# RESEARCH INTO ALTERNATIVE METHODS TO DISPOSE INTERMIXTURE

By

Leslie Colin Naidoo

Submitted in partial fulfillment of the requirements for the degree of
MASTERS IN BUSINESS ADMINISTRATION

Graduate School of Business, Faculty of Management
University of Natal (Durban)

Supervisor: Prof Elza Thomson

September 2003

**CONFIDENTIALITY CLAUSE**

15 September 2003

TO WHOM IT MAY CONCERN

RE: CONFIDENTIALITY CLAUSE

Due to the strategic importance of this research it would be appreciated if the contents remain confidential and not be circulated for a period of ten years.

Sincerely

096229

L.C Naidoo

## DECLARATION

This research has not been previously accepted for any degree and is not being currently submitted in candidature for any degree.

Signed.....

Date... 12 SEPTEMBER 2003

## ACKNOWLEDGEMENTS

I am most grateful to God for granting to me the ability and strength to go through an intensive MBA programme with Natal University, and to research the chosen topic. I am especially thankful for my wife Mimmie and my children Brenton and Bronwynne, for giving me time required to complete this MBA programme.

My sincere thanks and appreciation also goes to my Supervisor for this research, Prof Elza Thomson, for her invaluable assistance and time and for pointing out inconsistencies with respect to format and, in so doing help improved my text.

My thanks are also due to my CEO, Mr Charl Moller and colleagues Rodney Proud (Petronet Drawing Office), Glen Lund, Mike Khoza, and Peter Mthi for tapping into their resources and knowledge for information where required. I would also like to express my gratitude to my friends from the oil industry Sasol, Sapref and Enref for friendliness and their unselfish input into the study.

## ABSTRACT

It is the purpose of this research to provide a brief background to the South African Petroleum Industry and to focus in particular to Petronet with regards to finding an amicable solution to dispose the excess intermixture created, as a result of the Oil Industry reviewing the current blend rate at which intermixtures can be blended into pure products. The pipelines operated by Petronet are mainly multi-product pipelines i.e. many different refined petroleum products use the same pipeline at the same time and there is a level of co-mixing between each product which is termed intermixture.

The primary method that Petronet disposes intermixture is on continuous process into pipeline deliveries to clients (commonly known as blending). This means that while a delivery to a client is being made, careful analysis and calculation are done to blend some intermixture into this delivery, making absolute certain that the end product to the client remain within the predetermined specification. Originally, Petronet was allowed to blend 0,5% diesel into petrol and 0,25% petrol into diesel, provided that in the case of petrol the FBP of $215^0$C was not exceeded and that the residue content did not exceed 2%. With Motorcar manufacturers now producing hi-tech cars that require high quality fuel to be compatible with the extended service intervals, Industry have revised the original blending rates of diesel into petrol from 0,5% to 0, 25%. This means that Petronet cannot blend more intermixture as it did in the past, as a result there will be an accumulation of excess intermixture. The impact of this revision has and is adversely affecting the nature in which Petronet operates. This research seeks to explore alternative methods in which Petronet can use to address the excess intermixture problems. Three solutions are identified namely: short, medium and long term solution. The short being the sale of excess intermixture, the medium being the re-processing of excess intermixture by refineries and the long term sustainable solution is for Petronet to invest in its own Refractionator unit. This unit would be the ultimate and the best solution as it allows Petronet to re-process the intermixture back to its base and this product can then be blended back at a much higher rate.

## TABLE OF CONTENTS

## TABLE OF CONTENTS

## TABLE OF CONTENTS

## APPENDICES

# CHAPTER 1

## 1.1 INTRODUCTION

The original Petronet Conveyance Agreement dates back to 1965 when the pipeline was established. There are key principles and conditions set in that agreement that governs the conveyance of petroleum products by Petronet's pipeline. One of the principle conditions in the agreement allowed for a blending rate of 0,5% diesel into petrol and 0,25% petrol into diesel, provided that in the case of petrol the FBP of $215^0$C was not exceeded and that the residue content did not exceed 2%.

With Motorcar manufacturers now producing cars that require high quality fuel to be compatible with the extended service intervals, Industry have revised the original blending rates of diesel into petrol from 0,5% to 0,25%. The impact of this revision has seen considerable increase in intermixture accumulation, as Petronet is unable to blend all generated interfaces into the delivered product.

**Petronet modus operandi in the past**

Prior to the revised blend table, Petronet was always successful in optimizing its blending of all generated intermixtures into delivered products. Petronet maintained a manageable situation by balancing what intermixtures were generated and what was blended.

**Intermixture growth**

Since the implementation of the revised blend tables, Petronet intermixture has grown to a point where plans must be implemented to find a long term solution to prevent a disruption of the pipeline operation.

## 1.2 BACKGROUND TO THE STUDY

The primary method that Petronet disposes of intermixture is on continuous process into pipeline deliveries to clients. The pipelines operated by Petronet are mainly multi-product pipelines i.e. many different refined petroleum products use the same pipeline at the same time and there is a level of co-mixing between each product which is termed intermixture. The intermixture is almost in equal proportions to the two different petroleum products being transported on either side of it and is completely out of specification in that form and hence could not be sold for any use except maybe heating oil.

This intermixture is taken into special tanks trying as best we can to separate it into the base components. The contents of the intermixture tanks is then analyzed as well as the contents of the good product that is about to be delivered. It is then calculated at what rate this intermixture can be blended back into the product to be delivered into our clients tanks, making absolutely sure that all specifications are still met. (see table below: typical calculation of amount of intermixture that can be blended into pure products at 0.5% and at 0.25%)

In the perfect world, and up to a few months ago (before February 2003, Petronet has always been able to dispose of all of its intermixture in this manner.

**Table 1.1**

**Example of old Blend Table vs. Revised Blend Table**

| | Old | Revised |
|---|---|---|
| Percentage Blend Tables | 0.5 | 0.25 |
| Petrol Intermixture Tank( Distillation at 190 degrees) | 70 | 70 |
| Diesel Intermixture Tank( Contaminant) | 30 | 30 |
| Delivery Time( Minutes) | 484 | 484 |
| Blend % rate | 1.67 | 0.833333 |
| Pure Petrol ( Liters) | 2850000 | 2850000 |
| Slop to blended( Liters) | 47500 | 23750 |
| Blend Rate( Liters/Min) | 98 | 49 |

However a problem has arisen over the last year or so where the Oil Industry Technical Committee has requested that Petronet reduce the amount of intermixture blended, particularly into leaded petrol's. In actual fact the requested blending rate of diesel into

leaded petrol has been reduced by 50 %.( 0.5 % to 0.25%). This has had the effect that Petronet has not been able to blend away all generated intermixtures (this problem was made worse during the Natref fire and shutdown when changes to normal pipeline operations resulted in the generation of additional intermixture) by normally practiced means. Intermixture tanks were filling up and this was threatening the continued operating of the pipeline network. Alternate methods for the disposal of the extra intermixture had to be found.

## 1.3 MOTIVATION FOR THE STUDY

In search for alternative methods to dispose intermixture other than the conventional, Petronet entered into a short-term solution to a re-refining contract with Oil Industry whereby Petronet would send intermixture to the refinery and pay a tariff for it to be re-refined. There would be a certain refinery loss (+/- 10%) and that refinery would then give Petronet the product back at it's refinery gate at the proportion of the make up of the offered intermixture minus the refinery loss. The intermixture that is sent for re-refining is tested in Petronet laboratories at the delivery depots concerned. These tests indicate the composition of the intermixture as to the percentage mix of petrols and diesel and samples are kept for one month. The refined product will then be injected back into the pipeline from the refinery.

Oil refineries that are currently assisting in disposing some of the intermixture are not always in a position to assist Petronet, as there are other important issues that need to be attended to at Refinery. There assistance is also limited and Petronet often find its intermixture tanks are filling more than what is blended away or taken away by the refinery.

The purpose of this study is to investigate whether there is an alternative method to dispose intermixture other than the current method.

## 1.4 VALUE TO THE COMPANY

- A saving on consultant fees
- A time saving as there is not much time before the phasing out of leaded petrol (2006)
- bringing new skills and knowledge to Petronet
- Preliminary specification before tender
- Petronet to make an informed decision
- Patent rights (intellectual rights)
- Drawings for the proposed Refractionator and accessories

## 1.5 PROBLEM STATEMENT

Is there an alternative method to dispose intermixture for Petronet other than by the current blending methodology?

## 1.6 OBJECTIVES OF THE STUDY

- To evaluate intermixture trend after implementation of revised blend table and its impact to the company.
- To determine other methods of handling and disposing intermixture.
- To establish whether Petronet's current infrastructure is adequate to implement other methods of handling intermixture.

## 1.7 RESEARCH METHODOLOGY

Information gathering will be conducted through interviews with key Oil industry and Petronet personnel for data search. The key personnel and decision makers from the Oil Industry will be carefully targeted for their views and input into the research.

1.7.1 Secondary data

- Petronet weekly intermixture reports

- SABS specification for petroleum products
- Petronet Conveyance Agreement

1.7.2 Industry's current method of handling intermixture

1.7.3 International method of handling intermixture

## 1.8 LIMITATIONS

**None**

## 1.9 STRUCTURE OF THE STUDY

**Chapter two**

In chapter two, a brief overview of Petronet and the South African Petroleum Industry will be discussed. This chapter is to present the various refineries operating in the Southern hemisphere, their location, ownership and production capabilities. One would appreciate the fact that pipelines play an integral role in the distribution of the inputs ingredient (crude oil) and output products (refine products, namely petrol, diesel, Avtur, etc) This chapter also defines intermixture, its generation and problems in having to deal with this inevitable existence when operating a multi-products pipeline. In this chapter, the reader is made aware of what can happen should intermixtures not be blended away as normal practice and what can be done to minimize to a certain extent the overall size of the intermixture.

**Chapter three**

In chapter three, an evaluation of the intermixture data from Petronet is done. This data is sourced from the weekly reports generated by each depot with respect to their holding intermixture size on hand. What is quite noticeable is the increase in intermixture holding once a revised blend table was introduced. The revised blend table basically restricts Petronet to blend less than what it normally blends in products. This is the crux of the problem and it is this issue that is further explored in this research to find an alternative method to get rid of the excess intermixture. (excess intermixture in the context of this research will be defined as intermixture that has been generated due to the revised blend

table)This chapter also presents three solutions namely; short, medium and a long term solution to deal with the excess intermixture.

**Chapter four**

In chapter four, the solutions are tested to evaluate whether the critical depots can use these solutions. This chapter also gives recommendations of what needs to be in place for the solutions to be successfully implemented.

**Chapter five**

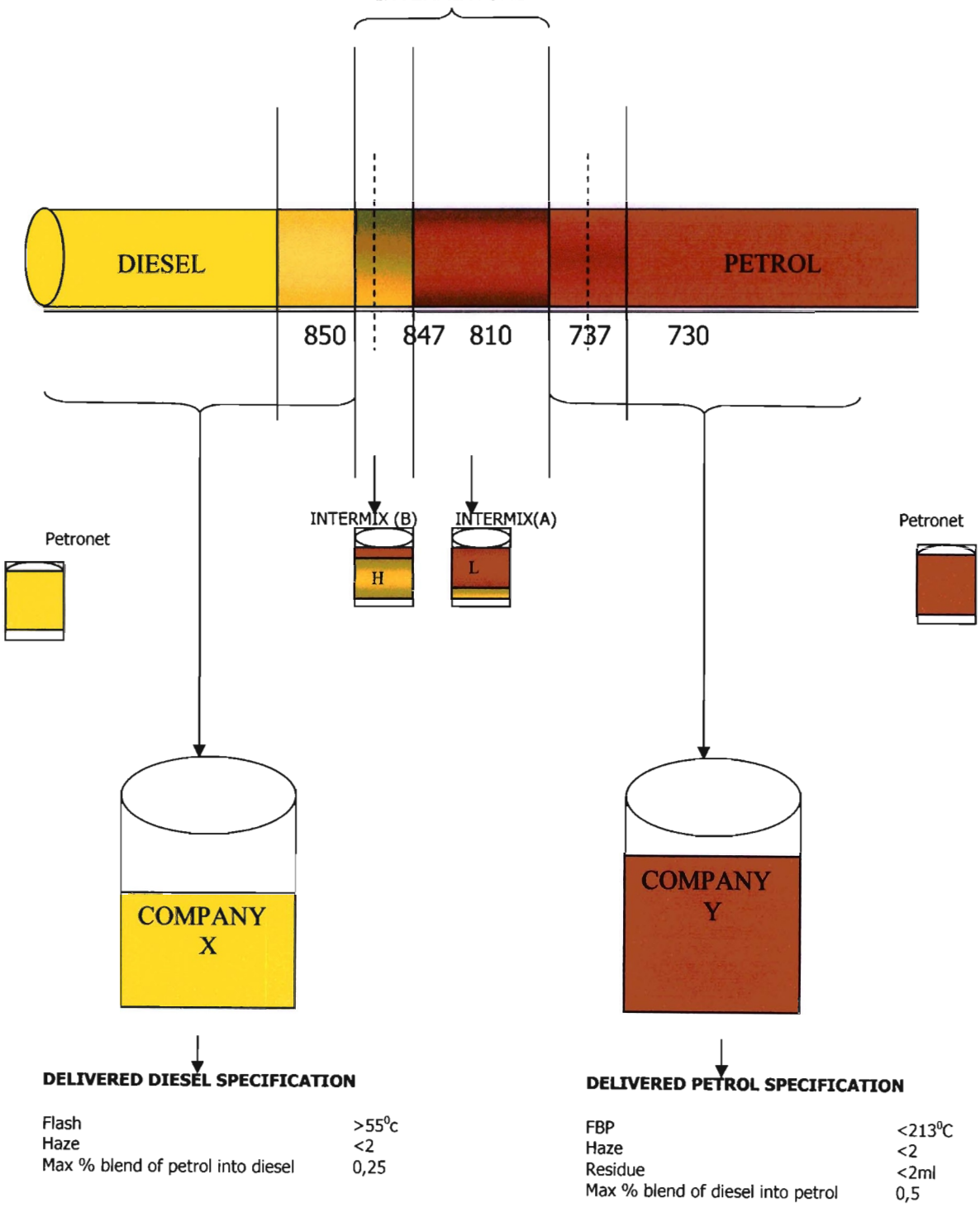
In concluding and making a recommendation, this chapter clearly states that Petronet or any other company that intends operating a multi-products pipeline, will always have the issue of what to do with the intermixtures generated. This chapter recommends methods that can be implemented now to reduce intermixture stocks and also the ideal long term strategy.

## 1.10 SUMMARY

The effect of the revised blend table has forced Petronet to identify short, medium and long term strategies. Each of these strategies has operating and financial risk associated with its implementation. Given the fact, that except for Tarlton depot, no other depot has facilities to handle rail or road hauling, is an issue that needs to be addressed and evaluated further in terms of financial implications and operating risks. It is recommended that Petronet invest in infrastructure upgrading at critical depots Kroonstad, Alrode and Langlaagte first before looking at other depots. The long term view in the best interest for Petronet would be to build a Refractionator with a joint venture with a BEE company. One can only assume that as time progresses and having more sophisticated cars manufactured, that there will be a tighter control on the quality of product produced and used. Legislation may even demand, zero blending, it therefore makes absolute sense for Petronet to invest in the long term solution of a Refractionator, which would ensure that they are able to deal with excess intermixtures and abide by any future legislation on product specification.

**Figure 1.1**

## GRAPHICAL REPRESENTATION OF BLENDING INTERMIXTURE




**DELIVERED DIESEL SPECIFICATION**

| | |
|---|---|
| Flash | >55$^0$c |
| Haze | <2 |
| Max % blend of petrol into diesel | 0,25 |

**DELIVERED PETROL SPECIFICATION**

| | |
|---|---|
| FBP | <213$^0$C |
| Haze | <2 |
| Residue | <2ml |
| Max % blend of diesel into petrol | 0,5 |

**Explanation: Figure 1.1**

Let us assume that this is a new piece of pipeline and those are the only two products namely: petrol (indicated in red) and diesel (indicated in yellow) that are currently being conveyed and that the given density for petrol and diesel is 0,730 Kg/l and 0,750 respectively.

**Monitoring process**

Let us assume that this petrol was scheduled to be delivered to a client Y at Ladysmith and diesel was scheduled for client X at Ladysmith. When the petrol arrives at Ladysmith, the controller would start delivering the clean petrol to client Y. The controller will monitor the quality of the product being delivered. When the controller notices a change in colour or density, the controller would then switch the flow of product from the client Y to Petronet's intermixture tank A. Tank A is normally used for light intermixtures which is more petrol based.

At a predetermined density closer to the new product, the controller would switch the flow from tank A to tank B. Tank B is the heavy intermixture tank (normally more diesel based). When the correct density for diesel is detected, the controller would then switch flow from tank B to the client X.

