CERTIFICATION OF APPROVAL

Intelligent Pig Launcher

by

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BACHELOR OF ENGINEERING (Hons)
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Approved by,

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Main Supervisor

UNIVERSITI TEKNOLOGI PETRONAS
TRONOH, PERAK
Jun 2004

CERTIFICATION OF ORIGINALITY

This is to certify that I am responsible for the work submitted in this project, that the original work is my own except as specified in the references and acknowledgements, and that the original work contained herein have not been undertaken or done by unspecified sources or persons.

(SAIFUL ZAREEK BIN YAHAYA)

ABSTRACT

The project selected for Final Year Project is Intelligent Pig Launcher. The selection of this project is based on the pigging operation underwent during industrial internship. Pig is an acronym for Pipeline Inspection Gauge. One of the most common type of pig is the corrosion detection pig (CDP), or more commonly known as intelligent pig. Intelligent pig is an advanced type of pig which is used to locate metal loss, dents and cracks. The metal loss is located by using magnetic flux field. The data is recorded in a standalone memory.

Currently in pipelines industry insertion and receiving of pigs are both time consuming and inefficient. The intelligent pig launcher is designed to overcome this problem. The launcher is intrinsically safe to be used in oil and gas industry. It is also expected to reduce the cost of operation. To design this, the specifications of the intelligent pig were studied in detail. The existing method of launching and receiving was also investigated. Then, the design was drafted using engineering graphic software.

The objective of this to project is to design a device that can assist in inserting intelligent pig that requires less number of manpower and time during insertion activities. The feasibility of the project is also discussed in this report, which includes the estimated cost to accomplish and the time frame allocated. Also, the equipments required are explained.

ACKNOWLEDGEMENT

In the name of Allah, it has been two semesters of beneficial experience conducting the project. However, the study would not be possible without the overwhelming guidance and assistance from many parties.

First of all, I would like to express my utmost gratitude to my supervisor, Puan Norrulhuda Mohd Taib, for her assistance and guidance has helped me through thick and thin throughout the period of the work. Without her assistance, it would be impossible to complete this project in the specified time frame.

Next I would like to convey my appreciation to En Azlan Abdul Rashid, Superintendent of Operations Department in PS Pipeline Sdn Bhd for his guidance. His willingness to cooperate brought a better prospect towards the conclusion of this project.

Also thank you to all FYP committee, chairman, and coordinators especially Mr. Saravanan, to whom I owed the smoothness of the final year project for both semesters.

Thank you to my beloved parents for their moral and material support. Also, thanks to my friends for helping me for the sake of the project. Last but not least, I would like to thank everyone who has contributed to this project in one way or another but have been inadvertently not mentioned.

Thank you very much.

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CHAPTER 1

INTRODUCTION

1.1 Background

Pig is the general term for pipeline inspection gauge. Pigs are devices that are inserted into a pipeline and travel throughout the length driven by a product flow. One of the many types of pig is a Corrosion Detection Pig (CDP), or more commonly known as an intelligent pig. An intelligent pig is an advanced type of pig as it can locate metal loss, dents and cracks. To record these anomalies, the pig is equipped with a standalone memory.

This project is conducted to enhance the operations of intelligent pigging. This project is inspired from the industrial training which the author has undergone in the host company, PS Pipeline Sdn. Bhd (*refer section 2.2*). The company has also agreed to become the collaborator of this project.

1.2 Problem Statement

Currently in local pipeline industry, the launching and receiving of intelligent pigs are time consuming and both human and mechanically inefficient. The reason to this problem is the magnetic field that is generated between the magnetic fins of the pig and the pipeline wall. This is called cogging force. A great amount of force has to be exerted to overcome this magnetic field.

The method currently used in the Malaysian pipeline industry to insert and remove the pig is only by human force with the aid of chain blocks. Up to four men have to handle the operation, and this operation lasts up to four hours.

No machine has been developed so far to assist the operation. This is because machines to be used in pipeline terminals have to be spark-proof. A common battery can be spark-inducing.

1.3 Objectives

The objective of this project is to design a device with the following characteristics:

a) Capable to assist in inserting intelligent pig
b) Requires small amount of manpower and time during insertion and removal
c) Its operation must be economically attractive
d) Its operation must be intrinsically safe for use in the oil and gas industry

At first, the objective is to design a device that is also capable of assisting in receiving the pig. However, due to time constraint, the project now is narrowed to pig insertion only.

1.4 Scope Of Study

After several consultation, the scope of the study is now narrowed as a case study for the internship host company (*refer section 2.3*) only. The scope of this project can be divided into literature review, draft designing and modeling and verification.

1.4.1 Literature review

This stage is basically desk study. This involves a thorough study of the intelligent pig characteristics and the research of the existing method of launching the intelligent pig.

1.4.2 Draft designing

The designing of the intelligent pig launcher and receiver will start right after the basic requirements are understood. From the many designs, the best will be chosen

1.4.3 Simulation

After choosing the best design, the simulation will be generated. The initial plan to construct a working model is now cancelled as the expenses are unfeasible.

This is the most critical part of the project. There are three sections to be simulated. They are:

i. the intelligent pig
ii. the pig traps (launching)
iii. the launcher

Thus, it is essential to obtain all the necessary information of the intelligent pig and the pig traps used.

CHAPTER 2

LITERATURE REVIEW AND THEORY

CHAPTER 2

LITERATURE REVIEW AND THEORY

2.1 Introduction to Pipeline Pigs

Pig is the common word for Pipeline Inspection Gauge. Pigs are devices that are inserted into a pipeline and travel throughout the length driven by a product flow. They were originally developed to remove residue, which could obstruct product flow through a pipeline. Pigging can be categorized as a Non-Destructive Test (NDT). There are basically three reasons for pigging:

- To displace contaminants (debris, water, etc);
- For internal inspection (oxidation, corrosion, etc);
- To batch or separate dissimilar products.

However, certain pigs may have additional features that can accommodate the different needs of pipelines.

There are many types of pigs used in the industry to date. Basically, pigs can be categorized into three, which are as follow:

a) Utility pigs (also known as maintenance pig)
b) Inline Inspection Pigs
   i. Caliper pig (also known as Electronic Geometry Pig, EGP)
   ii. Intelligent pig (also known as Corrosion Detection Pig, CDP)
c) Gel pigs

Appendix I describes in detail about the characteristics of the common types of pigs use.

This project is specific on intelligent pigs. There are various types of intelligent pig, thus the scope is narrowed down to a case study on the type used by host company (*refer section 2.3*) only.

2.1.1. Intelligent Pig

Intelligent pig, or also known as Corrosion Detection Pig (CDP), is employed to locate metal loss on pipeline wall due to corrosion or oxidization, dents, cavity and cracks. For this purpose, it applies Magnetic Flux Leakage (MFL). The magnetic flux is attained from the magnet fins attached to the body of the pig. Any irregularities from the flux are recorded in a standalone memory. Upon removal, the data is played back and analyzed.

In many cases including this project, the intelligent pig is much longer than a normal pig, requiring the pig traps to be extended (*refer section 2.1.3*). *Appendix II* describes the full specification of the intelligent pig under study.

2.1.2. Predicament

The problem rises during insertion of the pig into the pig launching hatch. From the magnets fins attached on the high resolution sensor (both primary and secondary), exists powerful magnetic field. A large amount of force must be exerted to overcome this magnetic field. To insert an intelligent pig, up to four men are required with the aid of chain blocks, and almost four hours will be spent. The same problems are faced during the removal of the pig from the pig receiving hatch.

2.1.3. Pig Trap

A pig trap is the area of a pipeline where pigs are inserted or removed from the pipeline. Pig traps are designed for integrity of the pipe operator. With traps installed, product pumping operations does not have to be stopped during the insertion or removal of pigs.

Generally, the pig trap is used without having to make any modification. However, for the case of an intelligent pig, the traps have to be extended to contemplate its extra length. *Appendix III* describes the required specifications of the pig traps.

2.2 Magnetomotive Force

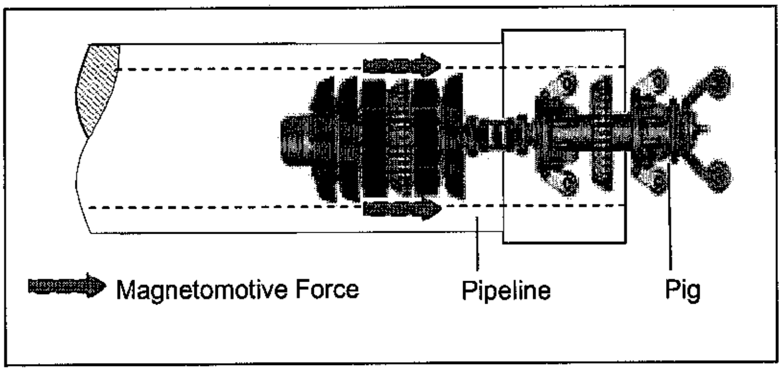


Figure 2.1: Magnetomotive Force

The primary sensor of the pig is made of mainly magnets. On the illustration above, the force that acts form the magnet repels the pipeline wall in all direction. This in turn cancels all force since the resulting force is zero. However, due to this condition, there exists another force that retards the forward motion of the pig, called magnetomotive force as per *Figure 1*

Magnetomotive force is defined mathematically as follow:

$$Magnetomotive\ Force = SAB$$

Where; $S = Reluctance$

$$= \frac{I}{\mu_r \mu_o A}$$

$A = Area$

$B = Magnetic\ Flux\ Density$

$\mu_r = Relative\ Permeability$

$\mu_o = Permeability\ of\ Free\ Space$

$I = Current$

Assuming standard ambient temperature and pressure,
Permeability of steel, μ_r=5000
Permeability of free space, $\mu_0 = 4\pi \times 10^{-7}$

2.3 The Pig Launcher

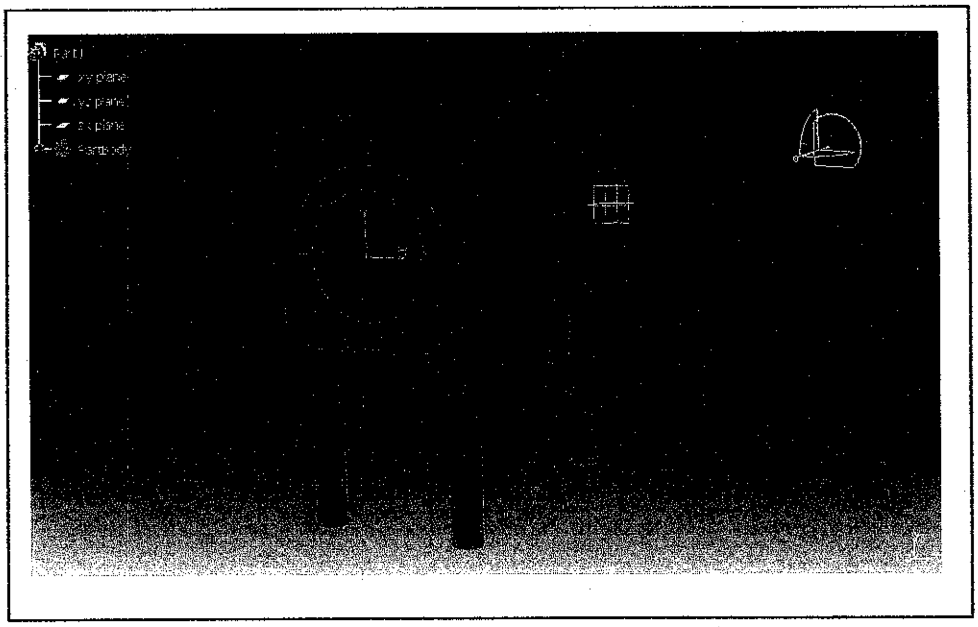


Figure 2.2: The Pig Barrel

Figure 2.3: The Pneumatic Body

The pig launcher is consisted of two major parts; the pig barrel, as per *Figure 2*, and the pneumatic body, as per *Figure 3*. The reason of designing the launcher into two parts is for mobility.

2.3.1 Specification

The specifications of the pig launcher are as follow:

a) General

Mass: 285 kg (approximate)

Length: 4.5 m (2.25m + 2.25m)

Height: 54.8 m

Material: Stainless steel 304 (E_{st} = 200 Gpa)

Pneumatic Driven

Compliant to PETRONAS Technical Standard (PTS) for Design of Pipeline Pig Trap Systems (*appendix IV*)

Both parts are made as hollow as possible to minimize material consumption and mass.

b) Pig Barrel

Mass: 158 kg

Length: 2.25m

c) Pneumatic Body

Mass: 127 kg

Length: 2.25m

2.3.2 Circuit

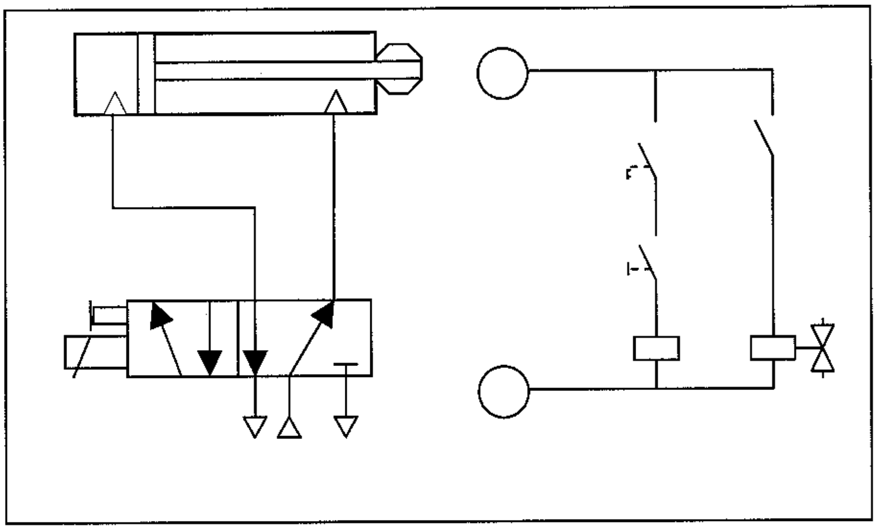


Figure 2.4: Double acting double switch electropneumatic circuit

Figure 4 shows a double acting double switch electropneumatic circuit. As the name suggests, the circuit consists of two switches. Analogous to an AND logic circuit, it will switch on when both swithces are activated.

