tray (or drip pan, door pit)	draining facility underneath an end closure door.
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.

1.4 ABBREVIATIONS

ESD	Emergency Shutdown
HIC	Hydrogen Induced Cracking
ID	Inside Diameter
MESC	Materials and Equipment Standards and Code

1.5 ACTION ITEMS

Items requiring a selection or decision to be made by the Principal are identified by the use of a bullet (•) in the margin. The required selection shall be indicated on the requisition.

1.6 CROSS-REFERENCES

Where cross-references to other parts of this PTS are made, the referenced section number is shown in brackets. Other documents referenced in this PTS are listed in (6).

2. TECHNICAL SPECIFICATION

2.1 GENERAL

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);
- 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 sections below describe each pig trap component, in order to give a clear understanding of its purpose, and give detailed minimum requirements. Components and configuration of typical pig traps are shown in Figures 1 and 2 and the minimum required components for any launcher or receiver are shown in Figure 3. The requirements for additional components not shown in Figure 3 shall be determined in accordance with this PTS, depending on actual service conditions.

2.2 BARREL

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 shall consist of four parts, as follows:

End closure	A quick opening closure welded (or in some cases flanged) to the major barrel allowing the insertion and removal of pigs.
Major barrel	An enlarged section of the barrel used for loading or retrieving pigs.
Reducer	A reducer between major and minor barrel.
Minor barrel	A section of the barrel between the pig trap valve and the reducer.

For pipelines with a nominal diameter smaller than 500 mm, the major barrel's nominal diameter should be 50 mm larger than the pipeline's nominal diameter (except as stated in Note 1 below). For pipelines with a nominal diameter of 500 mm and larger the major barrel's nominal diameter should be 100 mm larger than the pipeline's nominal diameter. Typical sizes for the major barrel (using standard nominal sizes) are given in Table 1.

NOTES:

1. Since pipe with a 300 mm nominal diameter has an outside diameter of 324 mm, the major barrel's nominal diameter should be 400 mm rather than 350 mm.
2. 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
3. For nominal pipe sizes based on inch units, the nominal diameters should be rounded to the nearest mm.

Table 1 Typical nominal diameter of major barrel and pipework

Pipeline mm	Bypass line mm	Kicker line mm	Balance line mm	Drain line mm	Major barrel ¹ 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

¹ For sphere launchers utilising an automatic retractable flap system, or where pigs are loaded into the launcher in a cartridge or cassette, a larger oversize may be required. Where such systems are used, the Supplier should be consulted.

The internal diameter of the minor barrel should be the same as that of the main line. However, transitions in the internal diameter due to wall thickness variations greater than 2.4 mm shall be tapered to a maximum angle of 14 ° to the pipe axis to allow the smooth passage of a pig.

Pig traps shall be designed for the longest pig that will be used (usually an intelligent pig);

- Major barrel for launcher shall accommodate the full length of the pig plus a margin of 10%
- Minor barrel for receiver shall accommodate the full length of the pig plus a margin of 10%

Dimensions for pig traps designed for intelligent pigs are shown in Table 3 (limited to common standard pipe sizes).

Where it is not feasible within the existing facilities to install the full barrel length to accommodate an intelligent pig, a pair of weld neck flanges shall be installed near the end closure to facilitate the installation of a temporary extension spoolpiece that can accommodate the launching or receiving of an intelligent pig and to facilitate efficient maintenance of the end - closure. Typical weld and neck flanges connection for end closures are given in Figure 12.

The design shall consider at least but not limited to the followings:

- Satisfy the operational safety requirement i.e. leak test
- Eliminate hot works during insertion of spool piece
- Modification on piping assembly for the kicker and equalizing line

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. Concentric reducers may be appropriate for horizontal traps when fitted with internal trays (4.4).

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

Where automatic sphere *pig* is intended, the major barrel length for launching and receiving should be based on the number of spheres to be handled. (The spheres can be loaded into the barrel in a cassette). To allow spheres to roll forward for launching, the launcher barrel should be inclined at least 10 ° to the horizontal for lines up to and including 300 mm and 5 ° for 350 mm and above. The receiver barrel should also be inclined at least 10° to the horizontal up to 300 mm and 5 ° for 350 mm and above to allow the spheres to roll away from the minor barrel/reducer.

Automatic pigging may be considered from not normally manned (NNM) locations; the basic pig launcher specifications in this PTS for vertical pig launchers, combined with the pin or flapper arrangement of sphere launchers, *are generally applicable in this case*.

2.3 PIPEWORK

2.3.1 Bypass line

A bypass line is required to connect the pipeline with related upstream or downstream facilities such as a booster station, tank farm, etc. Typical sizes for the bypass line are given in Table 1, depending on the fluid velocities for continuous service (3.6), *however there may be circumstances where the size of the bypass line is maintained at the same diameter as the mainline*.