**Intermixture Tank A&B**

The product in tank A and B is the intermixture. What does Petronet do with that intermixture? The current strategy is to blend this intermixture back into pure products as per Petronet's conveyance agreement. Petronet was allowed to blend 0,5% diesel into petrol and 0,25% petrol into diesel, provided that in the case of petrol the FBP of $215^{0}$C was not exceeded and that the residue content did not exceed 2%.

The new revised rate is now 0,25% diesel into petrol and 0,25% petrol into diesel. This effectively means blending less intermixture as a result Petronet having limited capacity for intermixture would inevitably have an overstock of intermixture. This research looks at the alternative of dealing with the excess intermixture.

**Figure 1.2**

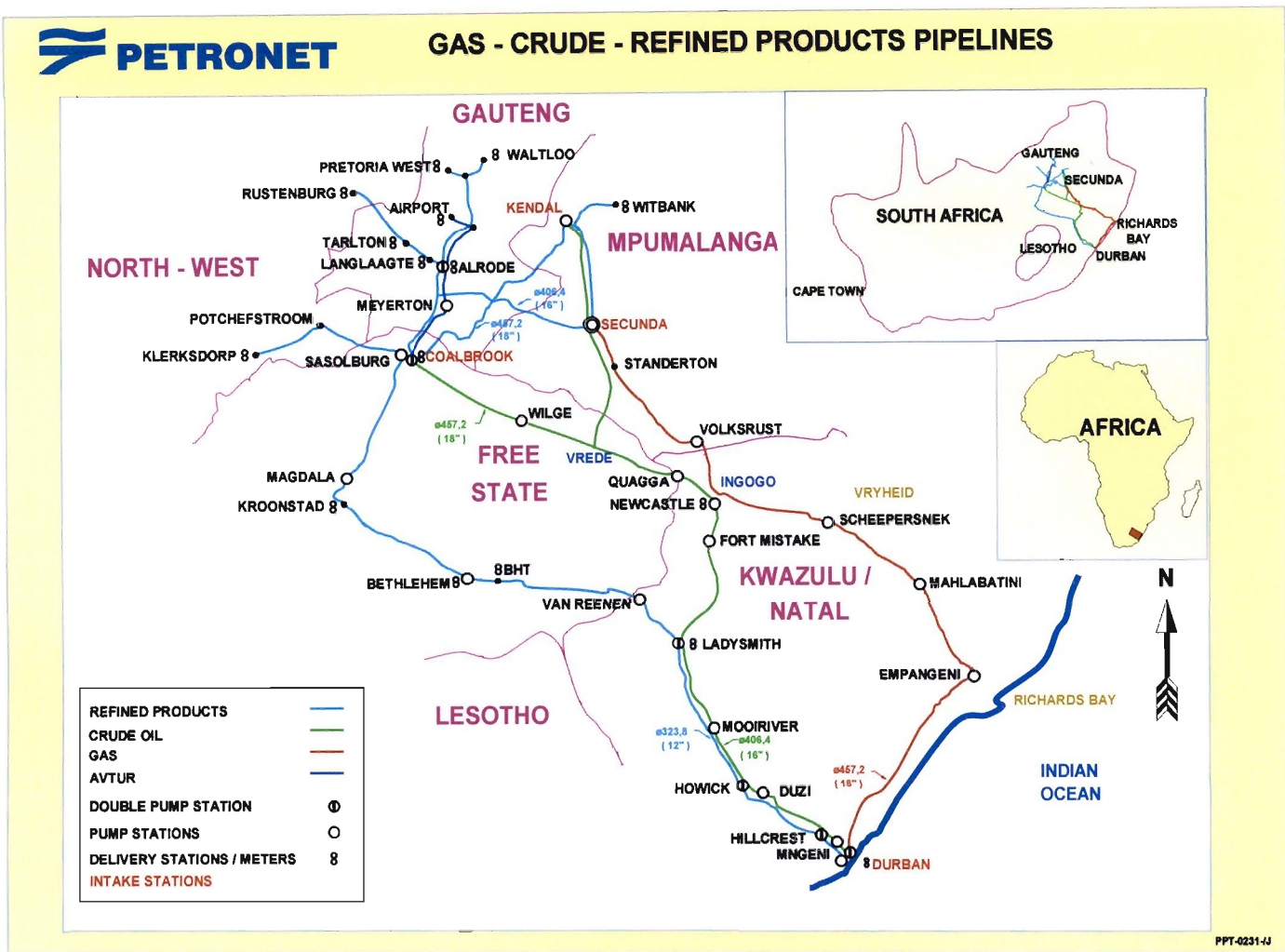



Figure 1.2 above is a schematic drawing of all the pipelines that Petronet currently owns, maintain and operate.

There are basically 4 pipelines namely: the multi-products pipeline (light blue), Avtur (dark blue), Crude oil pipeline (green) and Gas pipeline (red)

# CHAPTER 2

# OVERVIEW ON THE SOUTH AFRICAN PETROLEUM INDUSTRY

## 2.1 Introduction

In the early 60s when South Africa's economy began expanding rapidly and the oil industry forecasting an annual 12 percent growth in the demand for petroleum products , it became evident that the rail link from Lourenzo Marques ( now Maputo ) in Mozambique and from Durban would soon be unable to meet the demands of imports and exports.

After considering various alternatives, the government of the day decided to lay a pipeline from Durban to the Reef to convey the petroleum products, thereby relieving the pressure on the rail system. The government recognized not only the strategic importance of this project, but also the economic necessity of transporting fuel by pipeline.

In November 1965 SA Pipelines (now known as Petronet) was officially born and the first batch of fuel was sent from Durban to the Reef for the first client, Mobil. The next major development was to build the Sasol 2 and Sasol 3 complexes due to the growing unrest in Mozambique. The government of the day decided to build a second products pipeline running from Durban to the Reef via the Eastern Transvaal (now Mpumalanga).

Over the past 30 years many modifications have been made to the existing system which now consists of three lines, one for fuel ( refined products ), one for crude oil, and another for gas, which runs from Secunda to the coast. A dedicated line transports aviation fuel, Avtur, from the Natref refinery at Coalbrook to Johannesburg International Airport.

## 2.2 Petronet today

Petronet is a division of Transnet Limited. It was established in 1965. Petronet owns, maintains and operates a network of some 3000km of high-pressure petroleum and gas pipelines. The major pipelines are broken up into 4 namely;

Refined products pipeline (built in 1965: 12" diameter- flow rate of 440 $m^3$/hr), Crude oil pipeline (built in1969: 16" Diameter – flow rate of 840 $m^3$/hr), Gas pipeline (16"/18" diameter) and an Avtur pipeline (built in 1973 6" diameter 150 $m^3$/hr). Petronet transports through its network billions of litres of fuel. Some of the products transported by Petronet are leaded and unleaded petrol, diesel, aviation turbine fuel, crude oil and gas.

In the control center in Petronet's head office in Durban, the entire networks operations are planned and monitored for 24 hours per day, 365 days a year.

## 2.3 The pipeline network- Infrastructure (see annexure 1)

- The liquid fuels network has 32 pump stations/depots and transverses five provinces; Kwazulu Natal, Free State, Gauteng, North West and Mpumalanga.
- Petroleum products are injected into the pipeline from the following points: the two refineries at the coast (Sapref and Enref), the inland crude refinery at Coalbrook (Natref) and the synfuel plants at Secunda (Sasol II and III)
- Crude oil for the Natref refinery is transported via a dedicated pipeline from an outer SBM, which is situated offshore at Durban.
- The gas pipeline runs from Secunda to Durban via Empangeni. Clients are served at Newcastle, Richards Bay and along the route between Empangeni and Durban.
- The pipelines range from 6" (150mm) to 20" (508mm) in diameter and are all continuously welded x52 steel pipelines.
- All the pipelines have been constructed in accordance with the American Code ASME B31.4 for liquid and ASME B31.8 for gas.
- Products are transported through the various pipelines at a maximum allowable pressure of up to 100 Bar for petroleum products and 59 Bar for gas.

## 2.4 Monitoring, maintenance and protection of infrastructure

- Pressure in the pipeline network is monitored 24 hours a day, 365 days a year in the Master Control Centre in Petronet's head office Durban.
- Petronet uses internationally recognized technological inspection tools called "intelligent Pigs" which tells us the condition of the pipe. This is done on a five-year cycle and when otherwise necessary. It is a known fact that by monitoring the pipe wall condition, one can extend the life of the pipeline-even up to 65 or 70 years with diligent repairs and corrective maintenance.
- Inhibitor dosed at strategic points in the network protects the pipeline internally from internal corrosion.
- Cathodic protection protects the pipeline external metal loss caused by stray current corrosion.
- A specialized maintenance/operational crew is o standby 24 hours a day, 365 days a year to undertake pipeline repairs, to ensure that maximum utilization is obtained and that clients needs are met.
- Emergency plans that are regularly updated and practiced, are in place in the event of major catastrophes and/or incidents.
- Regular aerial inspections ensure that the servitudes are well-maintained and untoward occurrences immediately followed up.
- All pump stations are operated and monitored centrally via a proven tele-control system.
- Dynamic and passive leak detection systems are utilized.
- The pipeline is sectioned with the aid of block valves and check valves that minimize loss/pollution should a rupture occur.
- Pipelines are constructed to maximize safe operation and minimize risk of environmental damage.

## 2.5 Environmental Control

Since the first Bill was read in Parliament in 1963, it has been a stringent policy that wherever the environment was disturbed due to pipeline activities,

the area would be restored as far as possible to its former state. With an environmental awareness becoming a major concern of industry, Petronet's committed concern has been taken a few steps further, during the last few years gross spillage of 0.001% of product transport was recorded. Petronet can proudly boast that they are firm believers in the old maxim:

"Prevention is better than cure ".

Environmental Impact Assessments are done for all new projects. Depots, including fire protection equipment have been upgraded to conform to SABS 089 Standards.

To ensure compliance with the OHS Act (Occupational Health and Safety Act) Petronet has implemented the Petronet Health and Safety program whereby all stations and depots are required to achieve the equivalent of a 3 star National Occupation Safety Association standard (NOSA). In accordance with the OHS Act, Petronet as the responsible operator/owner has public insurance.

At present Petronet is in the process of putting together an even more comprehensive Environmental Management System in terms of SABS 0251 standards. All depots are being upgraded to combat and prevent pollution and damage to the environment. At present 90% of the depots conform to SABS 089 standards and the upgrading of the remaining ten percent is an urgent priority.

Bunds have been constructed around manifolds and contaminated water and spilt product is fed off into spill dams where it is contained. After processing through a separator tank, the clean product is stored and the water released into foul sewerage in consultation with local authorities.

Fire protection equipment at all stations conforms to NFPA and SABS 089 standards and has been further reinforced by upgrading fire equipment to include oscillating foam cannons.

Petronet is a member of the Oil Industry Environment Committee, a national body comprising the main role players in the South African Oil Industry. Contingency plans are available for any disaster that may occur and highly sophisticated spill response equipment and extensive expertise is available within the Committee for use by all its members. Petronet conducts Environmental Impact Assessments and consults local residents and municipalities when new developments are planned.

### 2.6 Role and function of pipelines from a statutory and a governmental point of view

Petroleum products pipelines and crude oil pipelines are a matured form of transport providing refineries with their raw material (crude) or else delivering completed products to the market. The pipelines operate on an open access principle and tariffs are equal to all users. These tariffs are published and used by Department of Minerals and Energy to set the different zone prices for regulated petroleum products.

Gas pipelines play a development role in a juvenile developing gas market. Pipelines form the cornerstone of bulk transport of petroleum products and gas.

### 2.7 Clients

Petronet's customers are the major Oil Companies in South Africa: BP, Shell, Engen, Caltex, Total, Exel, Sasol Oil and Sasol Gas. Impartiality is critical and the following principles are being applied:

- Provide transportation upon request.
- Charge just and reasonable published tariffs based on "Return on Assets" Managed and not "cost plus" principles.
- Collect same compensation for similar services.
- File tariff rates and conditions of carriage.
- Do not give preference.
- Do not disclose shipper (client) information.

## 2.8 Petronet swot analysis

| Strengths | Weaknesses |
|---|---|
| • Sole liquid fuel pipeline operator<br>• Political influence through Transnet<br>• Well developed pipe-line net work<br>• Competencies and expertise in operations and maintenance of pipelines<br>• Well developed systems and processes (SAP, OMS, MIS, telecontrol, EDI)<br>• Economies of scale<br>• Scheduling tool / technology<br>• In house communication systems (Transtel)<br>• Strategic value / position in the country<br>• Easy access to finance (due to Transnet influence) | • Lack of competitor intelligence<br>• Operate under Transnet's directive makes Petronet less agile than competitors (road haulers)<br>• Operations and Maintenance culture as opposed to being client driven (as per CSI report)<br>• Dependant client supply patterns<br>• Insufficient pipeline capacity<br>• Ageing assets (replacement of)<br>• Inherent inflexibility of pipelines due to immovable operating assets<br>• Percentage skilled vs. unskilled personnel<br>• Outdated operating procedures |

| Opportunities | Threats |
|---|---|
| • Form alliances with competitors (road or rail)<br>• Form alliance with Spoornet based on free market principles and not cross subsidisation<br>• To play an active role in formulating legislative environment with DME, DPE, DTI, future pipeline regulator<br>• Expand into providing other pipeline related services like training and technical expertise for bigger projects outside Petronet or country (pipe-wrapping, Cathodic protection, leak repairs, etc)<br>• Establishment of Refractionator alleviate intermixture problems<br>• Terminalling and logistics<br>• Build and lease tanks at pipeline fed depots<br>• Relieve bottleneck between Sasolburg and Coalbrook | • Termination of Sasol Supply Agreement (Dec 2003)<br>• Sasol could form alliances with Industry and formulate their own commercial agreements (swap outs)<br>• Proliferation of products will make pipeline operation more complex<br>• Loss of market share. Spoornet negotiate better tariffs than combined pipe and rail tariff.<br>• DAS (increased value of product in custody of Petronet)<br>• Economic recession (Zimbabwe, Argentina situation)<br>• Limitations on blending / intermixture disposal<br>• Lack of investment in infrastructure by clients causing constraints on the pipeline network (split deliveries)<br>• Servitude encroachment<br>• Impact of HIV Aids<br>• Alternative fuel (medium to long term)<br>• Specialist skills depletion within Petronet and the oil industry<br>• Dependant on sole power supplier<br>• Dependence on a few powerful clients |

## 2.9 Market Share within the Industry

- Petronet provides 100% of transportation of bulk petroleum by pipeline in South Africa.
- The inland refinery at Natref is supplied with all its crude requirements via our pipelines.

3 Approximately 81% and 92% of refined products manufactured at Natref and Secunda respectively are transported out of the refineries via the Petronet pipelines.

- The coastal refineries, not only provide product for the local market, but are also involved with exports. It is therefore extremely difficult to obtain figures relating to volumes transported by pipeline from these installations. Our figures show an amount of less than 20%.

## 2.10 International Standards

In the absence of specific South African technical standards for pipelines, Petronet adheres to well proven and accepted American Petroleum Industry Standards. These cover, amongst others, metering, custody transfer standards, maintenance and operations. Petronet is currently installing a total tele-control system which will take a few years to complete. This state of the art system will allow for the entire network to be on automatic control with leak detection and batch tracking.

## 2.11 Integrity of Pipeline

It is Petronet's policy to continually monitor the integrity of its pipeline network. To this end an internal inspection tool, commonly known as an Intelligent Pig has been implemented. The instrument uses the magnetic stray flux principle to determine and record any possible areas of metal loss due to corrosion and/or other phenomenon. The results of the Intelligent Pig survey indicate that the pipeline is generally in a good condition. The pipelines are also cathodically protected against electrolytic corrosion.

Petronet is acknowledged as one of the leaders in the development of this technology in South Africa.

Monthly helicopter inspections are carried out to ensure that the servitudes are free of encroachments and that no wash-away or other damage to the servitude or loss of cover over the pipe has occurred.

Concrete markers are installed along the pipeline route to ensure that the precise position of the buried pipe is known. Route co-ordinates of the pipeline are filed with the relevant Deed's Office's. The route is also depicted on records at various Local Authorities such as Durban. The registered servitudes generally embrace the right for Petronet to lay, maintain and operate the said pipelines. The servitudes are registered in the various Deeds Offices and are also registered against each title Deed. The landowners, who were compensated at the time of expropriation, generally retain the use of the land for agricultural and other shallow surface and non permanent structures. This allows for unobstructed access to the pipeline at all times.

A detailed Strategic Maintenance Plan (SMP) has been compiled and projects are at present being monitored by a Steering Committee to ensure that the culture of continuous improvement in Petronet is upheld.

### 2.12 Tariffs

When determining tariffs various factors are taken into account. The age of the pipelines are in excess of 25 years and Petronet have had to and will continue to replace and upgrade their assets at current prices. Petronet does not enjoy the benefit of tax deductions on the wear and tear of almost 90% of its asset base, compared to other modes of transport who do have this benefit.