There are a few reasons why a pneumatic system is preferred to hydraulic. They are:

a) Working Environment

Using a pneumatic system is more suitable in an oil and gas environment compared to hydraulic. A pneumatic system does not have the risk of liquid leakage since it is operating using regulated air.

b) Cost

In general, the cost for developing and maintaining a pneumatic system is lower than a hydraulic system. One factor that contributes to this is the fluid being used is abundant, which is air.

c) Simpler design

A pneumatic system does not require a return piping for fluid, compared to hydraulics system.

d) Wider range of temperature

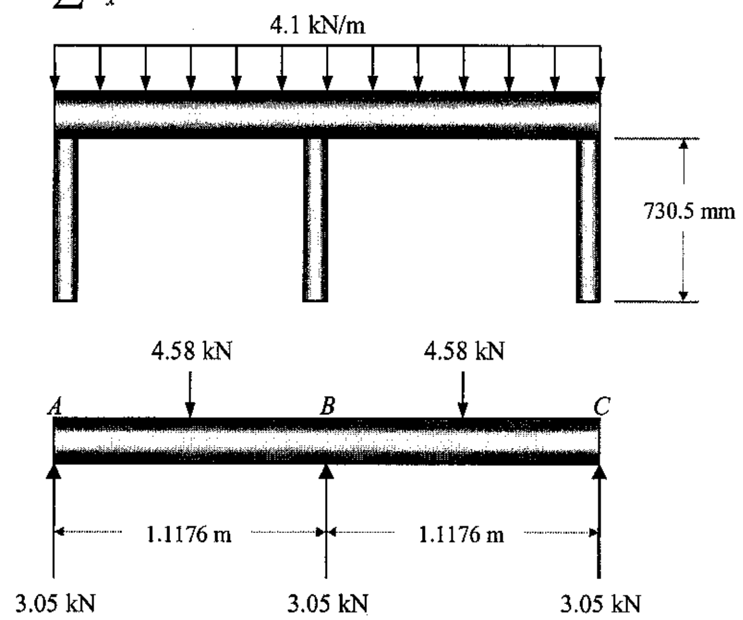
A pneumatic system can resist wider range of temperature, which is 0°C to 200°C.

2.3.3 Sustainability

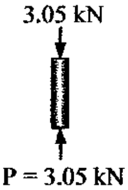
Since the pig is 316kg, one of the most important factors is whether the pig barrel can sustain the weight of the intelligent pig. The stress distribution is calculated first, and the result is verified from finite element analysis using CATIA.

Assuming equal weight distribution,

$$+\uparrow \sum F_x = 0$$



Known Modulus of Elasticity for Steel, E_{st} = 200 GPa,



$$\delta = \frac{PL}{AE_{st}}$$
$$= \frac{[3.05(10^3)](0.7305\ m)}{\pi(0.057)^2[200(10^9)\ N/m^2]}$$
$$= 0.001\ mm \downarrow$$

By percentage,

$$\delta_r = \frac{0.001(10^{-3})m}{0.7305m} \times 100\%$$
$$= \underline{\underline{0.00014\%}}$$

We can see that the deflection of the pig barrel is only 0.01mm, which is 0.00014%. The ability of the pig barrel to sustain the weight is verified in the *Figure 5* and *Figure 6.*

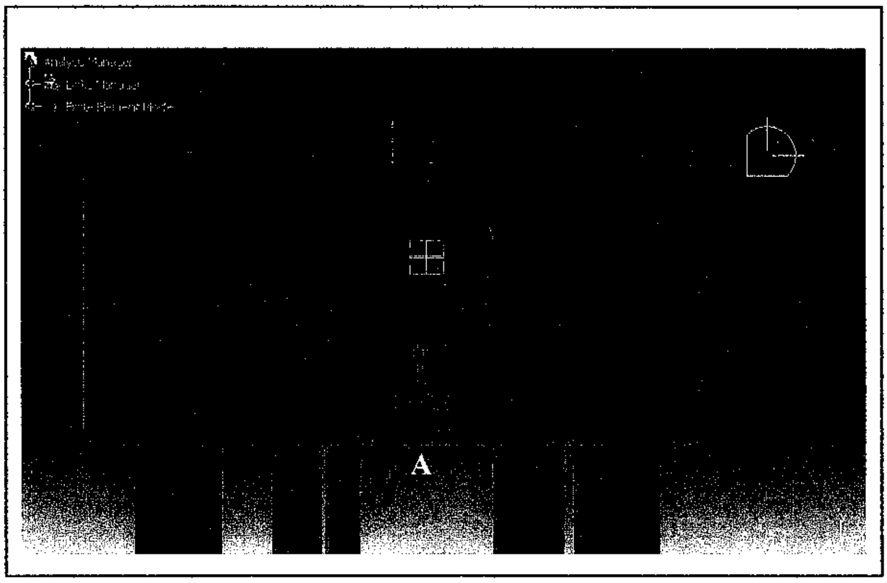


Figure 2.5: Front View Pressure Analysis

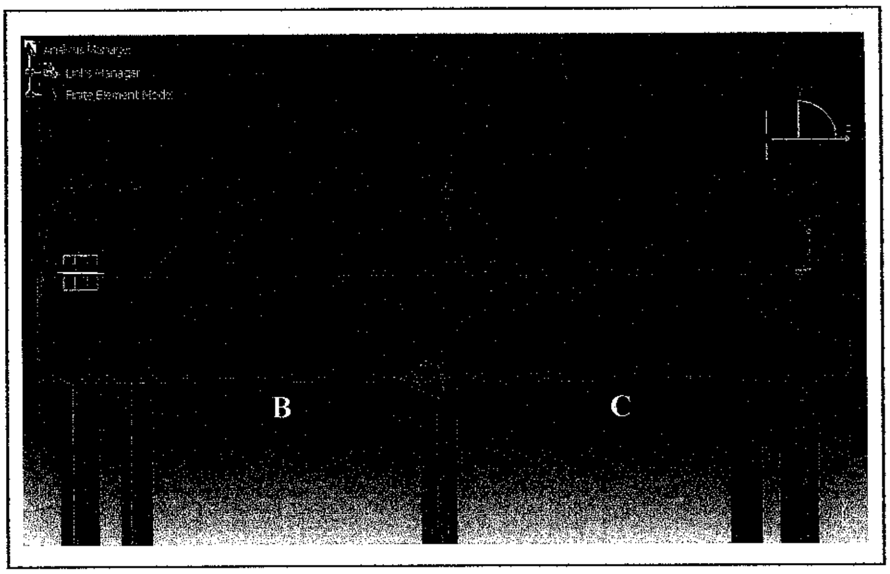


Figure 2.6: Side View Pressure Analysis

2.3.4 Pneumatic Preparation

For the pneumatic system to operate, some preparation must be done beforehand.

a) Pressure Relief Valves

Pressure Relief Valve is a designated spring loaded valves that open when a preset maximum pressure is reached to prevent a further rise in pressure.

b) Pressure Regulators

Pressure regulators are used to adjust the supply pressure to an appropriate level for a particular machine. Regulators are sued because the line pressure may be higher than is required by a given machine. Supplying a machine with air directly form the distribution lines will not give a consistent supply pressure because the line pressure will fluctuate, thus will cause inconsistence in machine performance.

c) Filters

Filters are used to prevent contaminants from entering the pneumatic systems. Contamination in pneumatic systems causes damage to components and greatly decreases their performance and efficiency.

d) Lubricators

The function of a lubricator is to spray a fine oil mist into the airflow that will be carried downstream and precipitate out onto the components. This is important as air has no lubricating capability.

e) Water Removal

Water exists in a pneumatic system in two forms; as water vapor and as liquid water. Liquid water in a pneumatic system is undesirable because it causes components to rust and reduces the effectiveness of lubricants. Water removal can either be in a form of gel material called dessicant, which absorbs water, or a device called refrigeration dryers.

2.3.5 Operation

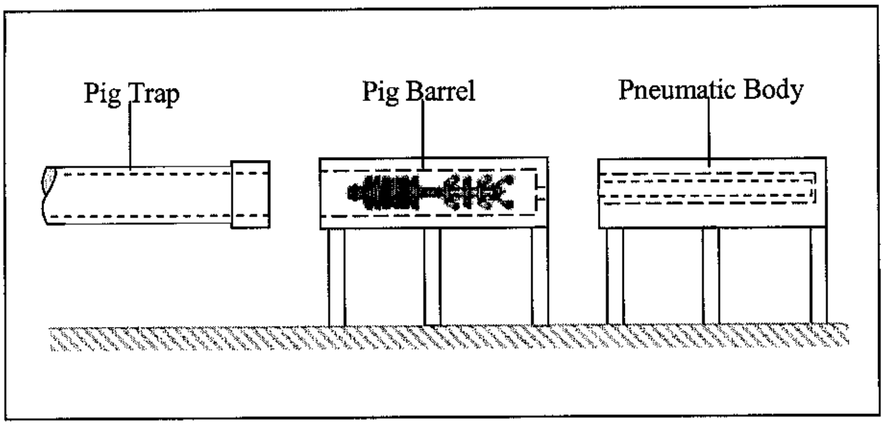


Figure 2.7: Pig Launcher Arrangement

1. The pig barrel is loaded with the intelligent pig, and both the loaded pig barrel and the pneumatic body is arranged in front of the pig trap, as per *Figure 7*.

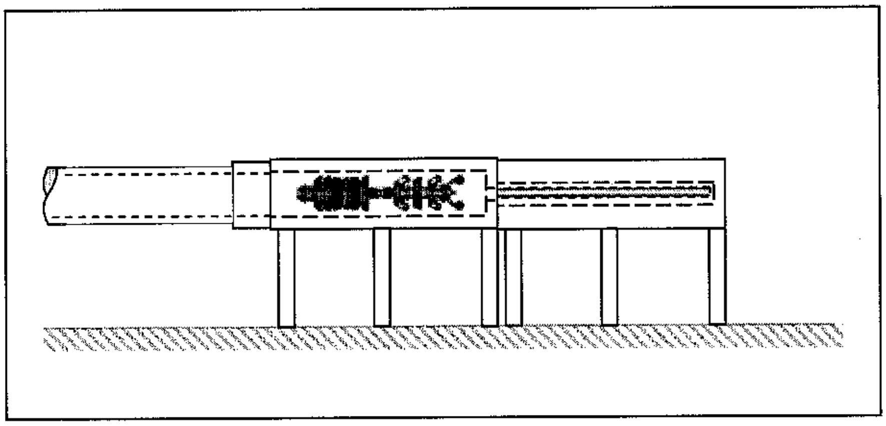


Figure 2.8: Attaching Pig Launcher to the Pig Trap

2. Attach the pig barrel and the pneumatic body to each other, and to the pig trap, as per *Figure 8*.

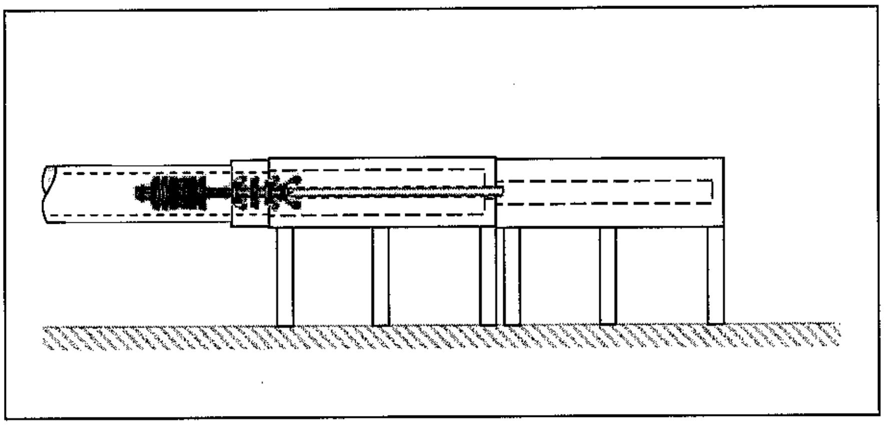


Figure 2.9: Pneumatic Rod Pushes Pig Forward

3. Deploy the pneumatic system. The pneumatic rod will push the pig forward.

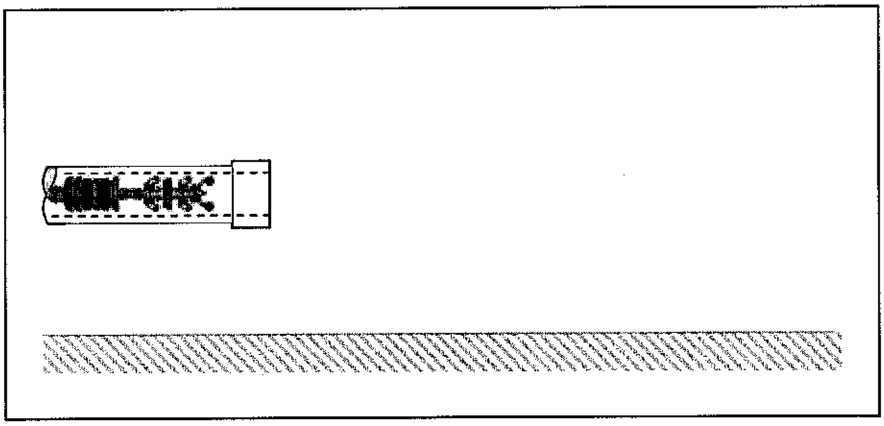


Figure 2.10: Pig Ready to Deploy

4. Once the pig is already inside the pig trap, remote the pig launcher. The pig now is ready to deploy, as per *Figure 10.*

2.4 Pipeline Wall Loss

The most significant feature of an intelligent pig is locating pipe wall loss, including defect length. Defect length (L) is defined as the affected area measured parallel to the longitudinal axis of pipe. Affected area is defined as a region on the pipe where the separation between the measured lengths of two defects does not exceed one inch longitudinally or four inches circumferentially.