2.3.2 Kicker line (or bridle line)

A kicker line is required to connect the major barrel with the bypass line to enable diversion of the fluid through the barrel to launch or receive a pig. For a launcher, *other than an automatic launcher*, the kicker line shall be connected to the major barrel as close as possible to the end closure (*or on the pipeline side of the pair of flanges, if installed*) and for a receiver as close as possible to the reducer. (For bi-directional pig traps a single kicker line could be located approximately half way along the major barrel, or twin kicker lines could be provided). Typical sizes for the kicker line are given in Table 1, depending on fluid velocities for intermittent service (3.6).

Normally the kicker line will connect into the side of the major barrel, but where significant pigging debris is anticipated, consideration should be given to locating the receiver kicker line connection on the top of the major barrel to reduce the quantity of pigging debris being carried into the kicker line and process facilities.

For automatic launchers, the kicker line should be positioned between the first and second pigs, so that it launches only the first pig.

NOTE: *A flanged connection in the kicker line on the barrel side of the kicker valve could facilitate commissioning and/or decommissioning and provide additional operational flexibility or kicker line flushing capability.*

2.3.3 Balance line

A balance line shall be provided on launchers to enable filling and pressurising of the barrel on both sides of the pig at the same time. This is to prevent a pig that is ready to be launched from moving either forwards (and thereby hitting and possibly damaging the pig trap valve) or backwards (and losing the seal in the reducer). To ensure this, the balance line, branching off from the kicker line, shall be connected to the minor barrel as close as possible to the pig trap valve. A balance line shall also be provided on receivers to prevent any possible pressure differential across a received pig.

The *nominal* diameter of the balance line should be 50 mm for pipelines having a nominal diameter of less than 350 mm, and 100 mm for larger size pipelines, as shown in Table 1.

2.3.4 Pressurising lines

A smaller diameter pressurising line may be required around kicker valves for several possible reasons: for speed of operation, for control of pig launching and receiving, for control of barrel pressurisation and/or to avoid damage to the kicker valve seats or other internals. The pressurising line should be at least 50 mm nominal diameter. Similarly a pressurising line around bypass valves should be considered, for equalising possible high differential pressures.

Where a pressure balance line by-passes an ESD valve, it shall be fitted with two valves, one an ESD valve or a key control valve which shall be operated either fully open or fully closed, and the other for graduated flow control.

2.3.5 Thermal relief line

A thermal relief line *is only required when a thermal relief valve is installed (2.5.13).*

2.3.6 Drain line

Drain points shall be provided on both launchers and receivers near the end closure and near the pig trap valve to drain any liquid accumulated in the barrel. For vertical launchers a single drain point shall be provided near to the pig trap valve. Drain points shall be provided with a 50 mm branch connection incorporating a 25 mm tell-tale valve to provide a means of checking that all liquid is drained before *the end closure is opened*.

NOTE: For pig receivers which are sloped for the use of spheres (2.2), the two drain points may be located together near the end closure but separated by half a sphere diameter so that the drains cannot be blocked by the spheres.

The *nominal* diameter of the drain line shall be at least 50 mm for pipelines having a nominal diameter of less than 350 mm, and at least 100 mm for larger size pipelines, as shown in Table 1, to minimise the chance of blockage. The barrel drain lines shall be sloped (at least 1:300) towards a closed drain system or a designated open drain. *For propane, butane and condensate, drain line shall be connected to burnt pit /flare line or pressurized storage tank.*

NOTE: Refer to EP-95000 for requirements relating to drain systems, particularly with respect to the possibility of overpressurisation.

2.3.7 Vent/flare/blowdown lines

A vent line shall be provided *on the top* near the end closure to vent/purge the barrel and near the pig trap valve for horizontal traps to ensure depressurisation behind a pig *in case it is stuck in the minor barrel*. *The vent line shall be tied to the facilities vent system*. The diameter of the vent line(s) shall be at least 50 mm. For high-pressure gas systems, consideration should be given to the provision of a blowdown line, incorporating a *plug* or globe valve or restriction orifice, for controlled depressurisation. The vent/flare/blowdown system shall conform to the requirements of PTS 80.45.10.10

NOTE: Pig traps can contain air or air/hydrocarbon mixtures which should be taken into account when they are connected to flare systems.

2.4 BRANCH CONNECTIONS

2.4.1 General

The configuration of the branch connections between the various lines and ancillary items should be as shown in Table 2, based on the typical pipe diameters listed in Table 1. *Welded branch connections shall comply with the requirements of PTS 31.40.00.20 Pipeline and Riser Engineering.*

The *nominal* diameter of all branch connections shall be at least 50 mm.

NOTE: Smaller diameter valves (*but not less than 25 mm*) may be used for items such as pressure gauges and thermal relief valves, but in such cases the length of the connection/reducer/valve assembly shall be minimised.