Since 1987 the pipeline tariffs are determined separately to that of rail and today the tariffs are about 25% below that of rail over routes where both rail and pipeline operate. There is no barrier to entry and other companies can, should they wish to do so, construct their own

pipelines. While the first pipeline cost about R20 000/km to construct and lay the cost of constructing even a 12-inch (324 mm) is over R 2 million/km today.

Where a pipeline has more than one user, set tariffs are published for the use by all clients. Preference is not given to one or the other. Service levels are the same for all users. In order for Petronet to maximize the volumetric throughput in the pipeline network, and hence to improve its asset utilization, it was considered necessary to, when transporting product to a centre not serviced by pipeline, to offer our clients a service that uses the pipeline part and then rail to its end destination. Petronet and Spoornet agreed on a method of joint tariffing (on-rail tariffs) whereby the client's most cost effective means of transporting product will be via this method.

This philosophy implies that the tariff for the total distance must be lower than any other mode of transport from origin to destination in one operation. The South African motorist benefits directly from this joint tariffing, especially in remote areas, where fuel prices would be higher if it were not for this tariffing method.

In 1993 and again in 1997, an international benchmarking study of comparable pipeline businesses was undertaken. Based on this study it was determined that return on assets managed (ROAM) is a generally accepted norm in evaluating the performance of a pipeline business and to judge the fairness of their tariffs and profits. It was found in the US and the UK that comparable pipeline businesses had real return on assets managed of about 7 – 14%. Petronet's return the last few years fell well within these margins. They were and are still towards the lower end of the 7-14% limit.

### 2.13 Human Resources

Petronet has compiled a Human Resources plan to ensure that the workforce will be reflective of the demographics of the country. Petronet have also embarked on a employee well-being program and a Lifestyle Management Program whereby all the basic needs such as housing, training and development, social issues (HIV) and employee benefits are addressed. Petronet believes in partnership with its employees and conducts peoples forum on a regular basis to enhance communication. An elected Joint Transformation Council has

been operational from March 1998 and forms part of the process of joint involvement in Petronet's future.

## 2.14 Future plans to ensure that pipeline infrastructure meets growing economic and social demands of the country and the region

In order to meet the needs of the Oil Industry, our clients, Petronet endeavors to keep abreast of market trends and changes in our area of operations and neighboring regions. Detailed studies are undertaken of petroleum product usage in all magisterial districts concerned and the various transport modes (competition) are identified. This is accomplished by undertaking capacity studies in our network and identifying bottlenecks or constraints that may need to be rectified in the future.

Building of computer based capacity models allows Petronet to investigate many scenarios that may occur and then easily make changes to the model as reality unfolds. Petronet's clients and Department of Mineral and Energy, are party to this Capacity study and assist us in making assumptions and the possible scenarios. A further requirement of the current Capacity Plan is to identify problem areas and plan actions, for possible contingencies that may affect the motorists and the economy of South Africa. These contingencies could entail the loss of any of inland refineries, infrastructure disruptions of the pipeline network, etc. These contingency plans could involve a diversity of solutions. e.g. rail and road bridging, emergency fuel supplies and possible rationing.

A detailed capacity plan has been drawn up to ensure that the needs of all clients, including those of neighboring states are assessed and that Petronet will be able to meet those needs for the foreseeable future.

In line with the vision to be the national gas transporter Petronet view the provision of this type of infrastructure as a national issue and would see some sort of inventive financing proposal similar to that of the Maputo corridor type funding to be put in place. Part of the motivation being that the pipeline routing would take into account possible target areas for growth whereby gas is used as an alternative, affordable clean source of energy in rural areas presently without energy sources other than biomass.

## 2.15 Summary of Financial Results

**Table 2.1**

| | Rm 2002 | Rm 2001 |
|---|---|---|
| Total Turnover | 717 | 685 |
| Net Operating Expenses | (345) | (286) |
| Profit from Operations before miscellaneous revenue and retirement costs | 372 | 399 |
| Post retirement benefit costs | - | (4) |
| Profit before finance costs, investment income and income from associates | 372 | 395 |
| Finance costs | (162) | (160) |
| Investment income | 26 | 26 |
| Profit/(Loss) before taxation | 236 | 261 |
| Total Assets | 3.389 | 3.389 |
| Total Liabilities | 188 | 155 |
| Capital expenditure | 141 | 108 |
| Depreciation and amortization | 141 | 94 |
| (Decrease)/increase in long term provision for leave | 1 | 1 |
| Number of employees | 585 | 614 |

**Table 2.2**

| **Financial Year** | **Total Turnover** | **Operating Profit** |
|---|---|---|
| 1997/1998 | R640.1 m | R451.5 m |
| 1998/1999 | R727.4 m | R509.3 m |
| 1999/2000 | R729.4 m | R447.4 m |
| 2000/2001 | R685.0 m | R399.0 m |
| 2001/2002 | R717.0 m | R372.0 m |

## 2.16 Overview on the South African oil refineries

### 2.16.1 Introduction

South Africa, prior to 1954, imported all refined products simply because there was no refinery operating in South Africa at that time. BP, Shell, Caltex and Mobil were the marketers and distributors of those products.

After World War II, the demand for fuel products in South Africa increased to such an extent that refineries were built to meet the growing demand. Genref was the first refinery, established by Mobil (now Engen) in 1954, followed by Sapref (Shell and BP) in 1964, both in Durban; Calref (Caltex) in 1966, in Cape Town; and Natref (Sasol and Total) in 1971/72 in Sasolburg.

Sasol I was established in 1954 to convert coal into synthetic fuel. The establishment of Sasol I was a strategic decision taken by the Government of the day. In 1964, the Strategic Fuel Fund Association (SFF) was established for the acquisition of crude on behalf of the country and administration of the strategic crude oil stockpile. This was done due to the growing uncertainties of the international crude oil supply situation, and the oil embargo applied against South Africa. The synthetic fuel industry expanded with the establishment of Sasol II in 1982, and Sasol III in 1983. Mossgas, which converts natural gas to synthetic fuels, was established in 1987.

The South African petroleum industry has developed quite considerably over the years and is still growing in terms of its structure and governance. The importance the petroleum industry plays in South Africa is fundamental when one considers its contribution directly or indirectly to the economics of the country and the overall GDP (Gross National Product). Every day millions of consumers are trading in this commodity called petrol or diesel, but have they ever considered where does it come from and how does it get into their hands. Probably very few have knowledge of its origin and its distribution. For a consumer to have access to the fuel, the fuel must first be produced, then transported to intermediate depots and finally distributed from these intermediate depots to the service station, where the consumer have access to. It is thus the purpose of this section of the

paper to provide background to the South African Petroleum Industry and to very basically look at the Production and Distribution of this important commodity called fuel.

### 2.16.2 Production

Majority of the fuels produced in South Africa is from imported crude oil. Oil tankers bring crude oil from countries in the Middle East, Europe and Africa. The oil is discharges by tankers at the single buoy mooring (SBM), about 2,5 kilometers off the coast near Prospection and enters the refinery through an underground pipeline. The oil is stored in tanks, from where it is fed into the refinery. Sapref manages the SBM on behalf of the Oil Industry. About seventy percent of our country's crude oil is supplied in industry via the SBM.

### 2.16.3 Refineries and their location

There are basically six refineries in South Africa that can produce fuel from either one of the following: crude oil, coal or gas. (see figure 2.1)

| | | |
|---|---|---|
| Natref (Sasolburg) | - | Fuel from crude oil |
| Sasol (Secunda) | - | Synthetic fuel product from coal /Gas |
| Sapref (Durban) | - | Fuel from crude oil |
| Enref (Durban) | - | Fuel from crude oil |
| Calref (Cape Town, Milnerton) | - | Fuel from crude oil |
| Mosgas (Cape Town) | - | Synthetic fuel products from natural gas |

Synthetic fuels are much more expensive to produce than conventional fuel due to it being very capital intensive.

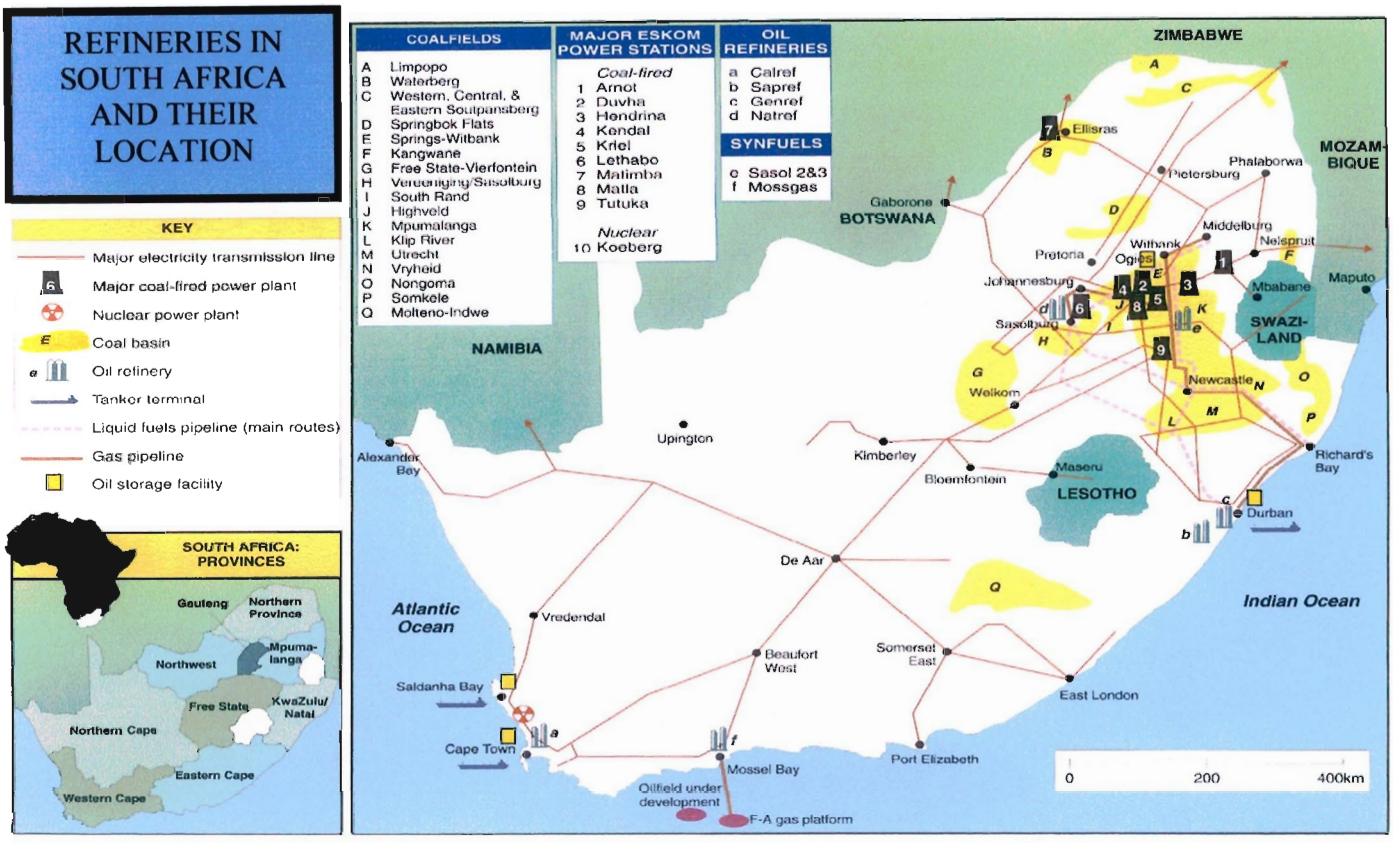



**Figure 2.1**

### 2.16.4 Refinery ownership

Natref at Sasolburg is owned by Total (36% share) and by Sasol (64% share). The synthetic refinery Secunda is wholly owned by Sasol.

Sapref is a 50/50 joint venture between Shell and BP Southern Africa. SAPREF is Southern Africa's largest crude oil refinery, with 35 percent of the country's refining capacity, which equates to 180 000 barrels of crude oil per day or 8.5 million tons per year. Sapref's facilities comprise a single buoy mooring, a storage facility at the Durban Harbour, joint bunkering services and the refinery itself, which is located in Prospection, about 16 kilometers south of Durban. There are seven underground fuel transfer lines running about 12 kilometers between the refinery and the Island View Harbour storage facility.

Enref situated in Durban is owned by Engen and was originally opened in 1954 by Mobil. The refinery was upgraded in 1992 and again in 1994. The current refinery has a refining capacity of 105 000 barrels per day.

Calref situated in Cape Town is owned by Caltex. Mosgas situated in Cape Town is operated by Petrosa

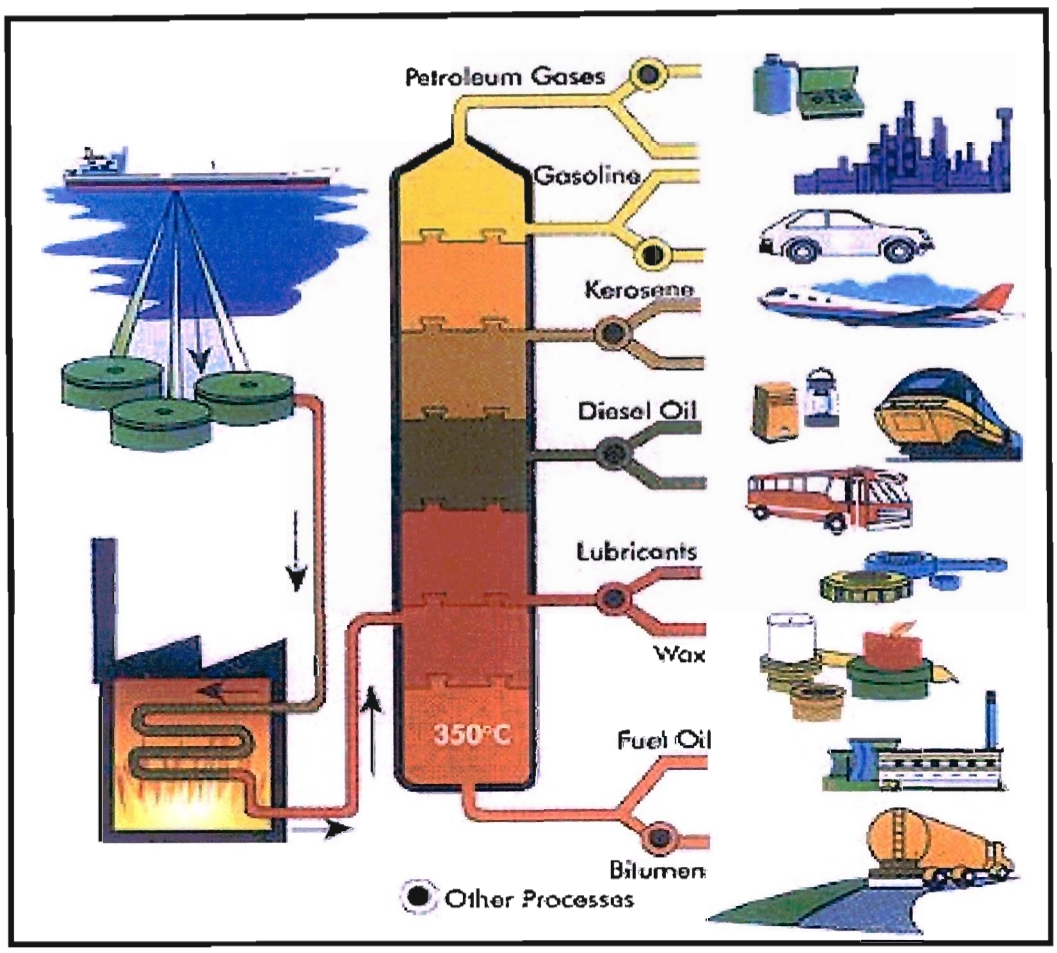
### 2.16.5 Distribution of Petroleum Products

Have you ever wondered how BP or Shell gets their product to Cape Town when there is no Shell/BP Refinery in Cape Town? Well the answer is quite simple. Over the years the oil Industry have put agreements together called "product swap agreement" whereby between oil companies they swap product which saves them the cost of transporting fuel around the country from their own refineries. This simply means that Shell/BP for example would agree to supply Caltex service stations in Kwazulu Natal and Caltex would agree to supply Shell/BP service stations in the Western Cape. What does this mean? This means that when a consumer fills his/her tank in a Caltex service station in Kwazulu Natal, that petrol came from either the Sapref or Enref Refinery.

From the refineries, the fuel is transported to various depots around the country by road, rail or Petronet pipeline. From the depots, the fuel is then delivered to service station.

### 2.16.6 Basic refinery process and end products

**Figure 2.2**




Source: Sapref

**Fractionation:** In the first step of the production chain, crude oil passes through the crude distillation units every minute of every day. The crude oil is heated and distilled in these units, breaking the oil into different constituents, known as fractions. This process is known as fractionation. Fractionation is the physical separation of crude oil components by boiling.

The heaviest fractions condense at the hottest temperatures near the bottom of the distillation column and provide feedstock for the making of bitumen. Fractions condensing around the middle of the column include kerosene for jet fuel and gas oil for heating and

diesel engines. The lightest fractions condense in the coolest temperatures near the top of the distillation column and include products such as propane, butane and naphtha.