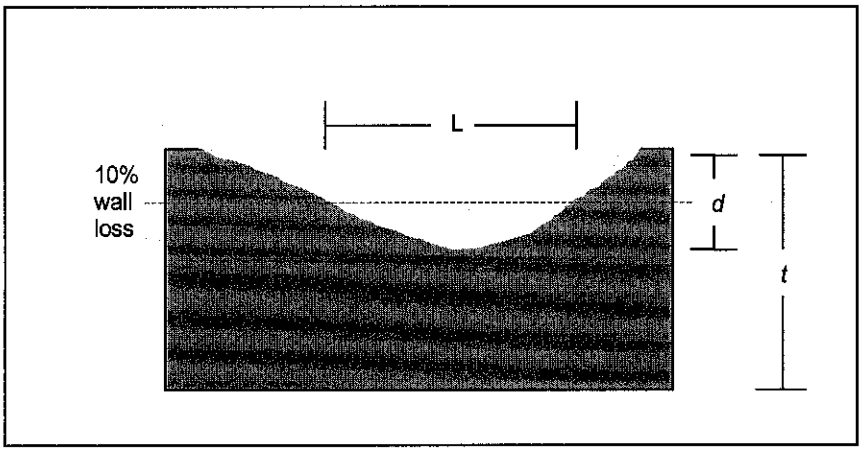


Figure 2.11: Defect Length and Defect Depth

Commonly, defect length calculation is the axial distance between the start and end points of an affected defect area, as per *Figure 11*. The boundary of the defect is determined at all body wall loss greater than or equal to 10% of the wall thickness. The anomaly continues as a single defect until the pipe wall returns to 90% or greater of the original thickness.

Another flaw that can be calculated is the defect depth (d). As illustrated in *Figure 11*, defect depth is defined as a percentage of wall loss, up to 80% penetration.

2.5 Collaborating Company

Collaborating with this project is the host company for the author's industrial training company, PS Pipeline Sdn. Bhd. PS Pipeline Sdn. Bhd. is a joint-venture company between PETRONAS Dagangan Berhad (PDB) and Shell Malaysia Trading Sdn Bhd (SMTSB). Its main objective is to undertake the management, operations and maintenance of the Klang Valley Distribution Terminal (KVDT) and Multi-Product Pipeline (MPP). The contact collaborator is agreed to be En Azlan bin Abdul Rashid, the company's Operations Superintendent.

2.5.1 Klang Valley Distribution Terminal

The Klang Valley Distribution Terminal (KVDT) is terminal constructed on 112 acres of land in Dengkil. Its main purpose is to store and distribute diesel and gasoline (petrol). There are ten product tanks; four for diesel and six for gasoline. From the storage tanks, products will be transferred using dedicated fuel pumps to the loading gantry where tankers are loaded (termed as 'lifting'). These tankers will later travel to petrol stations to deliver the products according to demands. Although the available storage can cater up to northern region of the Peninsular, almost 90% of the demand comes from Klang Valley, hence its name.

2.5.2 Multi Product Pipeline

The Multi-Product Pipeline (MPP) is designed to transport petroleum products from the PETRONAS Melaka Refinery and SHELL Port Dickson refinery to the Kuala Lumpur International Airport (KLIA) and Klang Valley Distribution Terminal (KVDT) in Dengkil. The 130km, 16 inch diameter pipeline traverses underground at average depth of one meter within 30-meter-wide route across the three states of Melaka, Negeri Sembilan and Selangor (*refer Figure 12*).

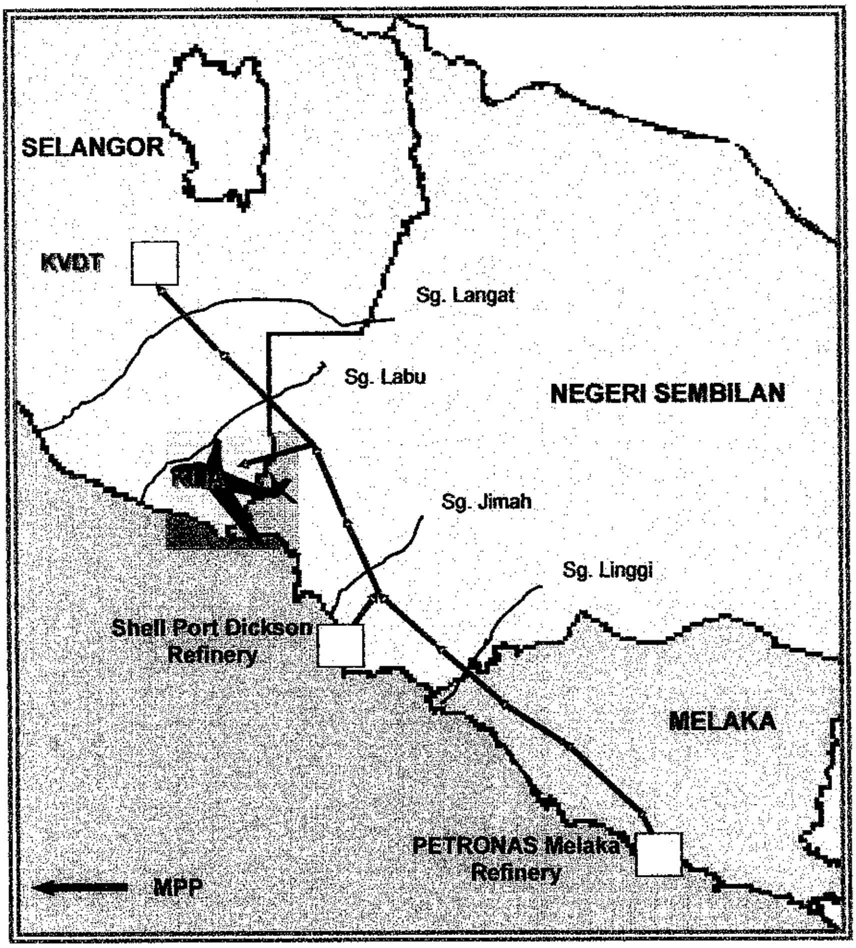


Figure 2.12: The Multi-Product Pipeline Route

2.6 Feasibility and Time Frame

Since the project will only involves simulations, expenses now in minimal concern. All software required is available in UTP, either in the computer laboratory or in personal computer.

At the moment, the model is being simulated. Despite having to re-acquaint with the software ADAMS, it is assertive the project can be completed as per schedule. Ample time will also be allocated for altering and correcting. See *Appendix V* for Gantt Chart.

CHAPTER 3

METHODOLOGY

CHAPTER 3

METHODOLOGY

3.1 Tool and Equipments Required

The following tools will be required to complete this project.

3.1.1 Computer-Aided Designing (CAD) Software

This software is essential to construct the blueprint to enable individuals to understand the design of the launcher and receiver. The preferred software is CATIA and AutoCAD, both available at UTP computer laboratories.

3.1.2 Simulation Software

Since the end result now is to simulate the project, simulating software is required. The most commonly used software is ADAMS. This software is also available in UTP computer laboratories. Simulations will be generated based on detailed fabrication drawing.

3.2 Cost Estimation

The following table summarizes the overall estimated cost of this project.

Table 3.1: Project Cost Estimation

Tools/Equipment	**Cost (in RM)**
Traveling and Accommodation	150
Miscellaneous	100
Total	250

CHAPTER 4

RESULTS AND DISCUSSION

CHAPTER 4

RESULTS AND DISCUSSIONS

4.1 Problems

4.1.1 Model Fabrication

The biggest problem that transformed the end result of the project is model fabricating. From consultation, the estimated cost is RM 8000. UTP, on the other hand, has insufficient source and tools to fabricate.

4.1.2 Resources

The biggest problem faced so far is resources. This is the first project ever conducted by a student that is related to pigging. Thus, it is difficult to search for resources on pipeline pigs, particularly intelligent pigs. In the resource center, all the information is generic and already available in hand. It is also almost impossible to obtain information from the internet as the network access in the college is often inoperative.

4.1.3 Communication

Another problem arising from the inoperative network access is communication. To obtain information from the collaborator, it is necessary to have internet to access to electronic mails (e-mail). This is for the transferring of data and soft copy files, apart of for correspondence. E-mail is preferred as it is economical, fast and efficient.

4.2 Recommendations And Solutions

4.2.1 Simulation

After discussing with the supervisor, it is agreed that the end result is changed to simulation instead. The software used is ADAMS. The simulation required is to verify whether the launcher can exert enough force to overcome the magnetomotive force in the pipeline.

4.2.2 Use external resources

To ensure that the project is not delayed, resources are obtained from outside. External resources are data gathering from collaborating company, PS Pipeline Sdn. Bhd. (*refer section 2.2*). The drawbacks, however, are distance, time consumption and financial

CHAPTER 5

CONCLUSION

CHAPTER 5

CONCLUSION

The main objective of this project is to design a device which can assist on the launching of intelligent pig. At first the idea was also to assist in receiving, but due to lack of time, the project now concentrates on launching. This machine will reduce the time consumption, and further minimize human and mechanical energy.

This project is feasible to be conducted for student's level. Equipments required are readily available, which is computer aided designing (CAD) software which are AutoCAD and CATIA, and simulating software, which is ADAMS. Since model fabrication is not possible, the project can simulated as a method of verification. The software to be used is ADAMS.

It is recommended that this project is continued by another student as a Final Year Project. For further improvement, the launcher can be designed as a single body, with pig receiving features and less weight.

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Anonymous < http://www.roseninspection.net>

Anonymous <http://www.pigsource.com>

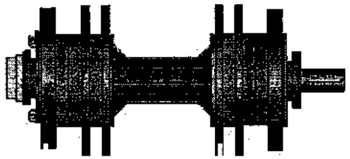
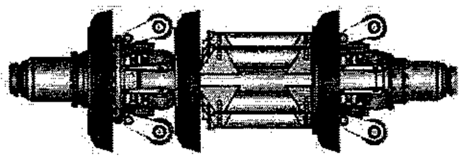
* FFP: Fitness For Purpose

APPENDICES

APPENDIX I

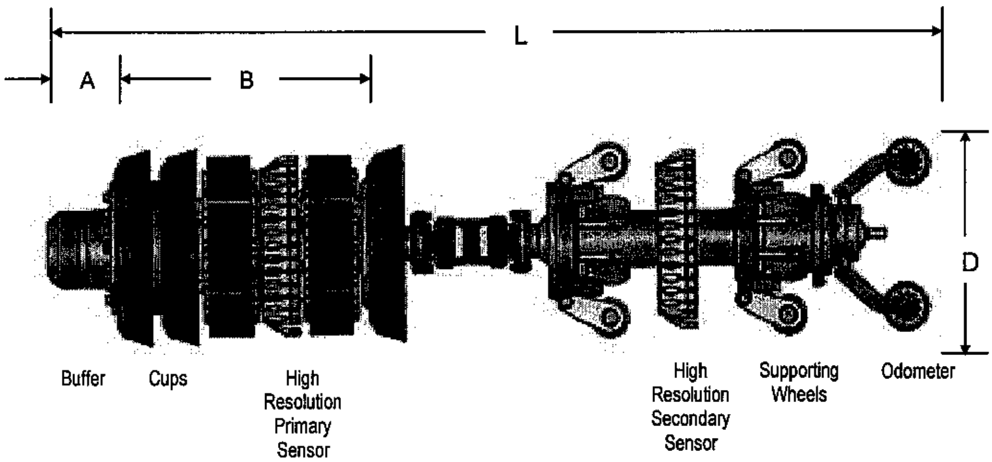
COMMON TYPE OF PIGS

APPENDIX 1

NAME	DESCRIPTION	APPLICATION	PRECONDITION
Utility Pig  **16" BIDI Pig with Gauge Plate**	• The most basic pig used for ordinary cleanup • Bi-directional	• Cleans pipewall • Removes debris and water • A prerequisite to other more advance pigs	• 1.5D minimum bend
Geometry Pig  **16" Electronic Geometry Pig**	• Electronic internal pipeline inspection pig that measures the geometry of the pipe. • Equipped with standalone memory. Upon removal, the data is played back and analyzed. • Uni-directional	• Locates: - Dents - Wrinkles - Bend radius - Pipe ovality. • A prerequisite to the intelligent pig	• 1.5D minimum bend • Pipeline must be clean.
Intelligent Pig  **16" Corrosion Detection Pig**	• Electronic internal pipeline inspection pig that identifies and measures metal loss (corrosion, gouges, etc.) • Applies Magnetic Flux Leakage (MFL). • Equipped with standalone memory. Upon removal, the data is played back and analyzed. • Uni-directional	• Locates: - metal loss - casing - valves - taps - dents - cracks (hi-res. pig)	• 3D minimum bend • Pig hatch must be extended • Pipeline must be clean. • No pipeline ovality

APPENDIX II

FULL SPECIFICATION OF INTELLIGENT PIG



16" Corrosion Detection Pig

Tool Specification	
L:	2052 mm
A:	167 mm
B:	660 mm
D:	16"
Operational mass:	316 kg
Transport mass:	846 kg