Table 2 Branch connection configurations

Branch connection location	Nominal diameter mm	Configurations
Bypass line on main line	75 on 100	Tee
	All larger sizes	Barred tee or sphere (<i>radial flow</i>) tee
Kicker line on major barrel	50 on 100/150	Weldolet
	All larger sizes	Welded branch connection ¹
Balance line on minor barrel Drain <i>line</i> on minor and major barrel	50 on 100	Tee
Balance line on kicker line	50 to 100 on 150 and <i>larger</i>	Welded branch connection ¹
Kicker line on bypass line	All sizes	Tee
Pressuring line to kicker line	50 and larger	Welded branch connection ¹
Small items (e.g. vents and gauges)	50	Weldolet
<i>The distance between branch connections should be checked to ensure that it does not coincide with pig cup/disc separation as this could halt the pigs. Connections should not be located less than one half the branch diameter (nominal) to the nearest girth weld or other branch connection; refer to the applicable design codes for additional information on the requirements for branch spacing.</i> ¹ Welded branch connections include <i>barred tees</i>, <i>sphere (radial flow) tees</i>, extruded outlets/sweepolets and weldolets as well as fabricated items. In all cases they shall comply with PTS 31.40.00.20.		

Table 3 Barrel lengths for intelligent pigs

Pipeline diameter <i>mm</i>	Approx. maximum tool length ² <i>m</i>	Approx. maximum tool mass ³ <i>kg</i>	Approx. minimum barrel length ^{1,2} <i>m</i>			
			Launcher		Receiver	
			<i>A_L</i>	<i>B_L</i>	<i>A_R</i>	<i>B_R</i>
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
¹ See Figure 6 for definition of dimensions A and B.						
² These lengths are <i>based on available data</i> for magnetic flux and ultrasonic <i>internal inspection tools</i> and are considered very 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. <i>These conservative</i> 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 since there are significant variations between tools (particularly between magnetic flux and ultrasonic tools). Thus it may be decided to design for only one type of tool, or the use of temporary extension pieces (2.2) for the major barrel could be considered.						
³ The mass indicated excludes the mass of lifting/loading trolley or tray.						
⁴ To be checked with Supplier.						

Barred tees or sphere (radial flow) tees shall be installed on all branches larger than 50 % of the pipeline diameter or 25 % of the pipeline diameter *where unwrapped foam pigs or spheres are to be used*. Figure 4 shows a suggested design for barred reducing tees. *For offshore pipelines or other pipelines that handle multiple size scrapers, disc pigs, spheres or poly pigs, the use of sphere (radial flow) tees should be considered.*

Spheres, soft foam and poly pigs could be obstructed or destroyed at a normal or barred tee and sphere (radial flow) tees should be fitted if such pigs are to be used.

- Sphere (radial flow) tees shall only be installed where it is intended to use spheres, foam, or poly pigs, as indicated by the Principal, since they are more difficult to fabricate and may lead to corrosion problems. (If corrosive conditions are possible, consideration should be given to providing a drain connection on the sphere tee.)

If foam, poly pigs or spheres are to be used, a catching basket should be used in the major barrel of receivers to prevent loss of foam pigs or sphere into the kicker line, alternatively the use of sphere (radial flow) tees should be considered.

2.4.2 Orientation

On horizontal pig traps, connections shall be orientated as follows:

- Drains - bottom of pipe;
- Vents, pressure gauges, blowdown, purge, thermal relief, pig signaller - top quadrant of pipe;
- Kicker line, balance line, bypass line - side (or possibly top) of pipe.

NOTE: The top-of-pipe position should be used for sphere receivers to prevent a sphere from being drawn into the outlet.

2.4.3 Pressure indicator connections

Pressure indicator connections shall be installed at the following locations:

- on the major barrel near the end closure (see 2.12);
- on the minor barrel near the pig trap valve;
- on the bypass line on the pipeline side of the bypass valve.

The diameter of pressure indicator connections shall be 50 mm, although the isolation valves may be of reduced diameter.

2.4.4 Purge connection

A flanged/quick connector with a combination of isolation valve and check valve shall be provided for toxic or hydrocarbon system. It should be located near to the pig trap valve to allow the full length of the barrel to be purged and/or flushed before the end closure is opened for HSE requirement (safe toxic level and low explosive limits). For horizontal pig traps the adjacent vent valve should remain closed during purging.

Purge connection can also be used for flushing the barrel or for temporary injection point for inhibitor.

2.4.5 Chemical injection connection

- (•) When chemical injection is required, as specified by the Principal, a flanged connection or proprietary fitting with an isolation valve shall be provided. The connection should be located on the bypass line between the isolation valve and the kicker line tee.

2.4.6 Thermowell connection

If a temperature measuring point is required it should consist of a standard thermowell arrangement in accordance with the Piping Classes (PTS 31.38.01.12 or PTS 31.38.01.15, as applicable) located in the bypass line on the facility side of the bypass valve.

2.5 VALVES

2.5.1 General

In line with PTS 31.40.00.20, a double block and bleed system should be installed at the location of the pig trap valve, the kicker line valve, the pressurizing valve (if fitted) and drain/vent valves in the following situations:

- Toxic fluids, any pressure class
- Category C fluids, and non-toxic category B and D fluids, ANSI class 600 and above

This shall consist of two ball, or gate valves with a 50 mm bleed connection between the two valves.

- Note: Double block and bleed valves complying to API 6D within a single valve body could offer advantages, especially where space is limited and the transporting fluids is clean processed hydrocarbon, however the necessity shall be decided by the Principal.