**Conversion:** Some of the heavier fractions are upgraded further in a catalytic cracker, which uses advanced technology to bring heavy fraction molecules into contact with a hot catalyst in a process that "cracks" the molecules to produce new hydrocarbon combinations. This is the start of the process of conversion. Conversion involves changing the chemical composition of crude oil components. These combinations are used for petrol and diesel. The gas separation plant processes the petrol and liquid petroleum gases produced by the cracker.

The refinery's products include:

- petrol
- diesel
- jet fuel
- lubricating oil
- liquid petroleum gas
- paraffin
- solvents
- bitumen
- marine fuel oil
- Chemical feed stocks.

The products are used in a variety of areas that are essential to modern living, as the diagram illustrates.

## 2.17 Intermixture

### 2.17.1 Definitions

Numerous definitions over the years have emanated for what intermixture means. Petronet's original Conveyance Agreement defines intermixture as "a mixture of products consisting of **slop** or **interface** or both of these"

**Slop** means any interface, a collection of interfaces or pipeline products drawn off into a tank from a pipeline

**Interface** means the mixture resulting from the commingling between products following each other in the course of conveyance through either a main pipeline or any of the feeder-lines.

Restating from various interpretations and for the purpose of this study **Intermixture shall basically mean a mixture of two or more products.**

**Slug** means a consignment of any particular product

**Excess Intermixture** in the context of this study is defined as intermixture that cannot be blended away and that has resulted from the company changing something to create this excess intermixture.

### 2.17.2 Intermixture generation in Petronet

**Figure 2.3**

Below is a sketch of a section of the pipeline


To explain how intermixture is generated in the pipeline. Let's assume that the pipeline is new and that the first slug of product to be injected into the pipeline is petrol followed by diesel. If this was the only two products being transported, then the intermixture created would lie in the area between the two spheres. The size of the intermixture is not constant but differs from point to point. At the intake point the intermixture generally tends to be small and then grows as the products move along the pipeline. Over the years, Petronet has gathered reasonable amount of information based on various real product movements to estimate what the size of the intermixture/interface would be at very stations along the pipeline. Table 2.1 illustrates the estimate size that an interface should be at certain depots. If these two products were destined for Kroonstad, one can estimate the intermixture size to be in the region of 80 000 litres. However, 80 000 litres is a norm that has been set, this norm can vary depending on what happens in the line between the intake and the delivery point. Some of the factors that contribute to the increased size of interface is shown in figure 2.2.

### 2.17.3 Typical intermixture sizes

**Table 2.1**

| DEPOT | INTERMIXTURE SIZE |
|---|---|
| Durban (Intake point) | 15000 |
| Hillcrest | 25000 |
| Howick | 35000 |
| Ladysmith (Delivery point) | 45000 |
| Bethlehem (Delivery point) | 60000 |
| Kroonstad (Delivery point) | 80000 |

### 2.17.4 Factors that have an influence on the intermixture size

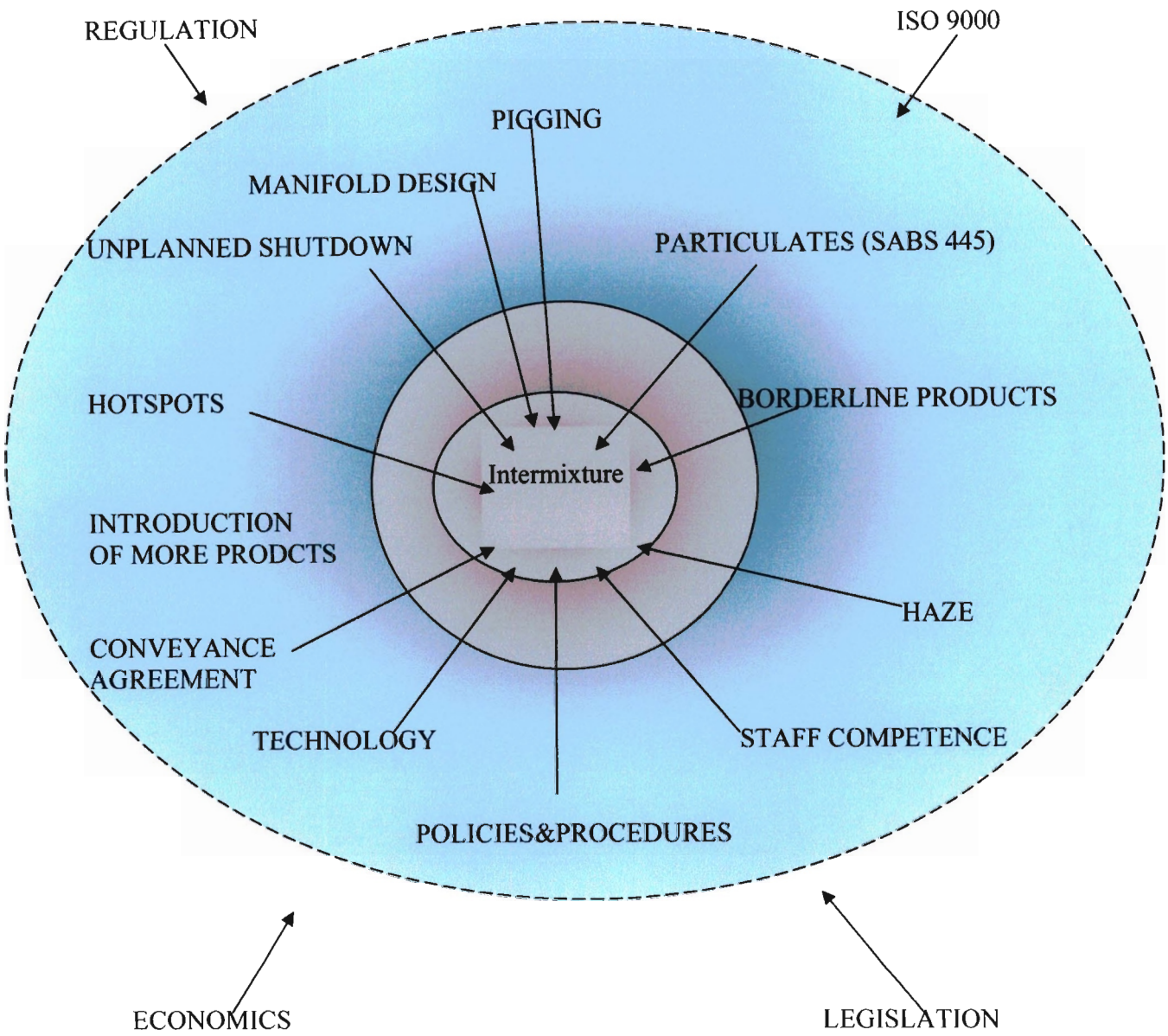



**Figure 2.4**

As can be seen from figure 2.4, there are many factors that directly or indirectly have an influence on the ultimate size of the intermixture. Staff competency must be ranked the highest priority and should be given the most attention before looking at the other factors.

### 2.17.5 Identified problems and possible solutions to reduce intermixture size

| PROBLEMS | POSSIBLE SOLUTIONS |
|---|---|
| 1. Manual vs. Automatic. Interfaces are handled manually. The likelihood of every depot or individuals to handle the interface in exactly the same manner is remote. Thus this lends itself to interfaces being cut at wrong places, which increases intermixture growth. Similarly launching of spheres. (over cautious) | • Automation<br>• Training and Re-Training<br>• Establishment of an *Independent quality control department that reports directly to Head Office. Their task is to handle quality control and intermixture problems. |
| 2. Instruments. Instruments, like the hydrometer could be defective or not calibrated as a result incorrect readings are taken. | • Have a programme in place to verify calibration and condition of test instruments. (FBP machine, Flash tester, hydrometer, thermometer)<br>• *Independent body to verify integrity of instruments. Possibly another function of the quality department. |
| 3. Lack of proper equipment. The quality of product at intake cannot be verified to the nth degree with respect to the various tests conducted by labs at the refineries. Petronet thus accepts, apart from the basic, that the x, y, z are correct. This might not be the case. | • Petronet to purchase the minimum necessary equipment or have the quality certificate validated by an *independent body.<br>• Petronet witnesses Industries tests to confirm that the quality certificate is a true reflection of the contents of the tank. This might require a full time representative to sit in industries lab. |

**Identified problems and possible solutions to reduce intermixture size (continued)**

| PROBLEMS | POSSIBLE SOLUTIONS |
|---|---|
| 4. Blend pumps/leaking valves/flushing valves not working as designed as a result contamination and incorrect blending takes place | • *Independent body that is technically minded that sits in the quality control department. |
| 5. Pigging for the sake of pigging/ Programmed pigging. At present, pigging gets done on a programmed monthly basis. No one interprets the data to evaluate whether the pigging programme is effective. | • *Independent body to evaluate data and establish when to pig and when not to pig. |
| 6. Checking of prover sphere gets done on a monthly basis as a result there is unnecessary generation of intermixture in the sump tank | • Checking of prover sphere must not be done as a routine maintenance function but done only when proving repeatability exceeds norms<br>(procedures will have to be updated) |
| 7. Blending ex-sump tanks | • Strict control and monitoring by *Quality Assurance Division |

The table above identified problem areas and possible solutions to reduce intermixture. This table is not fully exhausted and there could be other areas that can be considered.

## 2.18 Summary

Petronet owning, operating and maintaining pipelines are of strategic importance not just for shareholder wealth maximization but also for the economy of the country. Petronet is a vital link in the transport chain of petroleum products from refineries to the end user. The operation of a multi-products pipeline is not straight forward. There are many issues that need to be considered. One of the biggest issues that any multi-products pipeline poses is the issue of intermixture. Intermixtures are generated when two or more dissimilar products are conveyed in the same pipeline. The normal practice is to take these intermixtures into a separate holding tank and later blend this product at an acceptable agreed ratio back into pure products. The original blend ratio for Petronet allowed them to blend almost all intermixtures generated back into the system. However, with a revised blend ratio, Petronet is unable to do this any longer. The next chapter will look into the effects of the revised blend table on Petronet and identify what can be done in the short, medium and long term to deal with the issue of excess intermixture.

# CHAPTER 3

# CASE ANALYSIS

## 3.1 Introduction

Petronet keeps accurate records of all intermixture taken into their tanks and volumes that get blended. Each depot that has intermixture tanks does a daily log of their intermixture status. The close monitoring of these tanks ensures that depots do not overstock. As a starting point to evaluate what the effects the reduced blend rate has on the overall intermixture stock level, comparisons are made in table 3.1 to show the impact.

**Table 3.1**

**OLD BLEND TABLE VS REVISED BLEND TABLE**

| Depot | Tank Capacity | Interface Norm | Source | No of Slugs/month | Theoretical intermix/month | Actual Intermix handled/month | Ave intermix blend/month | Average Monthly Stock @0,25% blend | Average Monthly Stock @0,5% blend |
|---|---|---|---|---|---|---|---|---|---|
| Ladysmith | 2061 | 70 | Coast | 8 | 560 | 800 | 890 | 1200 | 800 |
| Kroonstad | 3600 | 120 | Coast | 16 | 1920 | 920 | 900 | 2477 | 1300 |
| Klerksdorp | 339 | 25 | SBG | 16 | 400 | 320 | 300 | 113 | 50 |
| Alrode | 3200 | 60* 85 | SBG* SEC | 20 | 1700 | 2048 | 2080 | 1616 | 800 |
| Langlaagte | 3200 | 85* 25 | SBG* SEC | 12 | 300 | 4000 | 2000 | 1863 | 500 |
| Waltloo | 2890 | 35* 35 | SBG* SEC | 12 | 420 | 360 | 800 | 541 | 250 |
| Tarlton | 921 | 25* 50 | SBG* SEC | 16 | 400 | 640 | 500 | 210 | 100 |
| Rustenberg | 482 | 20 | SBG | 8 | 160 | 350 | 300 | 130 | 60 |
| Witbank | 622 | 35 | SEC | 8 | 280 | 650 | 610 | 160 | 70 |
| | 17315 | | | 117 | 6140 | 10088# | 8380 # | 8310# | 3930 |

**# This is an average intermix which includes abnormalities**

## 3.2 Evaluation of intermixture data

The table below illustrates the change in average monthly stock of intermixture on hand when the original blend table of 0,5% was used compared to the new revised blend table of 0,25%. What is clearly noticeable is that there is a definite increase in stock holding and the increase is more than doubled.

The data below was sourced from weekly intermixture reports from all the depots beginning from April 2002 (when revised blend table was implemented) to June 2003

This data highlighted in red indicates the critical depots where intermixture stock build could pose a threat to operations of the pipeline. This means that if intermixture cannot be reduced to the average size at 0,5% blend, the tanks will at some stage overflow. This means interruption of pipeline and increased costs to all stakeholders.

### 3.3 Critical depots

Using the above table, the most critical depots are Kroonstad, Langlaagte and Alrode. These depots handle large volumes of intermixture and therefore cannot dispose of their intermixture much quicker when compared to the other depots. As a result at some stage, the above depots would reach a critical point (see note on critical point) which will eventually lead to their tanks overflowing which would lead to a shut down of the line.

### 3.4 Critical point defined

It is accepted by Industry and by Petronet that it is impossible to avoid mixing of products in the operations of a multi-products pipeline. As a result, the generation of intermixture is inevitable. The proposed blend table will undoubtedly have an adverse effect and put major constraints in the way Petronet operates. This means, the new proposed table does not allow Petronet to blend more intermixture, as a result at some stage; Petronet would not be in a position to take off interfaces and thereby cause a complete shutdown of the pipeline.
Petronet supports Industry's concerns on delivering product to specification and have pledged their support in finding an amicable solution to the problem. It is recommended that a contract between Industry and Petronet be reached in handling the excessive intermixture. Excessive intermixture can be defined as the critical point at which depots intermixture levels exceeds 60% of their total ullage. The 60% mark has been calculated to be the critical point at which the depot must get rid of the product or face the consequence of tank overflow or pipeline interruption (Unplanned shutdown).

**CRITICAL POINT**

**Figure 3.1**

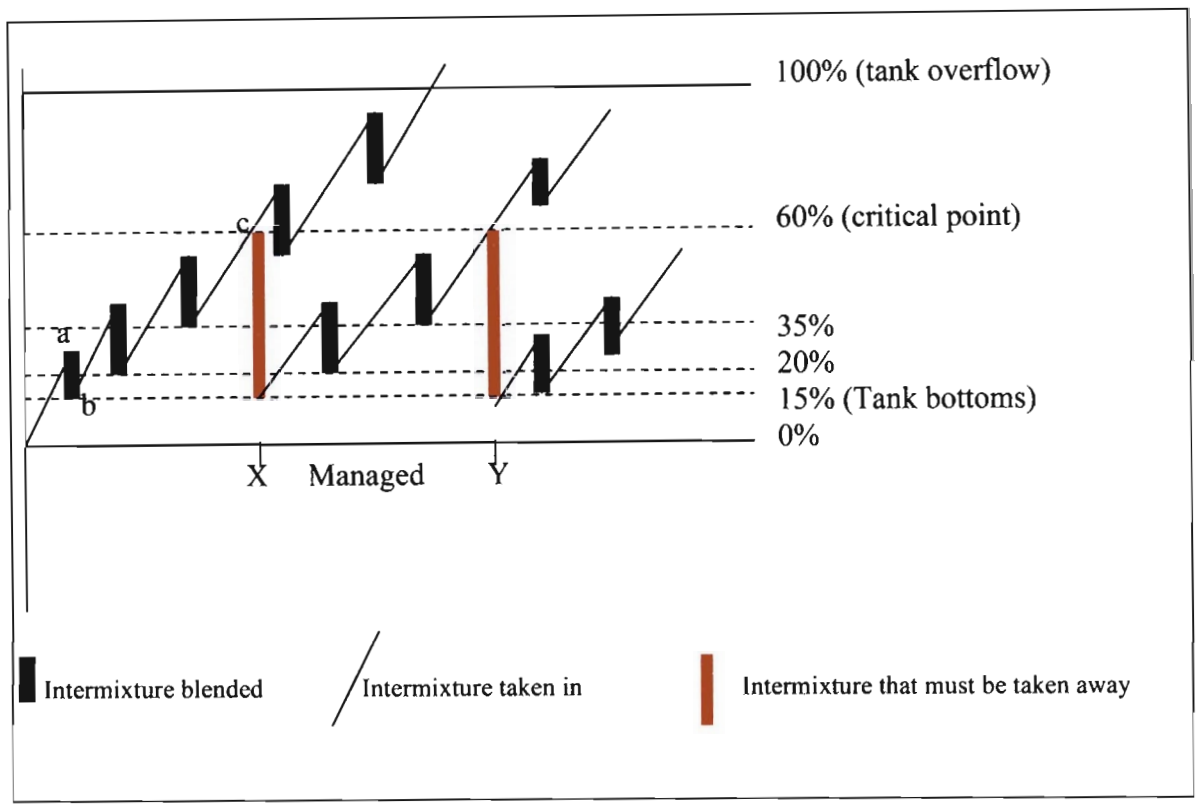



Figure 3.1 illustrates the critical point scenario. Let us assume that this figure represent a tank which has a capacity of 2000m$^3$ (2 000 000 litres) and that this tank has no intermixture in it (0%). The first batch of intermixture fills the tank to 30% (point a). The depot then blends away 15%. The level then moves to point b. This process continues as indicated in the above diagram. At point c, this is now a critical point because if nothing gets done, and two more batches of intermixture gets taken in, Petronet stands a good chance of overflowing the tank or bringing, putting a company tank off-spec or shutting the entire pipeline operations. It therefore makes sense for Petronet to have other strategies to deal with a situation like point c, should it not be in a position to blend sufficient product away.