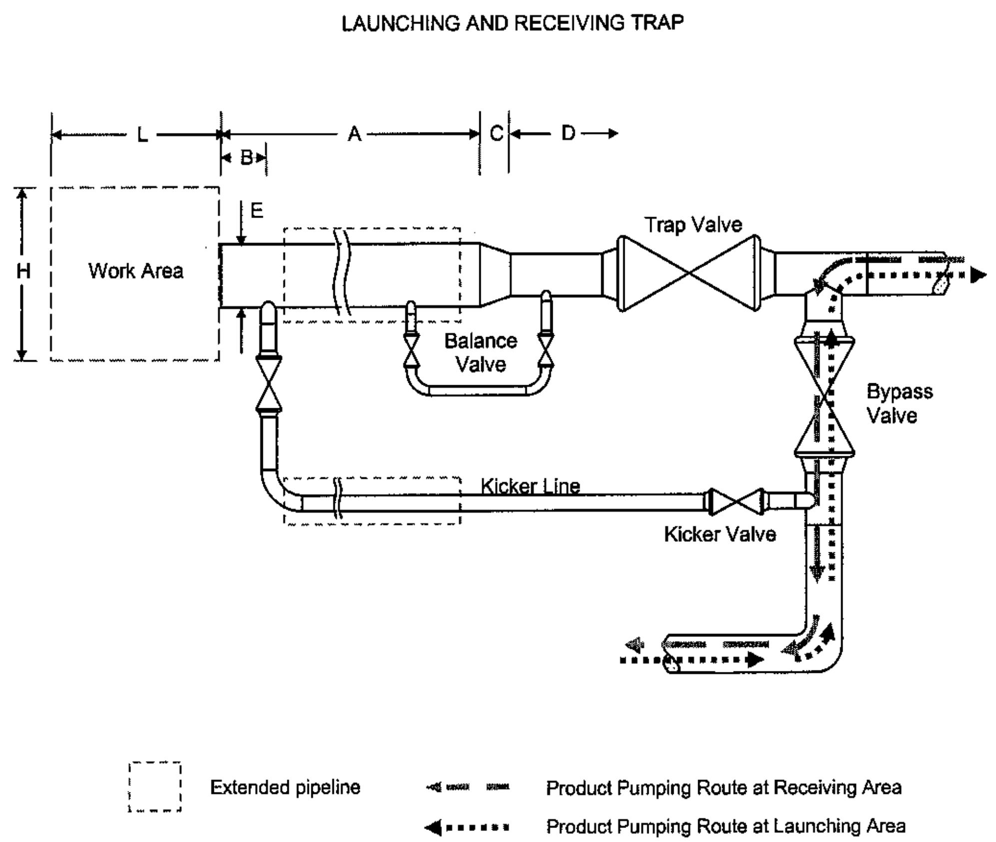
Inspection Specification	
Min inspection capability	293 km
Max operating time	38.1 hrs
Max wall thickness	24.3 mm

Pipeline Geometry	
Min bend radius	3D
Min bore in straight pipe	335 mm
Min bore in bend	347 mm

Operating Specification	
Velocity range	0.5 – 3 m/s
Max operating pressure	15 MPa
Max product temperature	65 °C

APPENDIX III

PIG TRAP REQUIREMENT



Launcher		Receiver	
A:	min 2052 mm	A:	min 2052 mm
B:	min 400 mm	B:	min 567 mm
C:	min 356 mm	C:	min 356 mm
D:	min 367 mm	D:	min 2052 mm
E:	min 18 ”	E:	min 18 ”
H:	min 3052 mm	H:	min 3052 mm
L:	min 3052 mm	L:	min 3052 mm

APPENDIX IV

PETRONAS TECHNICAL STANDARD (PTS)
FOR DESIGN OF PIPELINE PIG TRAP SYSTEMS

PETRONAS TECHNICAL STANDARDS

DESIGN AND ENGINEERING PRACTICE

(CORE)

TECHNICAL SPECIFICATION

DESIGN OF PIPELINE PIG TRAP SYSTEMS

PTS 31.40.10.13

DECEMBER 1998

PETRONAS

PREFACE

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They are based on the experience acquired during the involvement with the design, construction, operation and maintenance of processing units and facilities. Where appropriate they are based on, or reference is made to, national and international standards and codes of practice.

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APPENDICES

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 1 400 mm (4 to 56 inch). It is written in the context of liquid, gas and multi-phase hydrocarbon fluids, but may be applicable to other fluids.

This PTS is a revision of the PTS of the same number dated December 1992. This revision incorporates requirements for end-closures previously issued separately in PTS 31.40.21.32 "Pig Trap End Closures", issued in April 1993 (which is now withdrawn).

The following components or topics are not covered by this PTS:

- criteria for deciding whether pig traps are required;
- subsea pig launchers and receivers;
- pig launcher valves (i.e. valves where pigs can be loaded into the side of the valve).

NOTE: 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.

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 PETRONAS group and to Contractors and Manufacturers/Suppliers nominated by them.

This PTS is intended for use when designing pipelines 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 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 which carries out all or part of the design, engineering, procurement, construction, commissioning or management of a project, or operation or maintenance of a facility. The Principal may undertake all or part of the duties of the Contractor.

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

The **Principal** is the party which 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** indicates a requirement.

The word **should** indicates a recommendation.

1.3.2 Specific definitions

balance line	A small-bore line which allows pressurisation of the barrel on both sides of a pig at the same time.
barred tee	A 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.
cold bend	A bend made from linepipe at ambient temperature, normally on the construction site, by a mechanical bending machine.
drain line	A small-bore line used to drain fluid from the barrel.
end closure	A 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.
hot bend	A bend made under factory conditions by hot working billets, plate, pipe etc.
kicker line (or bridle line)	Piping from the major barrel to the bypass line used to control the launch or receipt of a pig.
launching pins	Retractable pins, used in pig launchers to release a sphere from a cassette holding multiple spheres.
main line	The major portion of a pipeline, between pig traps.
major barrel	Enlarged pipe section of a pig trap used for loading or retrieval of pigs.
minor barrel	Pipe section of a pig trap between the reducer and the pig trap valve, of the same diameter as the pipeline.
pig	A 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	A pig trap for launching pigs.
pig receiver	A pig trap for receiving pigs.
pig signaller	A device set onto or into a pipe which gives an indication of the passage of a pig.
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 trap system	A pig trap together with all associated piping, valves, supports and instruments.
piping	Pipework associated with the pipeline but not part of the main line.
piping classes	The standardised piping assemblies contained in PTS 31.38.01.12 and PTS 31.38.01.15
pressurising line	A small-bore line with valves to allow equalisation of pressure across a larger valve, avoiding damage to the seats of the larger valve.
requisition	the data/requisition sheet(s) PTS 31.40.10.93 and PTS 31.40.10.94, to be used by the Principal and completed by the Contractor. The forms can be found in the requisitioning binder (PTS 30.10.01.10).
sphere tee	A jacketed tee-piece with a perforated inner pipe allowing flow to enter the side branch but preventing entry of a sphere in the side branch.
catch pit or tray	Draining facility underneath an end closure.
tell-tale vent	A safety device provided as part of the end closure door locking mechanism to safeguard personnel during door opening.

NOTE: Pipe diameters, expressed in inches, are nominal diameters unless specifically mentioned otherwise.

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, based 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 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 smaller than 20 inch diameter the diameter of the major barrel should be 2 inches more than the pipeline diameter. For pipelines with a diameter of 20 inch and larger the oversize should be 4 inches. Typical sizes for the major barrel (limited to common standard ISO 3183-1 pipe sizes) are given in (Table 1) below.

NOTES:

1. Since 12 inch pipe has an actual diameter of 12.75 inches a 16 inch major barrel should be used.
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.

Table 1 Typical diameters of major barrel and pipework

Pipeline diameter mm (inches)	**Bypass line** mm (inches)	**Kicker line** mm (inches)	**Balance line** mm (inches)	**Drain line** mm (inches)	**Major barrel** mm (inches) (Note 1)
100 (4)	75 (3)	50 (2)	50 (2)	50 (2)	150 (6)
150 (6)	100 (4)	50 (2)	50 (2)	50 (2)	200 (8)
200 (8)	100- 150 (4-6)	100 (4)	50 (2)	50 (2)	250 (10)
250 (10)	150 (6)	100 (4)	50 (2)	50 (2)	300 (12)
300 (12)	150-200 (6-8)	100 (4)	50 (2)	50 (2)	400 (16)
350 (14)	150-250 (6-10)	100 (4)	50 (2)	50 (2)	400 (16)
400 (16)	200-300 (8-12)	150 (6)	100 (4)	100 (4)	450 (18)
450 (18)	250-300 (10-12)	200 (8)	100 (4)	100 (4)	500 (20)
500 (20)	250-400 (10-16)	200 (8)	100 (4)	100 (4)	600 (24)
600 (24)	300-450 (12-18)	200 (8)	100 (4)	100 (4)	700 (28)
700 (28)	400-500 (16-20)	250 (10)	100 (4)	100 (4)	800 (32)
750 (30)	400-550 (16-24)	250 (10)	100 (4)	100 (4)	900 (36)
800 (32)	400-600 (16-24)	250 (10)	100 (4)	100 (4)	900 (36)
900 (36)	450-650 (18-28)	300 (12)	100 (4)	100 (4)	1000 (40)
950 (38)	500-650 (20-28)	300 (12)	100 (4)	100 (4)	1 050 (42)
1 000 (40)	500-800 (20-32)	300 (12)	100 (4)	100 (4)	1 100 (44)
1 050 (42)	500-900 (20-36)	400 (16)	100 (4)	100 (4)	1 150 (46)
1 200 (48)	600-900 (24-36)	450 (18)	100 (4)	100 (4)	1 300 (52)
1 400 (56)	800-1 000 (32-40)	500 (20)	100 (4)	100 (4)	1 500 (60)

NOTE: (1) For sphere launchers utilising an automatic retractable flap system 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 for the smooth passage of a pig.

Pig traps should be designed for the longest pig that will be used (usually an intelligent pig) plus a margin of 10 per cent. Dimensions for pig traps designed for intelligent pigs are shown in (Table 3) (limited to common standard pipe sizes).

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 (typically 1:100) down towards the end closure to improve draining of liquids from the barrel. Horizontal launchers may be sloped (typically 1:100) down towards the pipeline. For bi-directional traps the barrel should be level.

Where automatic sphering 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 (12 inch) and 5° for 350 mm (14 inch) and above. The receiver barrel should also be inclined at least 10° to the horizontal up to 300 mm (12 inch) and 5° for 350 mm (14 inch) 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 would generally apply. In some sub-sea cases a horizontal trap with individual kicker lines may be considered, possibly with a cassette for ease of loading. This would be a special design, but would be expected to follow the principles contained within this PTS.

2.3 PIPEWORK

2.3.1 Bypass line

A bypass line is required to connect the pipeline with related facilities such as a booster station, tank farm, etc. Typical sizes for the bypass line are given in (Table 1), based on the fluid velocities for continuous service (3.6).

2.3.2 Kicker 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 the kicker line shall be connected to the major barrel as close as possible to the end closure 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), based on fluid velocities for intermittent service (3.6).

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 which 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. Consideration should also be given to the provision of a balance line on receivers to prevent any possible pressure differential across a received pig.

The diameter of the balance line should be 50 mm (2 inch) for pipelines having a nominal diameter of less than 350 mm (14 inch), and 100 mm (4 inch) 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 barrel pressurisation and/or to avoid damage to the kicker valve seats or other internals. The pressurising line should be at least 2 inch 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 shall be provided at locations where shut-in pressure of trapped fluid could exceed the design pressure. The relief system shall conform to the requirements of PTS 80.45.10.10

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 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 (2 inch) branch connection incorporating a 25 mm (1 inch) tell-tale valve to provide a means of checking that all liquid is drained before opening the end closure.

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 such that the drains cannot be blocked by the spheres.

The diameter of the drain line shall be at least 50 mm (2 inch) for pipelines having a nominal diameter of less than 350 mm (14 inch), and at least 100 mm (4 inch) 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.

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 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 the event of it being stuck in the minor barrel. The diameter of the vent line(s) shall be at least 50 mm (2 inch). For high-pressure gas systems consideration should be given to the provision of a blowdown line, incorporating a 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 connecting 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).

fNOTE: Under the design codes ASME B31.4 and B31.8 it is necessary to calculate the acceptability of branch connection configurations larger than 2 inch (see Article 404. 3.1 and 831.4 respectively).

The diameter of all branch connections shall be at least 50 mm (2 inch).

NOTE: Smaller diameter valves (1 inch minimum) for items such as pressure gauges and thermal reliefs may be used but in such cases the length of the connection/reducer/valve assembly shall be minimised.

Table 2 Branch connection configurations

Branch Connection Location	Sizes mm (inches)	Configurations
Bypass line on main line	75 on 100 (3 on 4)	Tee
	All larger sizes	Barred tee or sphere tee
Kicker line on major barrel	50 on 100/150 (2 on 4/6)	Weldolet
	All larger sizes	Welded branch connection (see note 1)
Balance line on minor barrel Drain on minor and major barrel	50 on 100 (2 on 4)	Tee
Balance line on kicker line	50-100 on 150 (2-4 on 6) and above	Welded branch connection (see note 1)
Kicker line on bypass line	All sizes	Tee
Pressuring line to kicker line	50 (2) and larger	Welded branch connection (see note 1)
Small items (e.g. vents and gauges)	50 (2)	Weldolet

NOTES:

1. "Welded branch connections" include tees, extruded outlets/sweepolets and weldolets as well as fabricated items. In all cases they shall conform to the design codes as discussed in (2.4).

2. The distance between branch connections should be addressed to ensure that it does not coincide with pig cup/disc separation as this may result in pig stoppage.

Table 3 Barrel lengths for intelligent pigs

Pipeline diameter mm (inches)	Approx. maximum tool length (m) (see NOTE 2)	Approx. maximum tool weight (kg) (see NOTE 3)	Approx. minimum barrel length (m) (see NOTES 1 and 2)			
			Launcher		Receiver	
			A_L	B_L	A_R	B_R
100 (4)	2.8	60	2.8	0.5	2.8	2.8
150 (6)	2.8	90	2.8	1.5	2.8	2.8
200 (8)	3.9	170	4.1	1.5	3.9	3.9
250 (10)	4.3	300	4.3	1.5	4.3	4.3
300 (12)	4.3	365	4.3	1.5	4.3	4.3
350 (14)	4.8	380	4.8	1.5	4.8	4.8
400 (16)	5.1	700	5.1	1.5	5.1	5.1
450 (18)	5.1	810	5.1	1.5	5.1	5.1
500 (20)	5.1	840	5.1	1.5	5.1	5.1
600 (24)	5.7	1 600	5.7	1.5	5.7	5.7
650 (28)	5.8	2 000	5.8	1.5	5.8	5.8
700 (30)	6.0	2 000	6.0	1.5	6.0	6.0
750 (32)	6.6	2 270	6.6	1.5	6.6	6.6
900 (36)	6.6	3 560	6.6	1.5	5.3	6.6
950 (38)	6.6	3 600	6.6	1.5	5.5	6.6
1 000 (40)	6.6	4 090	6.6	1.5	5.5	6.6
1 050 (42)	6.6	4 550	6.6	1.5	6.4	6.6
1 200 (48)	6.6	See NOTE 4	6.6	1.5	6.6	6.6
1 400 (56)	6.6	See NOTE 4	6.6	1.5	6.6	6.6

NOTES:

1. See Figure 6 for definition of dimensions A and B.
2. These lengths are extreme figures, based on data for presently available magnetic flux and ultrasonic tools. 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 overall length of the pig and this leads to very long receiver dimensions if the trap is to cater for all possible pigs. The extreme 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 for the major barrel could be considered.
3. The weight indicated excludes the weight of lifting/loading trolley or tray.
4. To be checked with Supplier.

Barred tees or sphere tees shall be installed on all branches larger than 50% of the pipeline diameter or 25% of the pipeline diameter where sphering is to be a regular activity. (Figure 4) shows a suggested design for barred reducing tees.

Spheres may hold up or be destroyed at a normal or barred tee and consideration shall be given to the use of sphere tees if spheres are to be used.

(•) Sphere tees shall only be installed where it is intended to use spheres or foam 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).

NOTE: Soft foam pigs can also be damaged or lost at normal or barred tees and sphere tees may be useful on receivers in some instances. If foam 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 into the kicker line.

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 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.

2.4.4 Purge connection

A flanged purge connection with an isolation valve and check valve shall be provided on systems with toxic fluids and should be considered for all systems. It should be located near to the pig trap valve to allow purging and/or flushing the full length of the barrel before opening the end closure. For horizontal pig traps the adjacent vent valve should remain closed during purging.

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, PTS 31.38.01.15) located in the bypass line on the facility side of the bypass valve.

2.5 VALVES

2.5.1 General

The following valves shall be provided as a minimum on each pig trap system:

- 1 x pig trap valve (full bore/through-conduit)
- 1 x bypass valve
- 1 x kicker valve
- 1 x balance valve (for launchers)
- 1 x drain valve (2 for horizontal traps with possible liquids)
- 1 x vent valve (2 for horizontal traps)

Most of these valves are required for isolation purposes (i.e. on/off use) and therefore would be either ball valves or gate valves.

(•) The use of either ball or gate valves in these applications shall be as specified by the Principal.

(•) Valves may need to be suitable for vacuum drying, or resistant to methanol drying, depending on precommissioning philosophy, as specified by the Principal.

(•) Valves should have weld ends rather than flanges if the elimination of potential leak paths is more important than maintainability and replaceability (e.g. for toxic substances), as specified by the Principal.

(•) Depending on the intended frequency of pigging operations, the pig trap, kicker and bypass valves may require power-operation (hydraulic or motor actuated). The intended pigging frequencies shall be indicated by the Principal.

(•) Irrespective of frequency of use, large valves may require power operation.

Actuated valves shall have provision for a hand wheel or hand pump on the actuator.

(•) If specified on the requisition a double block and bleed system shall be installed at the location of the pig trap valve, the kicker line valve, the pressurising valve (if fitted) and drain/vent valves (if a closed system). This shall consist of two gate or ball valves with a 2-inch bleed connection between the two valves. The bleed valve shall be at least 1 inch. For recommendations on when to install a double block and bleed system refer to Section 5.2 of EP 95-0230.

2.5.2 Pig trap valve

The pig trap valve(s) shall be a full-bore tight shut-off ball or through-conduit gate valve, installed to isolate the barrel from the rest of the pipeline (see Appendix 1 for selection criteria). The minimum internal diameter of the valves shall be consistent with that of the pipeline to avoid difficulties in pigging activities.

2.5.3 Bypass valve

The bypass valve shall be a tight shut-off ball or through-conduit gate valve installed to isolate the pipeline from facilities connected to the pipeline (see Appendix 1 for selection criteria).

2.5.4 Isolation valve

The isolation valve shall be a tight shut-off valve installed to isolate the pig trap system from the facilities.

2.5.5 Kicker valve

The kicker valve(s) shall be a tight shut-off ball or through-conduit gate valve installed to isolate the bypass line from the barrel (see Appendix 1 for selection criteria).

2.5.6 Pressurising valves

If a pressurising line is installed, it shall include an isolating valve and should preferably include a throttling valve. The isolating valve shall be installed on the bypass line side for tight shut-off of the pressurising line and the throttling valve shall be installed on the balance line side to control the flow in the pressurising line.

2.5.7 Balance valve

To cater for possible low flow conditions and to ensure that pigs can always be launched, a balance valve shall be provided in the balance line, so that all flow may be diverted behind the pig by closing the balance valve during launching. This valve should be normally open.

2.5.8 Drain valves

The drain valves shall be tight shut-off ball valves.

2.5.9 Vent valves

The vent valves shall be tight shut-off ball or gate valves to isolate the vent line from the barrel.

2.5.10 Blowdown valve

For gas service the blowdown valve shall be a tight shut-off valve with a downstream globe valve or an orifice restriction for controlled depressurisation of the barrel. For most applications, it is expected that depressurisation will be initiated by manually opening the valves locally. For situations where remote actuation is required, reference should be made to PTS 32.45.10.10

2.5.11 Purge connection valve

A 50 mm (2 inch) isolating valve and a 50 mm (2 inch) check valve shall be installed in the purge connection (if applicable). The isolating valve shall be installed on the barrel side for tight shut-off of the purge connection. (The check valve is intended to prevent hydrocarbons entering the purge/flush line.)

2.5.12 Chemical injection valve

If a chemical injection connection is required it shall include a tight shut-off valve to isolate the chemical injection line from the pipeline.

The diameter of the connection shall be at least 2 inch and the valve should normally be 2 inch.

2.5.13 Thermal relief valve

A thermal relief valve shall be installed where shut-in pressure of trapped fluid could exceed the design pressure as a result of thermal expansion of the static fluid. The relief valve capacity and setting shall comply with the pipeline design code and PTS 80.45.10.10

2.6 END CLOSURES

2.6.1 General

The end closure shall conform to the general requirements of ASME VIII, Division 1, Section UG-35 (b) (Quick Actuating Closures) and PTS 31.22.20.31 Attention is drawn to the requirement for a fail-safe design of the opening mechanism; specifically, the failure of any part of the opening mechanism shall leave the closure closed rather than open.

The design, material selection, fabrication and testing of the end closure shall be in accordance with PTS 31.40.21.30 The design of the end closure shall be compatible with the design code adopted for the adjoining pig trap, as stated in the data sheet.

NOTE: ASME B31.4 and B31.8 are widely adopted pipeline codes, and are also commonly used for pig traps. In some situations, the pig trap may be designed to a plant piping code, e.g. ASME B31.3.

The end closure is intended to be girth-welded to the end of the major barrel of a pig trap. Bevel preparation of the welding end hub shall meet the requirements of the design code. The position of the closure (horizontal or vertical) shall be as indicated in the data sheet.

The end closure shall be of the quick acting type, lever or handwheel operated, and hinged or supported from above by a carrier as indicated in the data sheet. The quick acting design should allow opening and closing by one man in a period of approximately one minute, without the use of additional devices.

The design of the end closure shall be suitable for permanent location in an open environment,

NOTES:

1. If the opening of the end closure is not in the vertical plane, i.e. on vertical or sloped pig traps, the end closure shall be equipped with a counterweight or hydraulic opening system or similar system to facilitate safe and easy opening of the door. There should be a locking device to hold open the door while personnel are loading or unloading pigs.

2. Closures 18" and larger are generally handwheel operated.

2.6.2 Closure components

The end closure shall consist of the following components:

- A removable door, which provides full-bore access when open, and terminates and seals the bore when closed.
- A welding end hub, for joining to the major barrel of a pig trap. The material used for the welding end hub shall be compatible with the major barrel material, as provided in the data sheet.
- A closure handling device, suitable to lift, hinge or swing the door. When the handling device is attached to the closure, it shall be attached to the welding hub, not to the major barrel of the pig trap.
- Ring seals for pressure containment (2.6.4).
- Two safety devices to prevent inadvertent opening of the closure before the pig trap is depressurised (2.6.3).

NOTE: An end closure with a flanged-end for joining to the major barrel has recently become available. This may have application in certain circumstances, e.g. where the use of a temporary barrel extension piece is proposed to allow intelligent pigging.

End closures with exposed screw expanders or captive ratchet braces should not be used, because of the high maintenance requirements and the non-fail-safe aspects of some opening mechanism designs.

2.6.3 Safety devices

The end closure shall have the following safety devices:

- A pressure locking device to prevent opening of the door when the pig trap is pressurised.
- A safety bleeder that when released will alert the operator to a possible hazard unless pressure in the pig trap is relieved completely. Opening of the door shall not be possible unless the bleeder is released. Engaging the bleeder shall only be possible when the closure is closed. The bleeder shall be designed such that there is no risk of blockage.

The devices shall be constructed and located so that they cannot readily be rendered inoperative. The devices shall be easily accessible for inspection.

(•) An interlocking system between various valves and the end closure door operating mechanism may be considered to protect personnel and equipment, depending on the service, trap location and the planned pigging frequency. The necessity for interlocking shall be decided by the Principal.

Interlock system features may be micro-processor solid-state-type logic, mechanical key systems or relay-based.

See (Appendix 2) for the interlock logic.

2.6.4 Ring seals

The activation of the seals shall be such that the fluid within the trap is contained at any pressure between 1 bar (abs) and the pig trap design pressure. Elastomeric materials for ring seals shall resist explosive decompression and shall be suitable for long-term exposure to the transported fluid at the design pressure and temperature conditions. The cross-section of the seals shall not exceed 7 mm in diameter for design pressures of 150 bar and above.

NOTE: Compatibility of ring seal material with the transported fluid may be checked with PTS 30.10.02.13 Polybutadiene acrylonitrile (NBR) and vinyllidene fluoride-hexafluoropropylene are commonly used materials.

2.7 SPECTACLE BLINDS

Spectacle blinds are not normally required in pig trap systems. However, if required for isolation of the trap from the pipeline the spectacle blinds shall be located on the pig trap side of the pig trap valve, kicker valve, isolation valve on the pressurising line (if fitted) and any vent and drain lines which are connected to other facilities. See EP-95000 for isolation requirements.

2.8 BENDS

Any cold bends on the main line portion of the pig trap systems should have a minimum bending radius of 60 D, where D is the pipeline diameter.

Main line hot bends should be of the following minimum radii (for intelligent pigs):

100 mm (4 inch)	10 D
150 mm to 250 mm (6 in to 10 inch)	5 D
300 mm (12 inch) and above	3 D

The actual choice of the bend radii depends on the wall thickness and on the types of intelligent pigs to be used, and the extent of out-of-roundness should also be taken into consideration. Straight pipe lengths of at least three pipe diameters should be allowed up and downstream of all main line bends.

NOTE: In situations where space is at a premium, the requirement for straight pipe may be reduced, depending on the bend configuration and/or the design of the Intelligent Pig. In such cases, Intelligent Pig Suppliers should be consulted.

2.9 PIG SIGNALLERS

Pig signallers should be installed on both sides of the pig trap valve. The purpose of these signallers is to provide confirmation that the pig:
i) has been successfully launched or arrived at the receiving station (in the case of a launcher/receiver respectively); and
ii) has successfully passed through the pig trap valve.

For launchers the signaller on the downstream side of the pig trap valve should be located on the pipeline at a distance from the main tee of at least the length of the maximum length pig to be used (Figure 3). This signaller will provide confirmation that the pig has successfully passed both the pig trap valve and the main tee.

NOTE: This may not be possible in an offshore application where space restrictions and the ESD valve location may be overriding and the location of the signaller shall be agreed with the Principal.

For receivers one signaller should be located on the minor barrel at a distance from the pig trap valve of at least the length of the maximum length pig to be used.

Pig signallers may be of the set-in mechanical type or of the non-intrusive type. The latter are preferred in some cases, such as toxic fluids and unstable fluids like ethylene.

NOTE: Set-in mechanical signallers may have direct or indirect (magnetic) mechanisms. In some applications/locations it may be desirable to have an isolation valve either in or under the signaller to allow removal under pressure.

Proprietary signallers designed for removal under pressure normally have small-size flange and bolt assemblies and consideration should be given to the use of a standard 50 mm (2 inch) flange assembly for such items.

Requirements for intrusive type pig signallers are given in PTS 31.40.21.33

2.10 CATHODIC PROTECTION ISOLATION AND EARTHING CONNECTIONS

Isolating joints or flanges and earthing connections may be necessary but requirements are not covered in this PTS. See PTS 30.10.73.31 and PTS 30.10.73.32

Requirements for isolating joints are given in PTS 31.40.21.31

2.11 SUPPORTS

Permanent supports/clamps shall be used to support and restrain the pig traps. These shall be designed to carry the weight of the pig trap system filled with water (or other fluids if their density is greater than that of water) together with the weight of intelligent pigs, if applicable.

The supports under the barrel should normally be of the sliding/clamp type to compensate for expansion of the unrestrained part of the pipeline.

NOTE: If there would be a possibility of corrosion occurring under clamps, then welded clamps should be used with no direct welding onto the pipeline except for circumferential welds.

Other supports may be fixed if design calculations indicate that sufficient flexibility is incorporated in the pipework to compensate for any possible axial and transverse movements. Where cathodic protection isolation joints are used, the supports shall allow sufficient movement to avoid stressing of the joint above its design limit.

Supports may need to be electrically isolated where isolating joints are not used.

Supports should be positioned such that the pig trap valves can be removed for maintenance or replacement without removal of the barrel.

2.12 PRESSURE INDICATORS

Pressure indicators, normally gauges, should be permanently installed. If not permanently installed they shall be fitted prior to any pigging operations commencing.

At least one pressure indicator should be clearly visible to the operator from the end closure activation point. If pig launching/receiving operations are anticipated during the hours of darkness, night-time visibility shall also be addressed.

2.13 SPHERE LAUNCHING/RECEIVING PINS/FLAPPERS

Where automatic sphering is intended, for pipelines up to and including 300 mm (12 inch) diameter, remotely operated retractable retaining/launching pins/fingers may be used to position the spheres in the launcher. For larger size pipelines hydraulically operated flappers are recommended.

Common sphere operational practice is to unload the receiver after several spheres have been received, For large diameter spheres (above 18 inch), this can lead to a hazardous run-away situation due to the combined weight of the spheres. In such cases, consideration should be given to providing a restraint (e.g. flappers or pins/fingers) to allow unloading the spheres one at a time. Alternatively, a horizontal receiving tray, long enough for the whole consignment, should be provided and fixed into position before opening the end closure.