### 3.5 Intermixture solution

#### 3.5.1 Short term solution: Sale of Intermixture

Petronet is only a transport company and in the normal course of business does not involve itself in the retailing of petroleum products. The products that are transported in the pipeline do not belong to Petronet. The products belong to the parties that have injected products into the pipeline. In order for Petronet to engage itself in retailing end, Petronet will need to apply for a license to sell petroleum products. In the current dispensation, it will not be possible to obtain the license due to a number of reasons.

The intermixture generated does not belong to Petronet but Industry. Petronet would need to consult with Industry to sell their product. The ideal manner, in which this solution would work, would require Petronet to form an alliance with Industry to sell the product. This means that because Industry has a license to trade petroleum products, Petronet would work under that banner to sell the intermixture. Furthermore, this intermixture can only be sold to Oil Industry members only.

#### 3.5.2 Working

When Petronet depots reach the critical point as defined in Chapter 4, Petronet would need to consult with Industry and have the elected Industry person assist Petronet in officially tendering the product to all interested oil industry members. A tender procedure would need to be drawn and the normal workings of the tender adhered to. This solution would be in conjunction with the stipulated medium-term solution

#### 3.5.3 Concerns

One the main concerns would be the Tender procedure and fairness. Secondly, will Petronet receive a fair price for the intermixture? What impact has this on the pipeline reconciliation?

Documentation needs to be strictly controlled, stored and formalized. One would need additional staff to control this process. Petronet depots in particular Kroonstad and Alrode were not designed to dispose of or receive intermixture by road or rail. Any such action would be an emergency measure and could have environmental and safety consequences.

### 3.5.4 Solution at the Kroonstad and Alrode

At Kroonstad the following needs to be considered:

- The first option is to make use of the mothballed Total site adjoining Petronet's depot. Petronet should approach Total to obtain a quotation to lease one of their tanks ($2000m^3$) and the road/rail loading facility.
- The second option, which is not preferred, is to modify the depot with little work to move intermixture by road. This is dangerous, as a truck would have to park outside the depot. Spoornet would have to be advised not to shunt when transfer is in place. In the interim the depot could road haul from inside the depot with careful monitoring.
- Whilst Petronet is in the process of Depot upgrades, consideration should be made for road/rail loading facilities.

At Alrode the following need to be considered:

- The first option is to modify the depot to handle road tankers immediately for the short term. A more permanent set up for a long-term road infrastructure will need to be pursued. This is not the ideal but can be accepted short-term.
- The second option is inject the intermixture into the pipeline to Tarlton where it can then be transported by road.
- The third option is to relieve the pressure on Alrode by whenever possible passing intermixtures to downstream depots, which are able to handle extra intermixture volumes.
- Whilst Petronet is in the process of Depot upgrades consideration should be given for road loading facilities.

### 3.5.5 Estimated costs of short term Solution (per litre)

- Any excess intermixture that is not taken to the refineries would be tendered.
- In this scenario, the successful bidder would remove the intermixture from Petronet's premises. In this way, Petronet does not incur any transport or refinery costs. All costs would be to the successful bidder.
- It is estimated that the sale of intermixture would be not less than 60 cents per litre.

### 3.5.6 Recommendations

Dual approach or multiple approaches

- Improve operation procedures to minimize intermixture
- Minimize number of interfaces by scheduling of slugs. e.g. let ULP be followed by Leaded product.
- Optimize agreements with refineries to maximize slug sizes
- Sale of excess intermixture to industry
- Provision of road hauling infrastructure
- Recommendations as in 3.1
- Initiate a project to cost and make provision for capital for depot upgrade.

### 3.5.7 Other Considerations

- Capital for infrastructure at depot
- Enter into road haul contracts
- Acceptance of principle to write off losses
- Method of financing loss
- Initiate depot upgrade project

## 3.6 Medium Term Solution: Re-refining of intermixture

### 3.6.1 Introduction

Petronet should negotiate with the Oil Refiners to re-refine intermixtures at a premium and then have the product delivered back into the market. Likely areas for re-refining are the following refineries namely Natref, Secunda, Sapref and Enref.

### 3.6.2 Working

Petronet will need to arrange with the refineries the appropriate time and volume to be sent to them.

The refineries will re-refine the intermixture at a cost plus a percentage loss in the process, and thereafter return good product back into the pipeline.

### 3.6.3 Concerns

- Can these refineries can take back sufficient volume to solve the problem long-term hence other solutions will need to be sought. (Secunda depending on the intermixture composition will take +-350$m^3$ per month. Enref will take +-500$m^3$ per month)
- Refineries can only receive intermixtures by road.
- If Secunda takes coastal intermixture and re-refine it and then put it back into the market, would they handle this as Inland or Coastal product, outside the SSA?
- Petronet depots in particular KRO and ALR were not designed to dispose of or receive intermixture by road or rail. Any such action would be an emergency measure and could put Petronet at environmental / safety risk.

### 3.6.4 Solutions at Kroonstad and Alrode

At Kroonstad, the following can be considered:

- The first option is to make use of the mothballed Total site adjoining Petronet's depot. Petronet must approach Total for a quotation to either lease or buy their tank (2000$m^3$), road loading facility, etc.

- The second option, which is not preferred, is to modify the depot with little work to move intermixture by road. This is dangerous, as a truck would have to park outside the depot. Spoornet would have to be advised not to shunt when transfer is in place. In the interim this option can be used with strict control to ensure that the right size truck comes into the depot, fire fighting facilities are available and that the process of transferring intermixture to the tank is carefully monitored. This must be purely a short-term option whilst options 1 and 2 are being pursued.

At Alrode the following needs to be considered:

- The first option is to modify the depot to handle road tankers immediately for the short term. A more permanent set up for a long-term road infrastructure will follow. This is not the ideal but can be accepted short-term. Alrode depot when compared to Kroonstad is bigger in area and a long term solution of building road handling infrastructure is possible.
- The second option is to move intermixture to Tarlton where it can then be transported by road. Tarlton depot is the only depot designed to handled road and rail loading.
- The third option is to relieve the pressure on Alrode by whenever possible passing intermixtures to downstream depots, which are able to handle extra intermixture volumes.

### 3.6.5 Estimated costs of Medium Term Solution (per litre)

| | KRO-DNR | ALR-SEC |
|---|---|---|
| • Transport cost | 0,23 Cpl | 0,11 Cpl |
| • Cost to re-refine | 0,16 Cpl | 0.16 Cpl |
| • % loss in re-refining | 5 % | 5 % |

Cpl denotes cents per litre

### 3.6.6 Recommendations

- Transport all possible intermixture to refineries.
- Cut intermixture size by diligent management.

## 3.7 Long term solution

### 3.7.1 Introduction

The long term solution is to find a process that can separate products to their natural base hence allowing much higher percentage of blending. The solution could be the construction of a Refractionator (see appendix 12). The Refractionator is like a mini refinery that basically separates the intermixture into different products. The Refractionator if properly designed should be able to convert intermixtures into petrol, diesel and other products. This re-processed product can then be blended back into pure products. This concept needs to be explored further and will require approval from the oil industry members, DME and other regulatory bodies.

The ideal location to build the Refractionator would be in the Alrode area because of the availability of steam in the area and Alrode serving as a Hub in the Petronet network. This needs to be further investigated in terms of risk and feasibility.

### 3.7.2 Concerns

- Impact on reconciliation. How does Petronet account for intermixture that has been re-refined?
- Documentation needs to be strictly controlled, stored and formalized
- Petronet depots in particular Kroonstad and Alrode were not designed to dispose of or receive intermixture by road or rail. Any such action would be an emergency measure and could have environmental and safety consequences.

### 3.7.3 Solution at the Kroonstad and Alrode

At Kroonstad the following must be considered:

- The option is to make use of the mothballed Total site adjoining Petronet's depot. Petronet would need to lease one of the tanks ($2000m^3$) and the road loading facility.
- Depot upgrading to load road tankers needs to revised

At Alrode the following must be considered:

- To build a pipeline to the Refractionator location and to modify the depot in terms of pumps, metering, etc. In this way, Petronet can transfer directly from Alrode's intermixture tanks to the Refractionator.
- Depot upgrading to load road tankers

### 3.7.4 Process that can be followed for the long-term solution

- Petronet pays for the transport of the intermixture to the Refractionator plant
- Normal Losses occurring in the processing of the intermixture to be handled in the reconciliation.
- Petronet to pay for the Cost to process intermixture
- Petronet blends the resultant product into petrol and diesel.

### 3.7.5 Estimated costs of long-term solution (per litre)

| | | |
|---|---|---|
| • Transport of intermixture | 0,10 | rail or road |
| • Product loss 10% | 0,18 | normal loss in process |
| • Cost to process intermixture | 0,10 | |
| **TOTAL** | 0,38 | |

| | |
|---|---|
| Annual intermixture processed | $24000m^3$ |
| Total annual cost | R9,12 million |

### 3.7.6 Recommendations

- Evaluate the possibility of Refractionator
- Prepare project for capital investment 2004
- Immediately seek method of setting up BEE Company with necessary agents.

## 3.8 Summary

Prior to the revised blend table, Petronet generated approximately 4 million litres of intermixture per month. The original blend table allowed Petronet to blend 0,5% diesel into petrol and 0,25% petrol into diesel, provided that in the case of petrol the FBP of $215^0$C was not exceeded and that the residue content did not exceed 2%. This ratio was perfect for Petronet, as most intermixtures generated could be blended away. The recent revision of this blend table now forced Petronet to reduce the 0,5% diesel into Petrol to 0,25%. This simply means that Petronet would not be able to blend more intermixtures and as a result would have excess intermixtures on hand.

The revised blend table has caused Petronet to generated approximately 8 million litres per month which is unacceptable as this poses threat to the continuous operations of the pipeline. If intermixtures continue to build, there would be no space to accommodate additional intermixtures and as a result the pipeline would inevitably come to standstill. To prevent disruptions to the system and to support the new revised rate, three options were identified namely; a short, medium and long term solution. The short term issue deals with getting an agreement with the oil industry to sell excess intermixture. The medium term solution is for refineries to re-refine the intermixtures and the long term solution is for Petronet to build a Refractionator. A Refractionator is similar to a mini refinery, which simply refines the intermixtures back to its base. The identified solutions cannot immediately be implemented in the present Petronet infrastructure and would require modification to successful implement them. The next chapter assesses the identified critical depots and makes recommendations on how to accommodate the proposed solutions.

# CHAPTER 4

# ASSESSMENT OF CRITICAL DEPOTS

## 4.1 Introduction

In finding an amicable solution to the dilemma facing Petronet, the three solutions identified in chapter 5, namely; a short, short to medium and long-term solution, cannot easily be implemented immediately due to the inherent design shortfall of the critical depots and depots in Petronet in general. The key inherent problems in all of the solutions are the inability of Petronet depots, to move intermixture out of the depot by either road or rail (except Tarlton). However, discussed below are recommendations that need to be further explored to overcome the inherent design shortfall of the depots and to implement the short, medium and long term solutions.

## 4.2 Findings and recommendations at Kroonstad (see appendix 14 for depot layout)

Detailed below are the various alternatives that can be used at the Kroonstad depot.

### 4.2.1 Road Hauling

- Road loading requires pump, strainer, metering and links to tele-control.
- The concrete slab design does not allow containment of spillages
- The road tanker has no turning facilities
- There are no electrical bonding facilities
- The road tanker takes too long to off-load due to sump-tank capacities and size of pump.
    a. Insufficient land to extend
    b. Relocation of buildings
    c. Major civil work
    d. Tele control project is going to take up most of the unused land to build new ablution facilities, upgrade lab, etc.
- Attaching costs to upgrade Kroonstad to accommodate road-handling ranks high into the millions and it is recommend that this is not a viable route to follow.
- The odd handling of a small 10000-litre vessel is permitted with upgrade.

### 4.2.2 Rail Hauling

- There are five take off points for rail loading. With the assistance of a bi-directional pump off-loading is possible.
- There is no electrical bonding
- There is no siding; the live rail section will have to be used. The depot does not have space to accommodate a siding. The current live line cannot be electrically isolated from stray currents as is the case of proper sidings. Gate, stopper block, drain to separator required. It is dangerous and not good.
- The take off points will need bund walls linked to a separator. Previous history with on railing cost Petronet dearly to replace the stones.
- There is no proper existing way to connect existing take off points to rail.
- Utilizing the current live section is costly and dangerous. We recommend that only in emergencies that this facility be used.

### 4.2.3 The use of Shell (site 1) and Engen depot

- Both Shell and Engen depots currently have on-rail facilities. Petronet could enter into an agreement to use their on-rail facility at a agreed contract. In this way, Petronet does not have to maintain sidings or have problems dealing with safety, health and environment, as we would assume that this is in order. Insurance and risk would need to be investigated.
- Petronet could use its own intermixture tank and build a line to Shell or Engen depot and use their on-rail facility or alternatively rent tanks from them to store excess intermix and on-rail as and when required.
- The problems faced in using this alternative is that having to construct a new line would prove expensive as one would have to go under a rail and the road with all types of crossings.
- Considerations must be given in using one of the existing feeder lines to the preferred depot and share that with intermix. The problem would be that when the line is displaced, the displacement rate would be approximately 7200 l/m, which will take less than 5 minutes to fill a tanker. This could be dangerous especially if

not monitored properly. The time is too short. However, if Petronet used one of their tanks, Petronet could displace intermixture into this tank and then switch to accumulator tank. There are risks associated with this method and will require additional investigation and intelligent input.

### 4.2.4 Adjacent depots: Caltex and Shell (site 2)

- Build a 6" pipeline to adjacent depots or use existing infrastructure (Caltex or Shell feeder-lines)
- If Petronet could construct a new 6" feeder line to an adjacent depot (Caltex or Shell), the distance would be small and Petronet would not have the rail or road to contend with.
- There are feeder lines currently in place to the Caltex depots; one would have to check to see if they are being used and if they are not used, one would have to enter into an agreement with the Company to tie this line to their rail facility.
- The cost to go this route would be the smallest of the entire alternative but not the best.

### 4.2.5 The use of the mothballed Total facilities

- The Total depot has not been used for a long period. Maintenance will have to be done to the on-rail facility to bring it back to standard. The normal Spoornet policy is to maintain sidings up to 2 to 3 years and thereafter it is the responsibility of the user to do the necessary maintenance and repairs.
- Modification and construction of a road off-loading facility from Total site to Petronet site via proposed intermix feeder line will have to be considered.
- The use of the tanks for temporary storage could be a solution to house excess intermixture but would require inspection and re-certification.
- One would also have to consider the existing feeder line between Shell site 1 and 2.
- It is recommended that considerations be given to use one of the existing feeder-lines to Total as an intermix line and extend the line downstream of the consignee to a new rail facility loading with two arms at least.

- Security of site or interlocks must be installed to prevent tampering of consignee valve.
- It is recommend that Petronet consider this route as the best option in handling intermixture either by road or rail.

### 4.2.6 Pipe injection

- Directly from Interface tank into mainline through to Tarlton (low pressure/high pressure)
- This option is not recommended for the following reasons:
    - Increase interface size
    - Cost of capital
    - Planning of injection

## 4.3 Findings and recommendations at Langlaagte (see appendix 16 for depot layout)

Detailed below are the various alternatives that can be used at the Langlaagte depot.

### 4.3.1 Pipe injection

- Directly from Interface tank into mainline through to Tarlton (low pressure/high pressure)
- This option is not recommended for the following reasons:
    - Increase interface size
    - Cost of capital
    - Planning of injection

### 4.3.2 Road Hauling

- The design does not allow containment of spillages
- The road tanker has no turning facilities
- There are no electrical bonding facilities
- The tanker takes too long to off-load due to sump-tank capacities and size of pump.
- The access road behind the intermix tanks can be used or alternatively a new exit gate cut on the side facing the main street.

### 4.3.3 Rail Hauling

- The K07 (alcohol line) feeder line to Engen or BP can be used.
- An agreement with the Companies must be entered into.
- Langlaagte will be upgraded. There will be pumps and blend meters available that can be used.

## 4.4 Findings and recommendations at Alrode (see appendix 15 for depot layout)

Detailed below are the various alternatives that can be used at the Alrode depot.