3. SERVICE CONDITIONS AND CODE REQUIREMENTS

3.1 GENERAL

(•) It may be appropriate, in view of possible future changes in service requirements of the pipeline, to design the pig trap such that, if required, it can be used as a launcher as well as a receiver and in gas as well as liquid service. The Principal shall specify if these options are required.

(•) The design should be based on the most onerous type of pigging operation which is envisaged for the pipeline. This shall be specified by the Principal and will, in most cases, mean designing for intelligent pigs.

(•) Onshore traps should be horizontal and offshore traps may be either horizontal or vertical, as specified by the Principal.

Note: The use of vertical receivers is strongly discouraged for operational reasons (i.e. arriving pigs will bring debris into the trap, upon closing the pig trap valve this debris will fall back into the valve and will damage the valve seats on the next operation). Where the use of vertical receivers cannot be avoided, particular attention shall be given to the pig trap valve selection and the need for ease of maintenance (e.g. the use of a "sacrificial" valve closest to the receiver).

In the design of a pig trap system special attention should be paid to the following features:

- safe operations;
- operational flexibility to facilitate commissioning and decommissioning operations;
- adequate venting, draining and purging facilities;
- facilities for possible chemical injection.

If during the life of a pipeline pigging might be required, it is recommended to carry out a full design of the pigging facilities, regardless of whether the traps are initially installed. Part of such a design shall be to provide piping arrangements, blanked off as necessary, to facilitate the subsequent installation of the trap and its ancillary piping. Particularly for offshore applications, provisions shall also be made for space and weight requirements of the trap and lifting arrangements for its installation, operation and removal.

Where used, portable or temporary pig traps shall as a minimum be designed to the full specification of the maximum pressure to which they can be subjected and if for hydrocarbon service use, to the same specifications as a permanent facility.

3.2 DESIGN CODE

It is assumed that the pipeline design is based on ASME B31.4 or ASME B31.8, depending on the product. The pipeline design code shall be stated on the requisition.

NOTE: Pipelines transporting certain fluids which are liquid under pipeline conditions (e.g. LPG) should be designed in accordance with the most stringent requirements of both codes.

For the purpose of code break locations it is also assumed that the piping of the facilities to which the pipeline/pig trap system is connected is designed in accordance with ASME B31.3. Where this is not the case e.g. at intermediate pig trap stations or where the pig trap ties into a slug catcher designed to ASME B31.8, the code break is not applicable.

(•) The entire pig trap system should be designed, constructed and tested according to the same code as the pipeline. However, various options of design code break between ASME B31.8/B31.4 and ASME B31.3 may be used, as shown in Figure 5A to 5D, where Figure 5A is the recommended option. Use of the options shown in Figures 5B to 5D should be by exception only. Option 5B may be applicable where pig traps are procured as prefabricated items. The acceptability of the selected code break location shall be confirmed by the Principal.

Wall thickness transitions shall meet the welding configuration requirements as specified in the design codes ASME B31.4 (clause 434.8.6) and ASME B31.8 (Appendix I, Figure I5).

NOTES:
1. t_D, the maximum thickness for design pressures, shall not be greater than 1.5 t, where t is the nominal thickness of the thinner pipe.
2. Pipes with a wall thickness less than 4.8 mm shall not be used.

3.3 DESIGN FACTOR

(•) The design factor shall be as stated on the requisition and should be applied to all piping of the pig trap system.

NOTE: This assumes that the traps are designed to ASME B31.4/B31.8 and is not applicable where ASME B31.3 is the chosen code.

3.4 DESIGN PRESSURE

(•) The design pressure of the pig trap system shall not be less than that of the pipeline. Pipeline design pressure and fitting class rating shall be specified by the Principal.

3.5 DESIGN TEMPERATURE

The maximum design temperature shall not be less than the maximum temperature which the pig trap system could attain or to which it could be exposed during operation, start-up or shutdown.

The minimum design temperature shall be based on minimum ambient temperature and on the conditions (e.g. blowdown) which could occur during operations. See (5).

(•) Minimum and maximum ambient temperatures shall be specified by the Principal.

3.6 DESIGN VELOCITIES

Suggested maximum velocities for the purpose of piping diameter selection are:

For piping in intermittent service:
In case of liquid 8 m/s.
In case of gas 40 m/s.

For piping in continuous service:
In case of liquid 4 m/s.
In case of gas 20 m/s.

Based on these velocities and the assumption that parts of the pig trap are in intermittent service, piping diameters are suggested in (Table 1). For every design, however, it should be checked that the velocities do not exceed designated maxima and that piping pressure drops are not excessive.

3.7 TEST PRESSURE

The pig trap system may be hydrostatically tested either together with, or separately from, the pipeline. In either case the test pressure shall not be less than that of the adjacent pipeline section.

3.8 CORROSION ALLOWANCE

The barrel, balance line and kicker line are intermittently exposed to oxygen ingress in combination with the possible presence of moisture. Depending on the frequency and duration of such exposure, consideration should be given to including a corrosion allowance.

4. LAY-OUT AND ANCILLARY FACILITIES

4.1 GENERAL

In determining the siting of pig traps systems, account shall be taken of possible adverse environmental effects which could result during construction and operations.

Pig traps shall be located so that they are orientated with their end closures pointing away from personnel areas and critical items of equipment, i.e. those containing hydrocarbons and/or toxic material or in safety service. This is to minimise the risk of damage to adjacent facilities that might occur in the very unlikely event of a pig being ejected from the pig trap.

The requirements for pig handling depend on the type and weight of pig and the pipeline size: normal pigs with a mass less than 30 kg may be manually loaded into or out of the pig traps. Typically this pig mass will occur in systems of 300 mm (12 inch) and below. Pig loading trolleys, cassettes or baskets enable heavier pigs to be properly loaded, aligned and retrieved in/from pig traps.

NOTE: Special provisions would normally be required for intelligent pigging. Depending on circumstance it may be appropriate to provide either temporary or permanent facilities for handling of these pigs.

Space is required beyond the end closure door of the pig trap for pig handling. Typical requirements are given in (Figure 6).

(•) Depending on the operational importance of the pipeline it may be appropriate to make provision for future pig trap valve or bypass valve maintenance/replacement using isolation plugs, pipe freeezing or hot-tap/stoppling techniques. If this is required, as decided by the Principal, an appropriate length of pipe should be included on the pipeline side of the pig trap valve and on the pipeline side of the bypass line valve.

4.2 ONSHORE

Pig traps should be located at least 15 m from any type of equipment, other than adjacent pig traps. Pig trap systems should generally be located adjacent to each other for ease of pigging operations.

Pig trap systems shall be fenced (either separately or as part of adjoining facilities) and access should normally be provided for light trucks and lifting cranes, subject to hazardous area classification constraints. Within the pig trap system plot, where buried pipelines are less than 1 m below the surface, barriers or other protective measures should be used to prevent vehicles damaging the pipeline.

When a drain system is not available, a sump shall be provided equipped with pumps for the disposal of the drained liquids to a designated disposal area. Alternatively the sump may have a 2 inch suction point at a safe distance from other facilities for connection to a vacuum truck suction for disposal elsewhere. The volume of the sump should be twice that of the trap for liquid systems. For gas systems the volume should be determined on an individual basis.

In addition, a catch pit or tray shall be constructed directly underneath the end closure with a volume equal to at least 5 per cent of that of the trap and of sufficient surface area to prevent any oil or debris contamination of the surrounding ground. This pit or tray may be connected to the sump but, if not, it should be designed such that it is safe and easy to empty.

NOTE: The use of a sump instead of a closed drain system may be appropriate where it is known or suspected that significant volumes of wax, debris, unwanted liquids, etc. will be removed from the pipeline.

4.3 OFFSHORE

Pig traps shall be installed in open areas to ensure adequate ventilation. Distances from other equipment shall be evaluated as part of overall platform facilities layout.

Pig trap layout shall be such that operation and maintenance of equipment, valves and instruments shall be possible without temporary ladders and scaffolding.

Access ways shall be provided to and from the pig storage area. To assist in handling pigs between the storage area and the pig trap, the storage area should normally be serviced by the platform crane. If the pig trap area is inaccessible to the platform crane and if pig weights are greater than 30 kg, a runway beam should be provided with handling and lifting facilities from the pig storage area or alternatively trolley facilities should be provided.

Pig storage and handling equipment shall not obstruct escape routes.

All pig traps shall drain by gravity into the appropriate drainage system.

In addition, a catch pit or tray shall be installed directly underneath the end closure (if possible below deck/grating level) with a volume equal to at least 5 per cent of that of the trap and/or of sufficient surface area and volume to prevent any hydrocarbon or debris contamination of the marine environment. This pit or tray should preferably be connected to the sump but, if not, it should be designed such that it is safe and easy to empty.

NOTE: Circumstances at a pig launcher may justify omitting such a catch pit or tray.

In view of the risk to the sensitive marine environment, during the design of an offshore pig trap particular attention shall be given to the following:

- The safe handling and disposal, without spillage, of any pigging products e.g. wax, debris etc.
- Provisions for testing the end closure door seal using non-polluting medium to prevent potential contamination in the event of a leak.

4.4 HORIZONTAL PIG TRAPS

The elevation of the bottom of the end closure on horizontal pig traps should be approximately 700 mm above grade to provide sufficient room to slope the drain lines as well as easy handling of the end closure and pigs.

Horizontal pig traps with a nominal diameter of 300 mm (12 inch) and above should normally be provided with pig lifting facilities, such as a runway beam, unless they can be readily accessed by cranes. Provision of a trolley with a push rod and pulling line should be considered to assist loading or removal of pigs from the trap. The use of these facilities, including the possible use of internal trays, shall be agreed with the Principal.

4.5 VERTICAL PIG LAUNCHERS

If a vertical pig launcher is inaccessible to the platform crane, a dedicated lifting facility shall be installed capable of lowering a (intelligent) pig into the barrel, unless it can be shown that the pig can be manually loaded in a safe manner.

The elevation of the barrel end closure above deck level should provide convenient access to the door locking mechanism.

A vertical ladder or local stairway shall be provided to allow access between deck levels local to the pig trap.

4.6 ACCESS PLATFORMS

A platform shall be provided adjacent to any valve where the centre of the handwheel is more than 1 500 mm above grade. Similarly, a platform shall be provided adjacent to any equipment (e.g. pig signallers) which is more than 1 500 mm above grade and which is used during pigging operations.

5. DESIGN ASPECTS OF MATERIAL PROCUREMENT

5.1 GENERAL

(•) The Principal shall specify the nature of the transported fluid, including details of toxicity and corrosivity.

All components in sour service should be resistant to HIC as well as conforming to the requirements of NACE MR0175. The HIC testing procedure and acceptance criteria for pipe, tees, reducers and any component made from plate (e.g. end closure door) shall be as specified in the appropriate material specification (5.3).

All main line items shall be compatible with the main line linepipe with respect to weldability, wall thickness/material grade transitions (3.2) and dimensions. Dimensional considerations include actual internal diameter, ovality and wall thickness transition taper angles (2.2).

5.2 LOW TEMPERATURE SERVICE

All items shall be designed and manufactured to avoid brittle fracture at possible low service temperatures (3.5). Reference is made to PTS 30.10.02.31 for guidance on definitions and requirements relating to materials in low temperature service. Although transmission pipelines are excluded from its scope it may be relevant for many of the pig trap components.

5.3 MATERIAL SPECIFICATIONS

The sections below relate to carbon steel pig trap systems only.

5.3.1 Barrel/Linepipe

The specification for all the main tubulars should be in accordance with the pipeline linepipe specification, preferably PTS 31.40.20.30 or 31.40.20.31

Note: If a corrosion allowance is used on the pipeline then a reduced allowance may be applicable for the major barrel since it is only used intermittently.

5.3.2 Valves

Valves should be procured in accordance with the MESC 77 buying descriptions and specifications, including any additional requirements for the particular service conditions. Specifications for valves in the mainline should be based on API 6D and attention should be given to the compatibility of any weld end pup pieces with the main line pipe.

Thermal relief valves should be procured in accordance with PTS 80.45.10.10

5.3.3 Flanges

Flanges should be procured in accordance with PTS 31.40.21.34

For main line flanges, the flange internal diameter should be specified to match the internal diameter of the adjacent linepipe.

5.3.4 Fittings

Tees, bends and reducers should be procured in accordance with PTS 31.40.21.30 For induction bends reference should be made to PTS 31.40.20.33

5.3.5 Bolting

The selection of bolting material shall be in accordance with PTS 30.10.02.11 Bolts and nuts shall be fluorocarbon-coated.

NOTE: The preferred materials for standard applications are ASTM A193/A193M grade B7 and ASTM A194/A194M grade 2H for non-sour service conditions, and ASTM A193/A193M grade B7M and ASTM A194/A194M garde 2HM for sour service conditions. For special applications, e.g. low temperature, other materials may apply.

5.3.6 Other items

Piping and ancillary items should be procured in accordance with the Piping Classes (PTS 31.38.01.12 and PTS 31.38.01.15).

NOTE: Specifications for Piping Classes (and associated MESC buying descriptions) are based on ASME B31.3 requirements. They will satisfy B31.4/8 requirements in most cases, normally with greater wall thickness because of lower allowable stress levels, but care should be taken with transitions to high strength materials, i.e. higher than X52 or WPHY52 grades as detailed in the above specifications.

6. REFERENCES

In this PTS reference is made to the following publications:

NOTE: Unless specifically designated by date, the latest edition of each publication shall be used, together with any amendments/supplements/revisions thereto.

PETRONAS STANDARDS

PTS publications and standard Specifications	PTS 00.00.05.05
Requisitioning binder	PTS 30.10.01.10
Metallic materials – selected standards	PTS 30.10.02.11
Non-metallic materials – Selection and application	PTS 30.10.02.13
Metallic materials – Prevention of brittle fracture	PTS 30.10.02.31
Design of cathodic protection systems for onshore buried pipelines	PTS 30.10.73.31
Design of cathodic protection systems for offshore pipelines (amendments/supplements to DNV RP B401)	PTS 30.10.73.32
Pressure vessels (Amendments/Supplements to ASME VIII, Div. 1 and Div. 2)	PTS 31.22.20.31
Piping classes - Refining and Chemicals	PTS 31.38.01.12
Piping classes - Exploration and Production	PTS 31.38.01.15
Data/requisition sheet for design of a pig trap system for a pipeline	PTS 31.40.10.93
Linepipe for use in oil and gas operations under non-sour conditions (amendments/supplements to API Spec 5L)	PTS 31.40.20.30
Linepipe for use in oil and gas operations under sour conditions	PTS 31.40.20.31
Linepipe induction bends (amendments/supplements to PTS 31/40/20.30 and PTS 31.40.20.31)	PTS 31.40.20.33
Pipeline fittings	PTS 31.40.21.30
Pipeline isolating joints (amendments/supplements to MSS SP-75)	PTS 31.40.21.31
Pig signallers: intrusive type	PTS 31.40.21.33
High grade pipeline flanges for non-sour and sour service	PTS 31.40.21.34
Data/requisition sheet for pig trap end closures	PTS 31.40.21.94
Instrumentation of depressuring systems	PTS 32.45.10.10
Pressure relief, emergency depressurising, flare and vent systems	PTS 80.45.10.10
MESC buying descriptions and specifications	MESC
Valves and accessories	MESC 77
EP HSE Manual	EP-95000

AMERICAN STANDARDS

Process piping	ASME B31.3
Liquid transportation systems for hydrocarbons, liquid petroleum gas, anhydrous ammonia, and alcohols	ASME B31.4
Gas Transmission and distribution piping systems	ASME B31.8
ASME Boiler and Pressure Vessel Code: Section VIII: Unfired pressure vessels	ASME VIII

Issued by:
American Society of Mechanical Engineers
345 East 47th Street
New York NY 10017
USA.

Alloy steel and stainless steel bolting materials for high-temperature service	ASTM A193
Carbon and alloy steel nuts for bolts for high-pressure and high-temperature service	ASTM A194

Issued by:
American Society for Testing & Materials
100 Bar Harbor Drive
West Conshokocken
PA 19428-2959
USA.

Pipeline valves	API 6D

Issued by:
American Petroleum Institute
Publications and Distribution Section
220 L Street Northwest
Washington DC 20005
USA

Sulphide stress cracking resistant metallic materials for oil field equipment	NACE MR0175

Issued by:
National Association of Corrosion Engineers
P.O. Box 218340
Houston
Texas 77218
USA

INTERNATIONAL STANDARDS

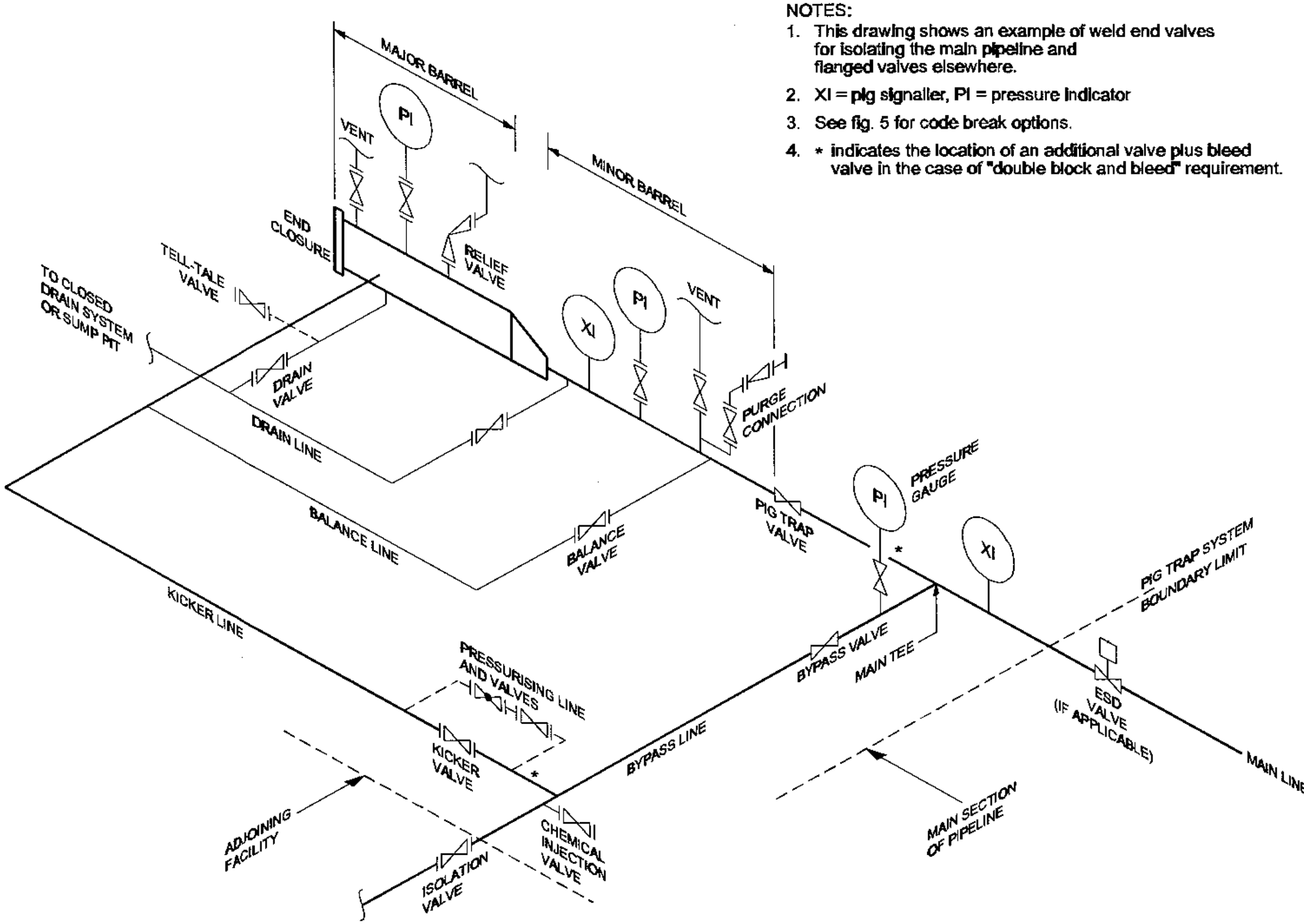
Petroleum and natural gas industries - Steel pipe for pipelines - Technical delivery conditions - Part 1: Pipes of requirement class A	ISO 3183-1

Issued by:
International Organisation for Standardization
1 Rue de Varembé
CH-1211 Geneva 20
Switzerland

Copies can also be obtained from national standards organizations.

7. FIGURES

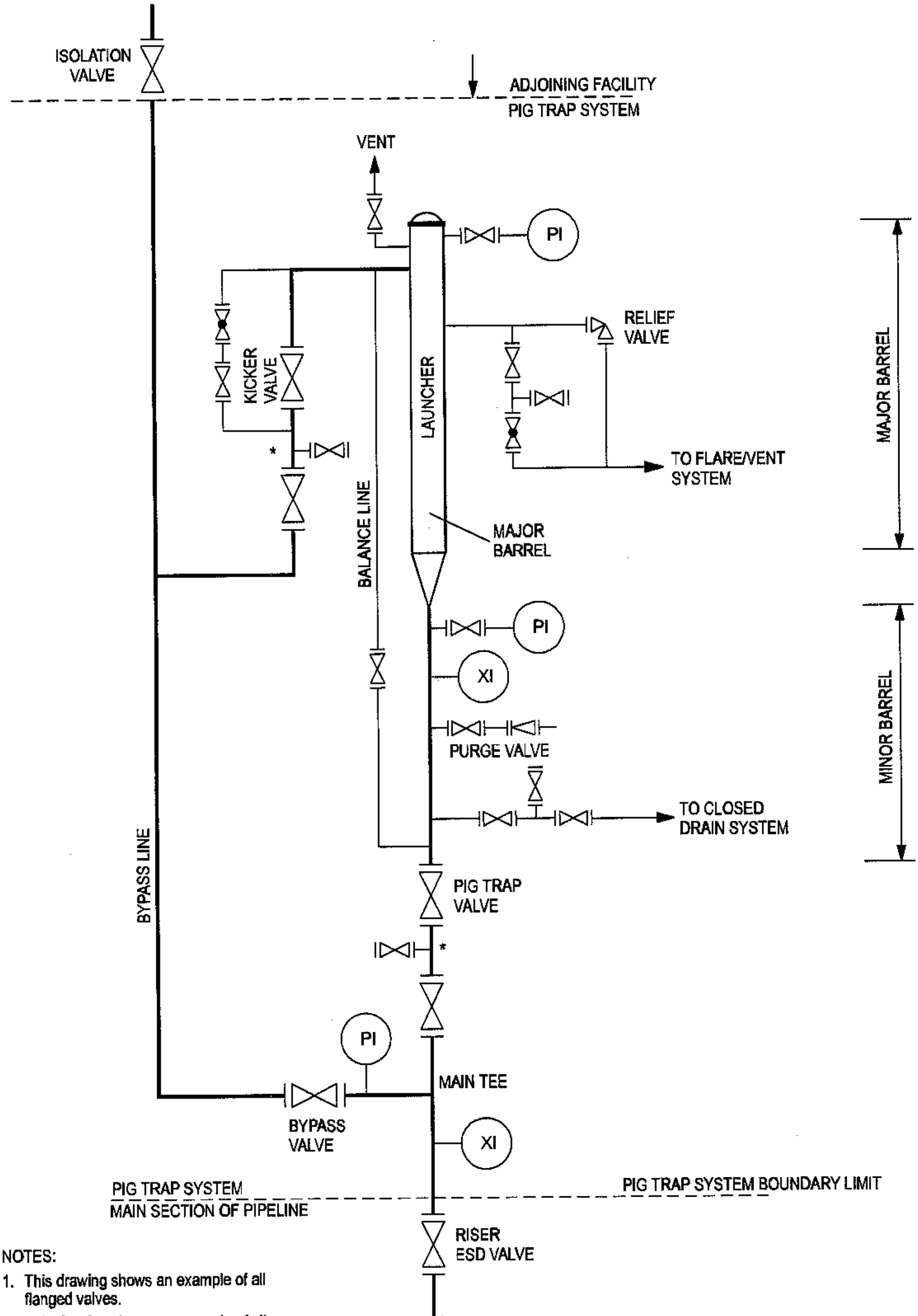
Figure 1 **Schematic of typical horizontal pig trap system**



NOTES:

1. This drawing shows an example of weld end valves for isolating the main pipeline and flanged valves elsewhere.
2. XI = pig signaller, PI = pressure indicator
3. See fig. 5 for code break options.
4. * indicates the location of an additional valve plus bleed valve in the case of "double block and bleed" requirement.

Figure 2 Schematic of typical vertical (offshore) pig trap system

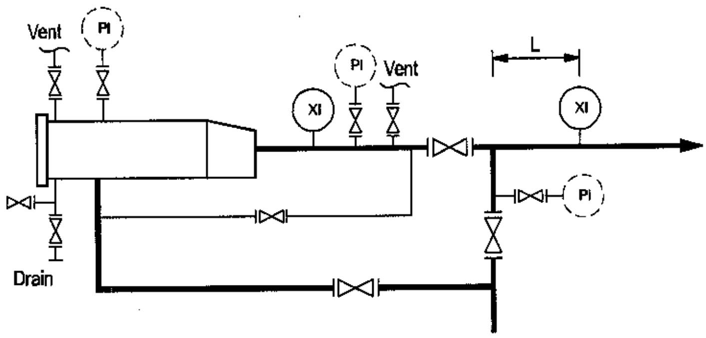


NOTES:

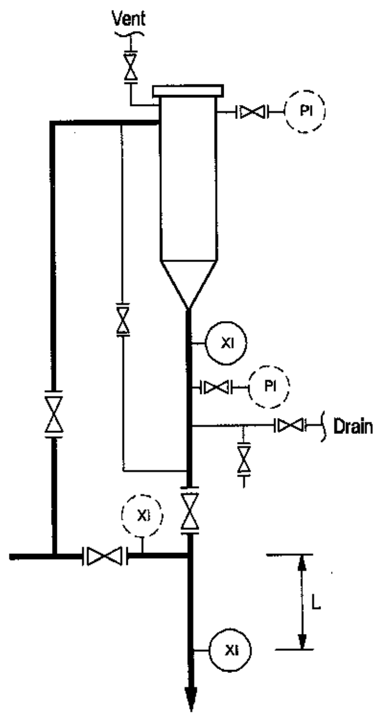
1. This drawing shows an example of all flanged valves.
2. This drawing shows an example of all double block and bleed valves at locations *
3. See fig. 5 for code break options.
4. XI = pig signaller, PI = pressure indicator.
5. Chemical injection point not included.
6. This drawing shows an example of a blowdown line to a flare system.