### 4.4.1 Pipe injection

- Directly from Interface tank into mainline through to Tarlton (low pressure/high pressure)
- This option is not recommended for the following reasons:
    - Increase interface size
    - Cost of capital
    - Planning of injection

### 4.4.2 Road Hauling

- The design does not allow containment of spillages
- The tank car has no turning facilities
- The tanker takes too long to off-load due to sump-tank capacities and size of pump.
- Small tankers could enter and leave the depot using current facility.
- Two alternatives for road exist:
    - Cut an exit gate behind the control room into the main street.
    - Reposition entry and exit. This requires major civil work. A hazop study would need to be undertaken on this.

### 4.4.3 Rail Hauling

- Use the current rail facility infrastructure.
- There are no electrical bonding facilities. This is dangerous.
- Enter into agreement with Shell for a long-term contract.

## 4.5 Summary

The three critical depots namely; Kroonstad, Alrode and Langlaagte has three options in most cases , either to road haul, rail haul or hire additional space from neighboring oil industry members. Kroonstad is not a big depot and does not have sufficient space to build additional infrastructure to accommodate road or rail movements from within the depot. The best alternative is to enter into an agreement with Total to use the mothballed Total site. This site requires some work but has the infrastructure to handle road and rail movements. Alrode should enter into an agreement with Shell to use their rail infrastructure under extenuating circumstances allow a small road trucks into the depot. Langlaagte has space to accommodate road hauling; the area where it is situated does not allow easy movements. Langlaagte is situated in a complex area where the traffic is high and there are many pedestrians in the vicinity. The best solution for Langlaagte is to use the K07 alcohol line to either BP or Engen and from there use the rail infrastructure. The next chapter is recommendations to Petronet on how to permanently deal with the situation of excess intermixtures as this is one of the risk of operating a multi-products pipeline.

# CHAPTER 5

# CONCLUSION AND RECOMMENDATIONS

## 5.1 Introduction

After reviewing the many alternatives available for Petronet in terms of disposing intermixture, the best options in the current predicament, is for Petronet to invest in the long term solution of constructing a Refractionator. (see appendix 12/ conceptual look of the Refractionator). Subsequent to start of this research, Foster and Wheeler South Africa was contracted to take a conceptual look into the design of the Refractionator and estimate costs to invest in this option. The figure seen in figure 12 is their view of what the Refractionator would look like. Should Petronet proceed with the investment in the Refractionator, it would be the first in South Africa. In other parts of the world, like Amsterdam, a Refractionator is in use. The investment in this major project will take anything from 18 to 24 months to construct.

## 5.2 Recommendations

In the interim, it is recommended that the following options below are available to meet industry's needs:

- Petronet can review their current handling and blending of intermixture. The continuous training and development of personnel can prove successful in reducing the size of the intermixture taken of. By training staff how to correctly monitor and cut intermixtures in the right position, will definitely contribute greatly in the overall stock holding.

- Petronet can negotiate with the Oil Industry to sell the intermixture as low grade fuel on behalf of them. This option must only be pursued in the event of a crisis as this option is a loss to Petronet.

- The more slugs you have in a pipeline of smaller sizes, the more intermixture you generate. By increasing slug sizes and scheduling of slugs injected (figure 3 and 4), the overall number of intermixture taken of will be reduced and invariably the size.

Petronet must have high level discussion with Oil Industry to co-ordinate this option which can prove to be less expensive and more profitable for Petronet.

- The question has always been, who does the intermixture belong to? Petronet as stated before is only a transport company. Petronet does not manufacture neither does it own products. On this basis, the intermixture clearly belongs to those that have injected it into the pipeline. However, the Oil Industry could argue and state that if they gave Petronet 5 million litres to transport to Kroonstad for example, they expect to receive their full 5 million litres when Petronet delivers to them. In the normal operations of pipeline, due to the operations of a multi-products pipeline, a percentage of that 5 million gets lost to intermixture due to it mixing with other products. The Oil Industry is aware of this loss. Petronet should consider negotiating with the Oil Industry to deliver that agreed loss of product (intermixture) to them or share the loss on a 50/50 basis. (see appendix 5)

- In order for products to reach the client at the time indicated in the operations notice, (An Operations Notice is a notice that is given to the clients indicating the time when products will be injected in the line and when products will be delivered) the pipeline must run without interruptions. As soon as the line gets interrupted for whatever reason, there is basically three things that happen. Firstly, the client will not get their product as indicated in the Operations Notice and secondly, the size of the intermixture in the line will increase and thirdly, additional costs such as overtime expenses and other claims arise. By running and maintaining a tight pipeline, the size of intermixture in the line is kept to a minimum. Unplanned shutdowns are caused by suppliers of electricity, Refineries equipment failure and incorrect operations. In appendix 6, a view on how to handle unplanned shutdown is discussed.

- In appendix 7, one can see that there are many players that have some influence in the quality of the product from the time it is manufactured, transported and used. Refineries also generate intermixtures during their production and internal transfers as a result they also blend into pure products that are either injected into pipeline,

road or rail. By Refineries blending into pure products before it get injected into the pipeline, restricts Petronet in blending and thereby inhibits the reduction of intermixture holding. It is recommended that the Refineries be approached to produce better fuel quality with zero blending. Refineries, unlike pipelines have the ability to rework the intermixtures back into the re-refining process.

- In this research, only critical depots were evaluated, however, the other depots of Petronet can sometimes end in crisis and have excess intermixture that cannot be blended away due to some irregularity. In figure 11, an emergency procedure is drawn that can provide relief for a depot that is in a crisis of tank overflowing or just not having space for any more intermixture.

- In chapter 2, intermixture sizes were tabled. These were typically sizes that one would expect at each point in the pipeline. However, these were just norms set and one would need to re-look at the norms to see whether they are correct. What happens generally with norms is that people get so comfortable with them that they just work towards them and even if they can do better than the norm, they fail to do. Many things have changed in pipeline over the years with regards to depot upgrade, people skills and equipment. There is therefore a need to re-evaluate the norm and set a norm that is realistic and in the process this could result in a reduction to the overall intermixture size.

- Tarlton depot is a new depot built by Petronet that have the capabilities of handling road and rail movements. Petronet should strongly consider routing where possible intermixtures from Alrode and Langlaagte to be Tarlton. By taking intermixtures to Tarlton, Petronet could use rail or road in a less risky manner to transport intermixtures to refinery in the short term for re-refining. In the long term, it would be advisable to build additional tanks at Tarlton, as this depot has the space and the infrastructure.

- The design of pipeline and more particular at depots plays an integral role in the keeping product to quality specification whilst in transit. The Technical department

of Petronet needs to revise some of the depot manifold designs to ensure that dead sections of pipelines not in use is removed to reduce any contamination. Where necessary, the design needs to be changed to improve flow quality.

- Leaded products (93 and 97) will not be available post 2006. In the interim Petronet can consider requesting refineries to inject only ULP and diesel into the pipeline. The lead can be dosed at the Company to create leaded product. Further the intermixture generated would not have any lead component, which can therefore be re-refined or blended into diesel quite easily. This is an option but not recommended due to the hazards of working with lead although it would minimize interface sizes.

## 5.3 Summary

As can be seen from this research, if Petronet or any company for that matter is in the business of operating a multi-products pipeline, they will always have the issue of what to do with the intermixtures generated. One can only assume that as time progresses and having more sophisticated cars manufactured, that there will be a tighter control on the quality of product produced and used. Legislation may even demand, zero blending, it therefore makes absolute sense for Petronet to invest in the long term solution of a Refractionator, which would ensure that they are able to deal with excess intermixtures and abide by any future legislation on product specification.

## APPENDIX

**Appendix 1**

## EXTRACT FROM THE ORIGINAL CONVEYANCE AGREEMENT

**Disposal of intermixture**

Clause

9. (1) The Company acknowledges that it is impracticable to avoid completely the commingling of products in the operation of a multi-products pipeline and consequently recognizes and accepts that the Administration shall have the right to include a quantity of intermixture in product delivered to the Company; provided that –

(a) Such quantity of intermixture shall not be in excess of an amount which will cause the delivered product to be contaminated-

Table I

Maximum quantity per centum by volume of a component product of intermixture permitted in a delivered product

| | Component product of intermixture | | | | | |
|---|---|---|---|---|---|---|
| Delivered Product | Premium Petrol | Regular Petrol | Diesel Gasoline | Power Paraffin | Naphtha | Hydrocarbon Component |
| Premium Petrol | 5,0 | 1,0 | **0,5** | 0,5 | 0,5 | 0,5 |
| Regular Petrol | 5,0 | 5,0 | 1,0 | 1,0 | 1,0 | 0,5 |
| Diesel Gasoline | 0,25 | 0,25 | 5,0 | 2,0 | 0,25 | 0,25 |
| Power Paraffin | 2,0 | 2,0 | 1,0 | 5,0 | 1,0 | 1,0 |

Table II

Maximum quantity per centum by volume of a contaminant permitted in a delivered product

| Delivered product | Contaminant |
|---|---|
| Premium petrol | 1,0 |
| Regular petrol | 1,0 |
| Diesel gas oil | 2,0 |
| Power paraffin | 2,0 |

Table III

Maximum quantity per centum by volume of an intermixture of unknown composition permitted in a delivered product

| Delivered product | Contaminant |
|---|---|
| Premium petrol | 0,5 |
| Regular petrol | 0,5 |
| Diesel gas oil | 0,25 |
| Power paraffin | 1,0 |

(4) The Administration recognizes that, in the light of future marketing requirements and/or other prevailing circumstances, the Company may desire from time to time to revise the tables contained in sub- clause (1) of this clause and to amend such other quality- control details as may be found necessary and **the Administration hereby undertakes that it will not unreasonably withhold its consent to any proposed amendment that may be submitted to it by the Company**; provided always that it shall not be required to consent to any such amendment which does not have the support of all the participating companies as a whole.

**Appendix 2**

## INTERMIXTURE TREND: AFTER IMPLEMENTING REVISED BLEND RATE

**Start of 0,25%**

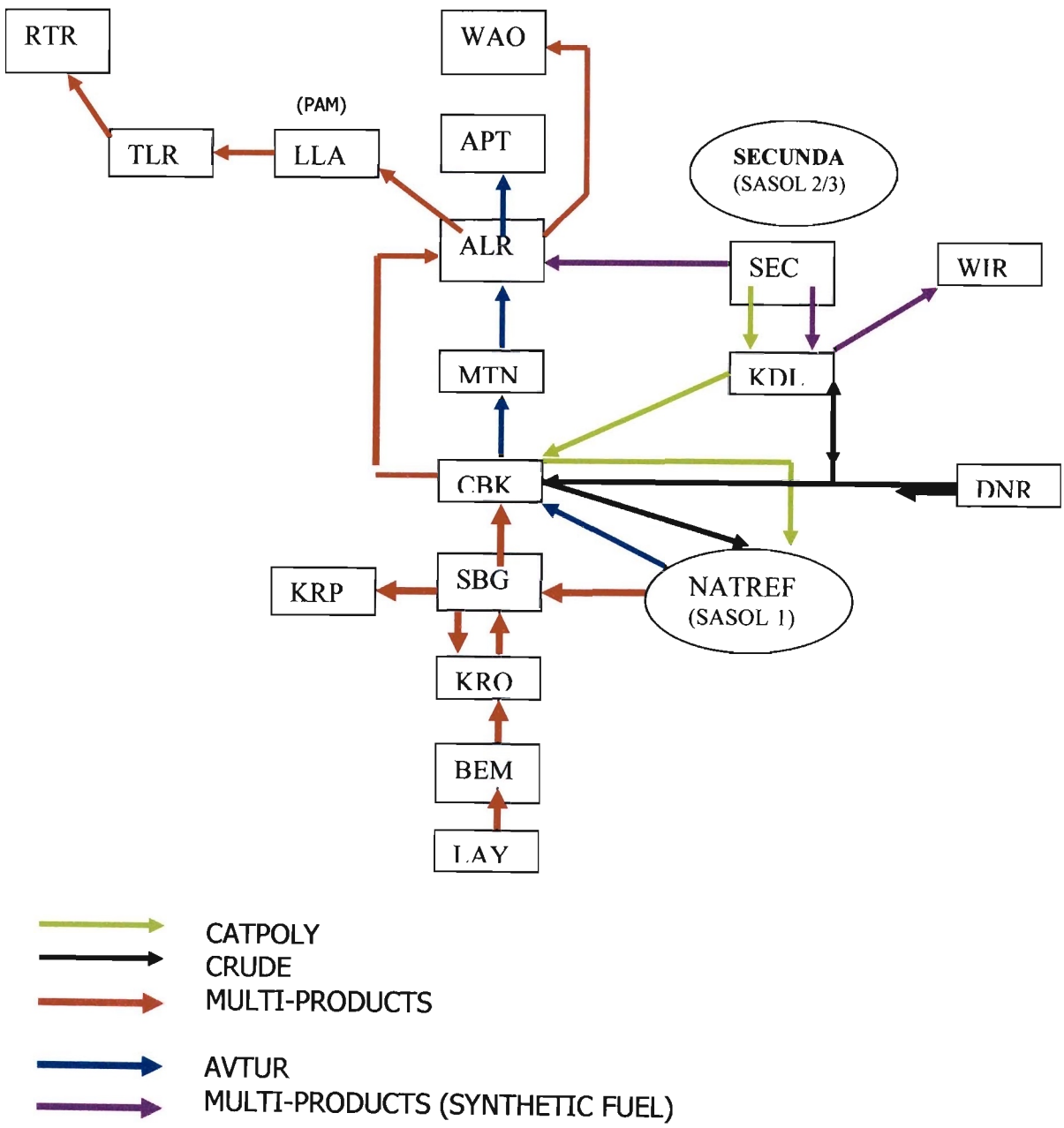
| AREA | 28 Jan-3 Feb | 4 Feb-10 Feb | 11 Feb-17 Feb | 18 Feb-24 Feb | 25 Feb-3 Mar | 4 Mar-10 Mar | 11 Mar-17 Mar | 18 Mar-24 Mar | MAXIMUM ULLAGE | CRITICAL POINT 60% |
|---|---|---|---|---|---|---|---|---|---|---|
| LAY | 1,069,391 | 1,139,986 | 1,005,095 | 954,671 | 944,097 | 928,601 | 859,501 | 857,587 | 2,061,000 | 1,236,600 |
| KRO | 644,274 | 392,838 | 279,710 | 301,885 | 442,582 | 378,455 | 1,225,666 | 1,367,110 | 3,600,000 | 2,160,000 |
| KPR | 91,734 | 90,891 | 80,374 | 134,032 | 173,098 | 95,389 | 60,001 | 95,549 | 339,100 | 203,460 |
| ALR | 1,149,108 | 1,194,158 | 1,841,197 | 1,896,239 | 1,646,662 | 1,375,723 | 1,604,549 | 1,458,120 | 3,200,000 | 1,920,000 |
| LLA | 173,324 | 211,118 | 315,751 | 277,942 | 181,911 | 399,286 | 323,470 | 179,774 | 3,200,000 | 1,920,000 |
| WAO | 160,797 | 147,050 | 214,493 | 198,464 | 138,811 | 97,992 | 171,425 | 143,696 | 2,890,000 | 1,734,000 |
| TLR | 382,411 | 420,086 | 413,915 | 406,805 | 533,807 | 413,591 | 445,776 | 407,302 | 921,000 | 552,600 |
| RTR | 57,501 | 57,527 | 36,319 | 152,893 | 142,817 | 144,489 | 132,535 | 127,965 | 482,000 | 289,200 |
| WIR | 89,451 | 305,556 | 255,850 | 187,794 | 195,011 | 212,544 | 167,479 | 158,642 | 622,292 | 373,375 |
| TOTAL | 3,817,991 | 3,959,210 | 4,442,704 | 4,510,725 | 4,398,796 | 4,046,070 | 4,990,402 | 4,795,745 | 17,315,392 | 10,389,235 |

| AREA | 25 Mar-31 Mar | 1 Apr-7 Apr | 8 Apr-14 Apr | 15 Apr-21 Apr | 22 Apr-28 Apr | 29 Apr 5 May | 6 May 12 May | 13 May 19 May | MAXIMUM ULLAGE | CRITICAL POINT 60% |
|---|---|---|---|---|---|---|---|---|---|---|
| LAY | 857,083 | 837,662 | 796,335 | 740,538 | 723,533 | 1609395 | 1542489 | 1538389 | 2,061,000 | 1,236,600 |
| KRO | 1,857,841 | 1,938,443 | 2,133,549 | 2,376,764 | 2,347,222 | 2726265 | 2769473 | 2830609 | 3,600,000 | 2,160,000 |
| KPR | 115,583 | 125,878 | 80,540 | 83,543 | 109,600 | 67135 | 164514 | 207138 | 339,100 | 203,460 |
| ALR | 1,464,856 | 1,106,327 | 1,399,660 | 2,194,013 | 2,662,686 | 253758 | 274640 | 965220 | 3,200,000 | 1,920,000 |
| LLA | 246,935 | 290,302 | 172,226 | 173,190 | 226,073 | 612772 | 688452 | 785239 | 3,200,000 | 1,920,000 |
| WAO | 170,744 | 126,599 | 77,195 | 178,104 | 100,601 | 203634 | 287991 | 159211 | 2,890,000 | 1,734,000 |
| TLR | 468,050 | 448,226 | 449,576 | 256,332 | 301,396 | 169235 | 284572 | 173857 | 921,000 | 552,600 |
| RTR | 130,482 | 125,407 | 128,865 | 138,908 | 115,094 | 164443 | 198599 | 221684 | 482,000 | 289,200 |
| WIR | 157,839 | 134,486 | 152,777 | 167,327 | 227,088 | 87411 | 67956 | 89537 | 622,292 | 373,375 |
| TOTAL | 5,469,413 | 5,133,330 | 5,390,723 | 6,308,719 | 6,813,293 | 5894048 | 6278686 | 6970884 | 17,315,392 | 10,389,235 |

**Appendix 3**

## SCHEDULING OF SLUGS TO DISTRIBUTE INTERMIXTURE

A weekly check on intermixture levels will help schedule the following week's interfaces to depots that have sufficient space to take in product or have the deliverable slug sizes to blend decent amounts of intermixture within specification.

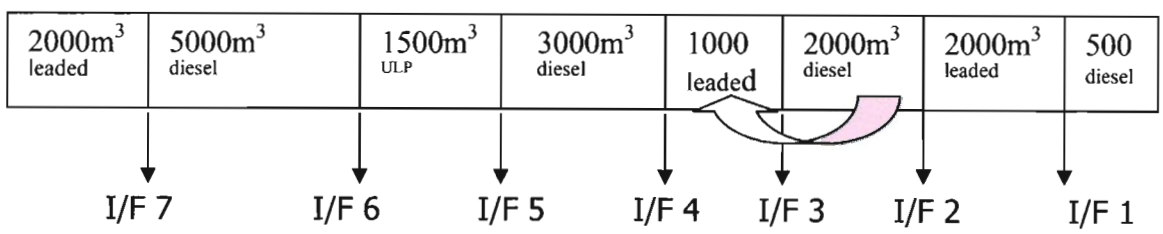


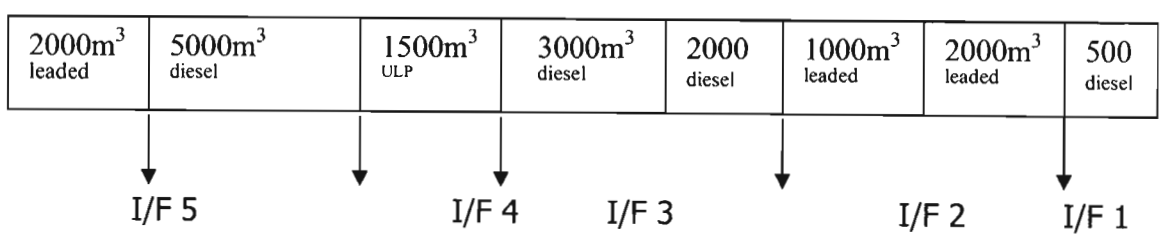
**Appendix 4**

## INCREASING SLUG SIZES / SHEDULING OF SLUGS INJECTED

The size of a slug injected into the pipeline plays an integral part in determining the size of intermixture accumulated at the end of the day. Frequent smaller slugs will result in more interfaces being taken off, which will undoubtedly increase intermixtures. (look closely at ULP slug sizes. What was the agreed minimum intake? Are we working within the agreement?)

The trend of smaller slugs over the years indicates that the Oil Industry have not invested in their depots or upgraded as a result they utilize pipeline as their storage facility. Forcing Industry to either increase their slug sizes or invest in their depots could have detrimental effects on Petronet's business, as Industry could use alternative mediums to transport their products. However, Industry must be enlightened on the adverse effects the frequent short slugs have on pipeline operations and more specifically, the handling of intermixture. Further, shorter slugs drastically inhibit Petronet from blending reasonable volumes of intermixtures as a result the build up of intermixture is inevitable.



- By re-scheduling the slugs, the slug sizes have increased and thus the numbers of interfaces handled have reduced.

It is recommended that Petronet run a test case to test the effectiveness of this option. The test case is described below.

**TEST CASE to Reduce number of interfaces**

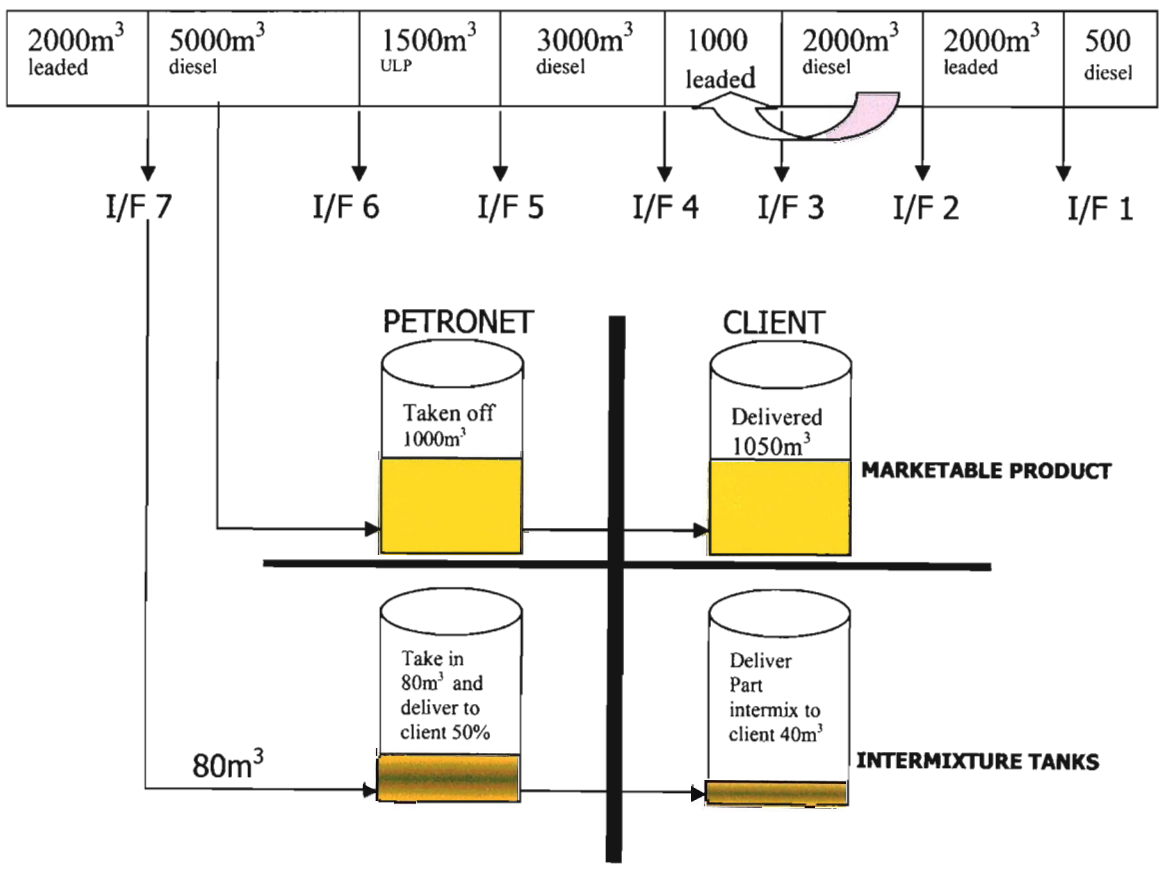
- Inject +-1500$m^3$ of ULP from SBG to KRP. Increase +-1500$m^3$ to +-1700 $m^3$. Deliver +-1500$m^3$ to the client. Balance into leaded product +-200$m^3$. The critical success of this exercise will depend on the availability of test equipment and competence of staff.

**Appendix 5**

## DELIVERING/SHARING INTERMIXTURES WITH CLIENTS

This option is applicable if the Company depots have the following:

- Dedicated intermixture tanks
- Available capacity
- Blend facilities



**Appendix 6**

**MINIMIZING OF UNPLANNED SHUTDOWNS**

Unplanned shutdowns have a negative effect on intermixture growth in the pipeline. They cause intermixtures to increase in size particularly so when they are not protected by batching pigs or spheres.

In Petronet unplanned shutdowns occur due to one or a combination of any one of the following:

- Municipal power failures; third party activities or interruptions by municipality
- Eskom power failures; third party activities or interruptions by Eskom
- Refineries not ready to inject product or product not available
- Clients not ready to take product
- Petronet ; equipment failure or bad operations

Municipality

- Municipalities are to be made aware of the nature of pipeline Operations
- Municipalities are to try and tie planned maintenance work around pipeline Operations.
- Petronet to have close liaison with Municipalities to achieve team work and thereby minimize UPSD.

Eskom

- Eskom are to be made aware of the nature of pipeline Operations
- Eskom are to try and tie planned maintenance work around pipeline Operations.
- Eskom to have close liaison with Petronet to achieve team work and minimize UPSD's.

Refineries

- Refineries are to advise Petronet timeously if they do not have product for pipeline
- Refineries to advise Petronet timeously when tanks are not within specification or available but not yet batched.

- Refineries are to ensure that they have trained staff available for "call out" (when valves jam or electrical trips)

Clients

- Clients must be advised timeously of product deliveries.
- Clients are to ensure that they have staff available for the delivery.
- Clients' equipment to be in working order.

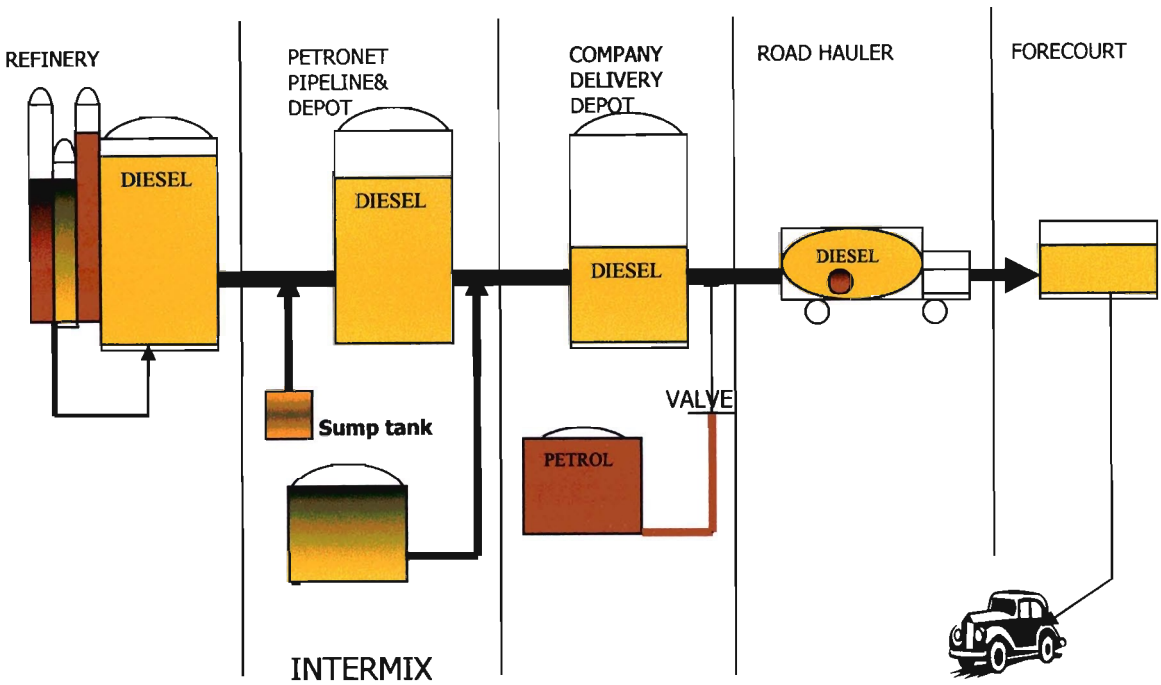
Petronet

- Have competent trained staff at depots
- Advise clients of delivery or changes in delivery times
- Maintenance of equipment verified by competent authority

**Appendix 7**

## REFINERIES TO PRODUCE BETTER FUEL QUALITY WITH ZERO BLENDING

There are many players in the chain from pipeline delivery to end point customer e.g. company delivery depots, transport by road or rail, end point delivery depots and forecourt garages. Each of these have the ability to contaminate the held product, and at some stage may also need to get rid of contaminated product.




In the above process, each of these players have the ability to contaminate the product. The refinery blend to get rid of their intermixture and so does Petronet. The company on the other hand may not blend, but could have leaking valves. The road hauler may also have a tanker that had been previously used for petrol deliveries and thus failed to clean the tanker that further contaminates the product.

Recommendation

- Zero blending done at the refinery
- Zero blend from sump tank and control blend from intermix
- Certification of slugs after pipeline delivery

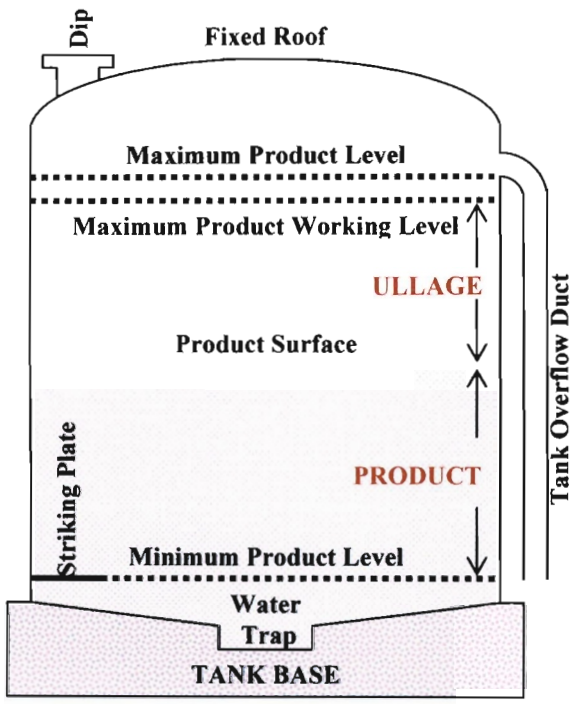
**Appendix 8**

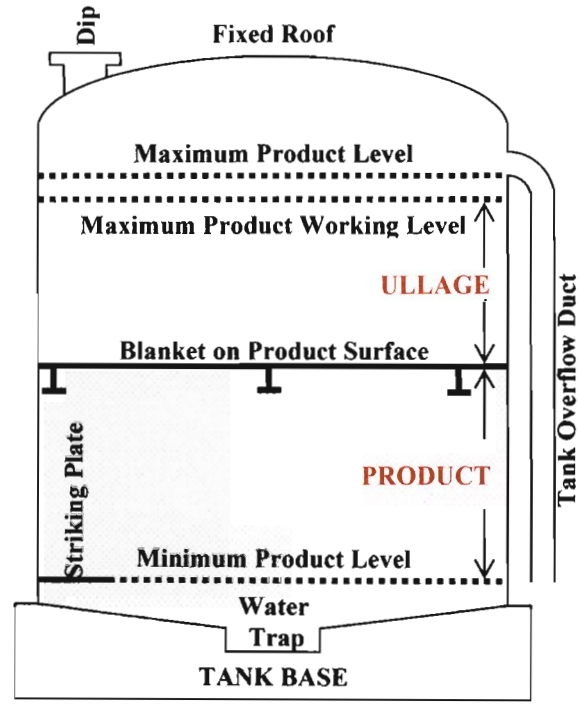
## PRODUCT QUALITY LIMITS AS AT JUNE 2003