Figure 3 Schematic of minimum required pig trap facilities

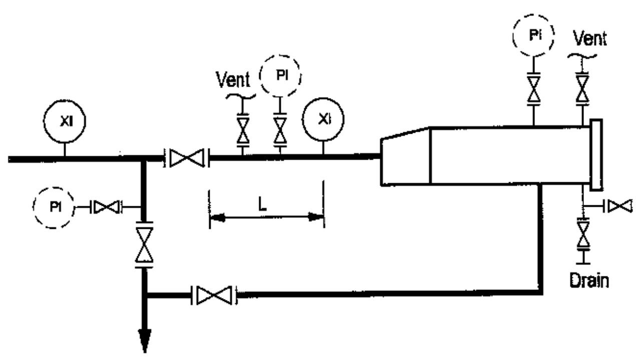
Horizontal launcher



Vertical launcher



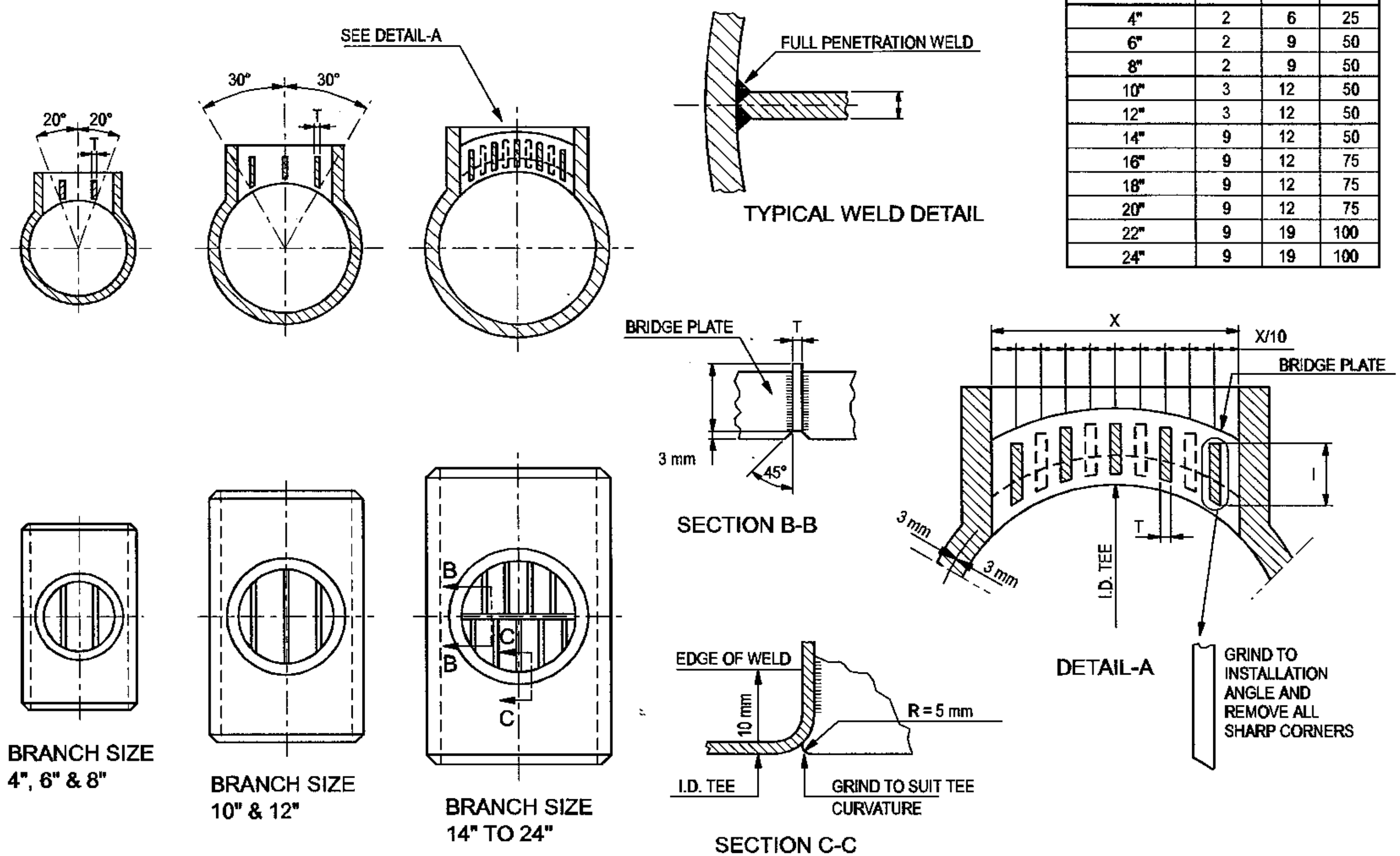
Receiver



L = Minimum length equal to maximum length of pig, usually intelligent pig - see Table 3.

Figure 4 Reducing barred tees

Note: This drawing is not meant to be a complete procurement specification.



REDUCING BARRED TEE			
NOM. BRANCH SIZE	No. OF BARS	T mm	I mm
4"	2	6	25
6"	2	9	50
8"	2	9	50
10"	3	12	50
12"	3	12	50
14"	9	12	50
16"	9	12	75
18"	9	12	75
20"	9	12	75
22"	9	19	100
24"	9	19	100

Figure 5 Code break for pig traps

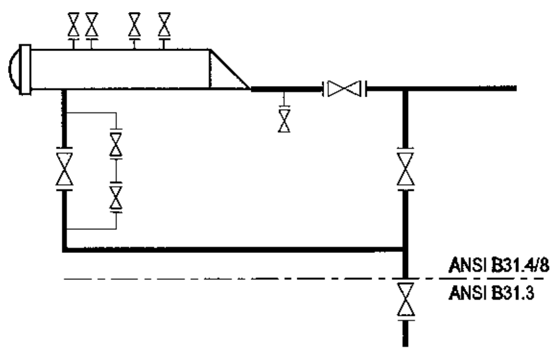


Figure 5A
(recommended option)

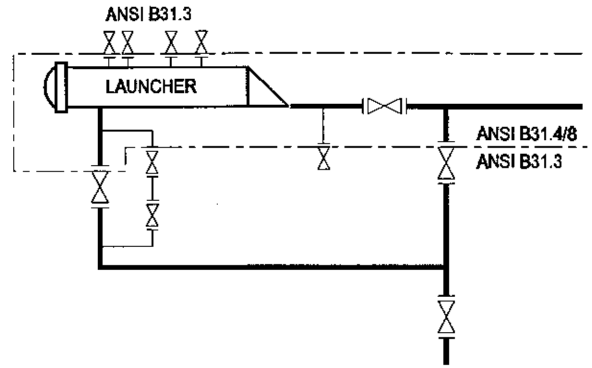


Figure 5B

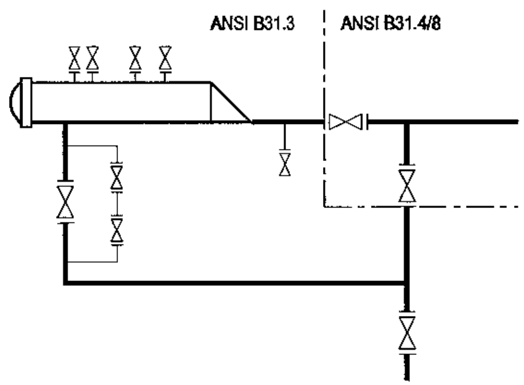


Figure 5C
(not recommended)

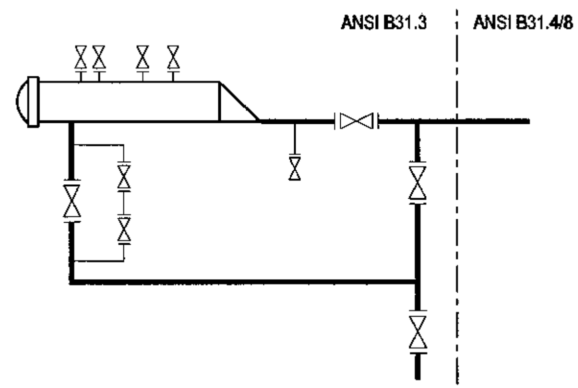
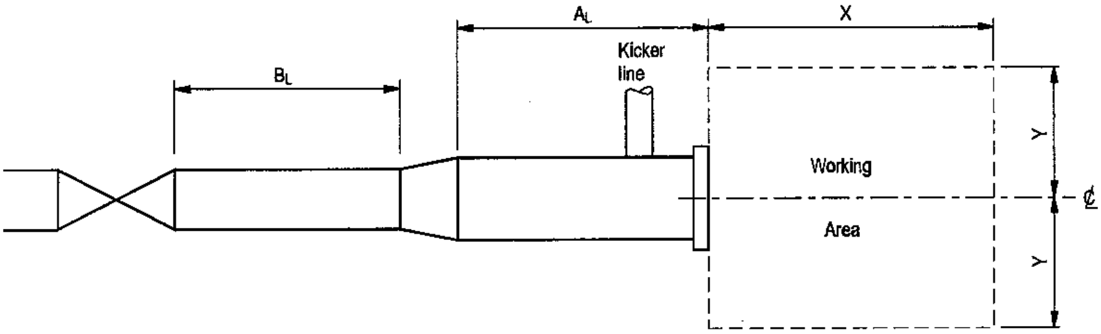


Figure 5D
(not recommended)

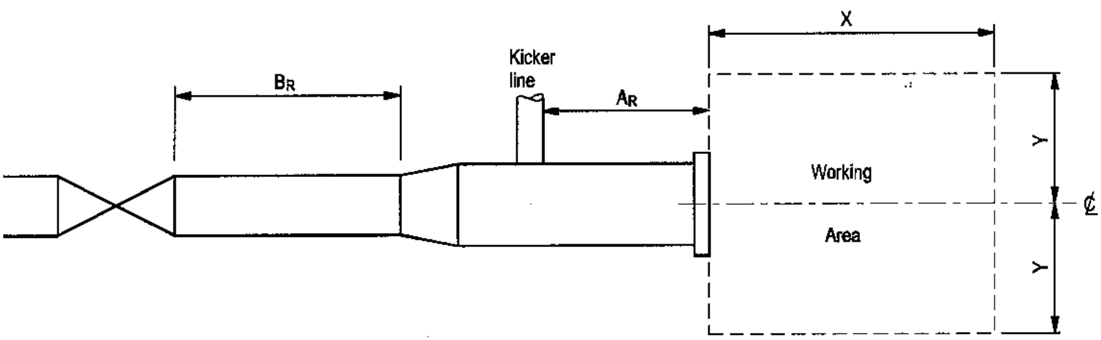
Note: These drawings show examples of all valves being flanged

Figure 6 Recommended pig trap dimensions

1. Launcher



2. Receiver



Recommended Values

A = see values in table 3
B = see values in table 3

X = maximum length of pig plus approx 1 m
Y = 0.9 m for 4" to 32" pipelines
= 1.5 m for 34" and above

APPENDIX V

GANTT CHART FOR FINAL YEAR PROJECT

APPENDIX V

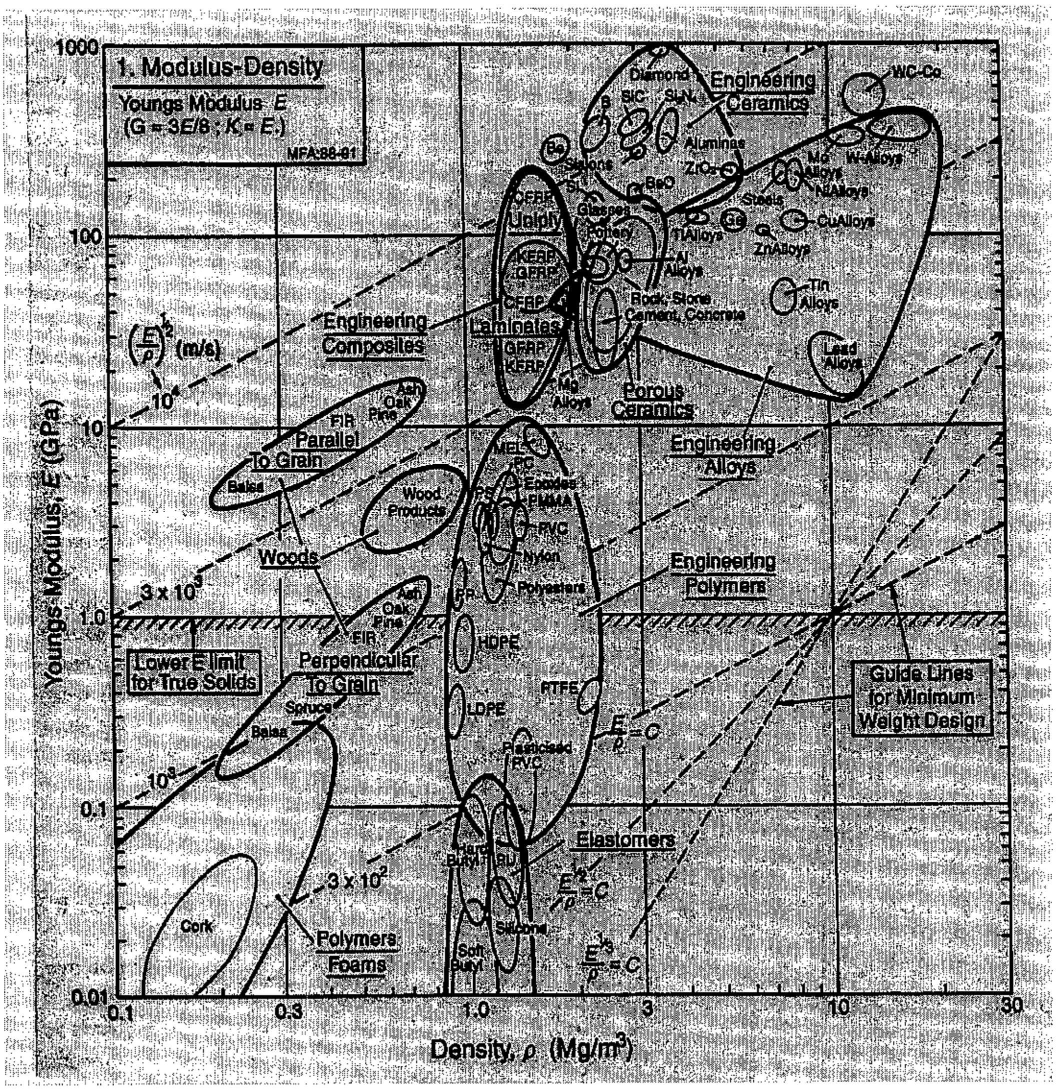
	SEMESTER 1																	
	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18
	21/07 – 27/07	28/07 – 03/08	04/08 – 10/08	11/08 – 17/08	18/08 – 24/08	25/08 – 31/08	01/09 – 07/09	08/09 – 14/09	15/09 – 21/09	22/09 – 28/09	29/09 – 05/10	06/10 – 12/10	13/10 – 19/10	20/10 – 26/10	27/10 – 02/11	03/11 – 09/11	10/11 – 16/11	17/11 – 23/11
Topic Selection	■	■	■															
Preliminary Research Work			■	■														
Preliminary Report				●														
Literature Review				■	■	■	■	■	■									
Project Work							■	■	■	■	■	■	■	■	■			
Progress Report										●								
Interim Report Final Draft														●				
Oral Presentation																●		
Project Dissertation																		●

Week 16 : Study Week
Week 17 - 18 : Exam Week

APPENDIX VI

ASHBY CHART FOR MATERIAL SELECTION

APPENDIX VI



Ashby Chart for Material Selection