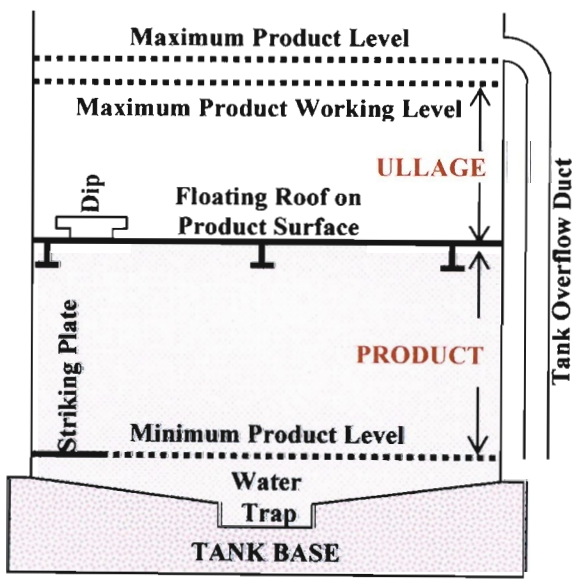
| PRODUCT NAME and CODE | PROPERTY | UNITS | LIMITS |
|---|---|---|---|
| Automotive Diesel (Diesel) (03) | Appearance | Yellow | Yellow |
| | Density @ 20°C | Kg / litre | 0,800 to 0,856 |
| | Flash point @ 101,325 kPa | ° C | 57 min at Intake<br>55 min at Delivery |
| | Haze Rating | Number | 2 max |
| | Millipore Filtration | Symbol | F or E |
| Leaded Premium Petrol (Premium) (01) | Appearance | Orange | Orange |
| | Density @ 20°C | Kg / litre | 0,705 to 0,785 |
| | Rating | Octane | 87, 93 or 97 |
| | Final Boiling Point | ° C | 210°C max Intake<br>215°C max Delivery |
| | Residue | % Volume | 2,0% max |
| | Haze Rating | Number | 2 max |
| | Millipore Filtration | Symbol | F or E |
| Unleaded Premium Petrol (ULP) (14) | Appearance | Yellow | Yellow |
| | Density @ 20°C | Kg / litre | 0,710 to 0,785 |
| | Rating | Octane | 91 or 95 |
| | Final Boiling Point | ° C | 210°C max at Intake<br>215°C max at Delivery |
| | Residue | % Volume | 2,0% max |
| | Haze Rating | Number | 2 max |
| | Millipore Filtration | Symbol | F or E |
| | Lead Content | Mg / litre | 4 max at Intake<br>5 max at Delivery |
| Synthetic Jet Fuel (SynJet) (10) | Appearance | Clear | Clear |
| | Density @ 20°C | Kg / litre | 0,755 to 0,600 |
| Hydro Carbon Blend (RON 90) (11) | Appearance | None | Orange |
| | Density @ 20°C | Kg / litre | 0,715 to 0,725 |
| Sasol Olifinic Petrol (SOP) (12) | Appearance | None | Clear |
| | Density @ 20°C | Kg / litre | 0,690 to 0,730 |
| Light Diesel Component (LDC) (13) | Appearance | None | Clear |
| | Density @ 20°C | Kg / litre | 0,750 to 0,780 |
| Low Sulphur Diesel (LSD) (15) | Appearance | None | 0,805 to 0,830 |
| | Density @ 20°C | Kg / litre | Yellow |
| Petrol / Alcohol Mixture (PAM) (17) | Appearance | None | Red, Orange or Yellow |
| | Density @ 20°C | Kg / litre | 0,705 to 0,785 |
| | Alcohol Content | % Volume | 12 max |
| Aviation Turbine Fuel (AVTUR) (08) | Appearance | Clear | Clear |
| | Density @ 20°C | Kg / litre | 0,771 to 0,836 |

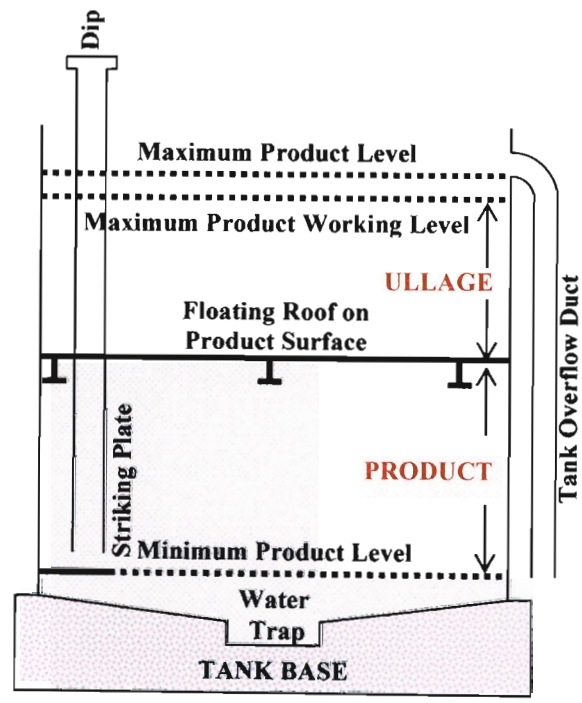
Appendix 9

## DIFFERENT TYPES OF INTERMIXTURE TANKS



**Appendix 10**

## CALCULATED TABLE BASED ON LINE FLOW RATE AND PERCENTAGE CONTAMINANT

The two tables have been calculated to indicate the different blend rates (0,50% and 0,25%) and their impact on the ability to blend intermixture. On close examination one would note that 0,5% Petronet can get rid of more intermixture than on 0,25% for the same flow rate and percentage contaminant.

| LINE FLOW RATE Litres per min | PERCENTAGE CONTAMINANT and MAX ALLOWABLE VOL INJECTED PER MINUTE FOR 0,50% MAXIMUM PURE CONTAMINANT (litres) | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 0 % | 5 % | 10 % | 15 % | 20 % | 25 % | 30 % | 35 % | 40 % | 45 % | 50 % | 55 % | 60 % | 65 % | 70 % | 75 % | 80 % | 85 % | 90 % | 95 % | 100 % |
| 2000 | 100 | 100 | 100 | 67 | 50 | 40 | 33 | 29 | 25 | 22 | 20 | 18 | 17 | 15 | 14 | 13 | 13 | 12 | 11 | 11 | 10 |
| 2100 | 105 | 105 | 105 | 70 | 53 | 42 | 35 | 30 | 26 | 23 | 21 | 19 | 18 | 16 | 15 | 14 | 13 | 12 | 12 | 11 | 11 |
| 2200 | 110 | 110 | 110 | 73 | 55 | 44 | 37 | 31 | 28 | 24 | 22 | 20 | 18 | 17 | 16 | 15 | 14 | 13 | 12 | 12 | 11 |
| 2300 | 115 | 115 | 115 | 77 | 58 | 46 | 38 | 33 | 29 | 26 | 23 | 21 | 19 | 18 | 16 | 15 | 14 | 14 | 13 | 12 | 12 |
| 2400 | 120 | 120 | 120 | 80 | 60 | 48 | 40 | 34 | 30 | 27 | 24 | 22 | 20 | 18 | 17 | 16 | 15 | 14 | 13 | 13 | 12 |
| 2500 | 125 | 125 | 125 | 83 | 63 | 50 | 42 | 36 | 31 | 28 | 25 | 23 | 21 | 19 | 18 | 17 | 16 | 15 | 14 | 13 | 13 |
| 2600 | 130 | 130 | 130 | 87 | 65 | 52 | 43 | 37 | 33 | 29 | 26 | 24 | 22 | 20 | 19 | 17 | 16 | 15 | 14 | 14 | 13 |
| 2700 | 135 | 135 | 135 | 90 | 68 | 54 | 45 | 39 | 34 | 30 | 27 | 25 | 23 | 21 | 19 | 18 | 17 | 16 | 15 | 14 | 14 |
| 2800 | 140 | 140 | 140 | 93 | 70 | 56 | 47 | 40 | 35 | 31 | 28 | 25 | 23 | 22 | 20 | 19 | 18 | 16 | 16 | 15 | 14 |
| 2900 | 145 | 145 | 145 | 97 | 73 | 58 | 48 | 41 | 36 | 32 | 29 | 26 | 24 | 22 | 21 | 19 | 18 | 17 | 16 | 15 | 15 |
| 3000 | 150 | 150 | 150 | 100 | 75 | 60 | 50 | 43 | 38 | 33 | 30 | 27 | 25 | 23 | 21 | 20 | 19 | 18 | 17 | 16 | 15 |
| 3100 | 155 | 155 | 155 | 103 | 78 | 62 | 52 | 44 | 39 | 34 | 31 | 28 | 26 | 24 | 22 | 21 | 19 | 18 | 17 | 16 | 16 |
| 3200 | 160 | 160 | 160 | 107 | 80 | 64 | 53 | 46 | 40 | 36 | 32 | 29 | 27 | 25 | 23 | 21 | 20 | 19 | 18 | 17 | 16 |
| 3300 | 165 | 165 | 165 | 110 | 83 | 66 | 55 | 47 | 41 | 37 | 33 | 30 | 28 | 25 | 24 | 22 | 21 | 19 | 18 | 17 | 17 |
| 3400 | 170 | 170 | 170 | 113 | 85 | 68 | 57 | 49 | 43 | 38 | 34 | 31 | 28 | 26 | 24 | 23 | 21 | 20 | 19 | 18 | 17 |
| 3500 | 175 | 175 | 175 | 117 | 88 | 70 | 58 | 50 | 44 | 39 | 35 | 32 | 29 | 27 | 25 | 23 | 22 | 21 | 19 | 18 | 18 |
| 3600 | 180 | 180 | 180 | 120 | 90 | 72 | 60 | 51 | 45 | 40 | 36 | 33 | 30 | 28 | 26 | 24 | 23 | 21 | 20 | 19 | 18 |
| 3700 | 185 | 185 | 185 | 123 | 93 | 74 | 62 | 53 | 46 | 41 | 37 | 34 | 31 | 28 | 26 | 25 | 23 | 22 | 21 | 19 | 19 |
| 3800 | 190 | 190 | 190 | 127 | 95 | 76 | 63 | 54 | 48 | 42 | 38 | 35 | 32 | 29 | 27 | 25 | 24 | 22 | 21 | 20 | 19 |
| 3900 | 195 | 195 | 195 | 130 | 98 | 78 | 65 | 56 | 49 | 43 | 39 | 35 | 33 | 30 | 28 | 26 | 24 | 23 | 22 | 21 | 20 |
| 4000 | 200 | 200 | 200 | 133 | 100 | 80 | 67 | 57 | 50 | 44 | 40 | 36 | 33 | 31 | 29 | 27 | 25 | 24 | 22 | 21 | 20 |
| 4100 | 205 | 205 | 205 | 137 | 103 | 82 | 68 | 59 | 51 | 46 | 41 | 37 | 34 | 32 | 29 | 27 | 26 | 24 | 23 | 22 | 21 |
| 4200 | 210 | 210 | 210 | 140 | 105 | 84 | 70 | 60 | 53 | 47 | 42 | 38 | 35 | 32 | 30 | 28 | 26 | 25 | 23 | 22 | 21 |
| 4300 | 215 | 215 | 215 | 143 | 108 | 86 | 72 | 61 | 54 | 48 | 43 | 39 | 36 | 33 | 31 | 29 | 27 | 25 | 24 | 23 | 22 |
| 4400 | 220 | 220 | 220 | 147 | 110 | 88 | 73 | 63 | 55 | 49 | 44 | 40 | 37 | 34 | 31 | 29 | 28 | 26 | 24 | 23 | 22 |
| 4500 | 225 | 225 | 225 | 150 | 113 | 90 | 75 | 64 | 56 | 50 | 45 | 41 | 38 | 35 | 32 | 30 | 28 | 26 | 25 | 24 | 23 |
| 4600 | 230 | 230 | 230 | 153 | 115 | 92 | 77 | 66 | 58 | 51 | 46 | 42 | 38 | 35 | 33 | 31 | 29 | 27 | 26 | 24 | 23 |
| 4700 | 235 | 235 | 235 | 157 | 118 | 94 | 78 | 67 | 59 | 52 | 47 | 43 | 39 | 36 | 34 | 31 | 29 | 28 | 26 | 25 | 24 |
| 4800 | 240 | 240 | 240 | 160 | 120 | 96 | 80 | 69 | 60 | 53 | 48 | 44 | 40 | 37 | 34 | 32 | 30 | 28 | 27 | 25 | 24 |
| 4900 | 245 | 245 | 245 | 163 | 123 | 98 | 82 | 70 | 61 | 54 | 49 | 45 | 41 | 38 | 35 | 33 | 31 | 29 | 27 | 26 | 25 |
| 5000 | 250 | 250 | 250 | 167 | 125 | 100 | 83 | 71 | 63 | 56 | 50 | 45 | 42 | 38 | 36 | 33 | 31 | 29 | 28 | 26 | 25 |
| 5100 | 255 | 255 | 255 | 170 | 128 | 102 | 85 | 73 | 64 | 57 | 51 | 46 | 43 | 39 | 36 | 34 | 32 | 30 | 28 | 27 | 26 |
| 5200 | 260 | 260 | 260 | 173 | 130 | 104 | 87 | 74 | 65 | 58 | 52 | 47 | 43 | 40 | 37 | 35 | 33 | 31 | 29 | 27 | 26 |
| 5300 | 265 | 265 | 265 | 177 | 133 | 106 | 88 | 76 | 66 | 59 | 53 | 48 | 44 | 41 | 38 | 35 | 33 | 31 | 29 | 28 | 27 |
| 5400 | 270 | 270 | 270 | 180 | 135 | 108 | 90 | 77 | 68 | 60 | 54 | 49 | 45 | 42 | 39 | 36 | 34 | 32 | 30 | 28 | 27 |
| 5500 | 275 | 275 | 275 | 183 | 138 | 110 | 92 | 79 | 69 | 61 | 55 | 50 | 46 | 42 | 39 | 37 | 34 | 32 | 31 | 29 | 28 |
| 5600 | 280 | 280 | 280 | 187 | 140 | 112 | 93 | 80 | 70 | 62 | 56 | 51 | 47 | 43 | 40 | 37 | 35 | 33 | 31 | 29 | 28 |

| LINE FLOW RATE Litres per min | PERCENTAGE CONTAMINANT and MAX ALLOWABLE VOL INJECTED PER MINUTE FOR 0,25% MAXIMUM PURE CONTAMINANT (litres) | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 0 % | 5 % | 10 % | 15 % | 20 % | 25 % | 30 % | 35 % | 40 % | 45 % | 50 % | 55 % | 60 % | 65 % | 70 % | 75 % | 80 % | 85 % | 90 % | 95 % | 100 % |
| 2000 | 100 | 100 | 50 | 33 | 25 | 20 | 17 | 14 | 13 | 11 | 10 | 9 | 8 | 8 | 7 | 7 | 6 | 6 | 6 | 5 | 5 |
| 2100 | 105 | 105 | 53 | 35 | 26 | 21 | 18 | 15 | 13 | 12 | 11 | 10 | 9 | 8 | 8 | 7 | 7 | 6 | 6 | 6 | 5 |
| 2200 | 110 | 110 | 55 | 37 | 28 | 22 | 18 | 16 | 14 | 12 | 11 | 10 | 9 | 8 | 8 | 7 | 7 | 6 | 6 | 6 | 6 |
| 2300 | 115 | 115 | 58 | 38 | 29 | 23 | 19 | 16 | 14 | 13 | 12 | 10 | 10 | 9 | 8 | 8 | 7 | 7 | 6 | 6 | 6 |
| 2400 | 120 | 120 | 60 | 40 | 30 | 24 | 20 | 17 | 15 | 13 | 12 | 11 | 10 | 9 | 9 | 8 | 8 | 7 | 7 | 6 | 6 |
| 2500 | 125 | 125 | 63 | 42 | 31 | 25 | 21 | 18 | 16 | 14 | 13 | 11 | 10 | 10 | 9 | 8 | 8 | 7 | 7 | 7 | 6 |
| 2600 | 130 | 130 | 65 | 43 | 33 | 26 | 22 | 19 | 16 | 14 | 13 | 12 | 11 | 10 | 9 | 9 | 8 | 8 | 7 | 7 | 7 |
| 2700 | 135 | 135 | 68 | 45 | 34 | 27 | 23 | 19 | 17 | 15 | 14 | 12 | 11 | 10 | 10 | 9 | 8 | 8 | 8 | 7 | 7 |
| 2800 | 140 | 140 | 70 | 47 | 35 | 28 | 23 | 20 | 18 | 16 | 14 | 13 | 12 | 11 | 10 | 9 | 9 | 8 | 8 | 7 | 7 |
| 2900 | 145 | 145 | 73 | 48 | 36 | 29 | 24 | 21 | 18 | 16 | 15 | 13 | 12 | 11 | 10 | 10 | 9 | 9 | 8 | 8 | 7 |
| 3000 | 150 | 150 | 75 | 50 | 38 | 30 | 25 | 21 | 19 | 17 | 15 | 14 | 13 | 12 | 11 | 10 | 9 | 9 | 8 | 8 | 8 |
| 3100 | 155 | 155 | 78 | 52 | 39 | 31 | 26 | 22 | 19 | 17 | 16 | 14 | 13 | 12 | 11 | 10 | 10 | 9 | 9 | 8 | 8 |
| 3200 | 160 | 160 | 80 | 53 | 40 | 32 | 27 | 23 | 20 | 18 | 16 | 15 | 13 | 12 | 11 | 11 | 10 | 9 | 9 | 8 | 8 |
| 3300 | 165 | 165 | 83 | 55 | 41 | 33 | 28 | 24 | 21 | 18 | 17 | 15 | 14 | 13 | 12 | 11 | 10 | 10 | 9 | 9 | 8 |
| 3400 | 170 | 170 | 85 | 57 | 43 | 34 | 28 | 24 | 21 | 19 | 17 | 15 | 14 | 13 | 12 | 11 | 11 | 10 | 9 | 9 | 9 |
| 3500 | 175 | 175 | 88 | 58 | 44 | 35 | 29 | 25 | 22 | 19 | 18 | 16 | 15 | 13 | 13 | 12 | 11 | 10 | 10 | 9 | 9 |
| 3600 | 180 | 180 | 90 | 60 | 45 | 36 | 30 | 26 | 23 | 20 | 18 | 16 | 15 | 14 | 13 | 12 | 11 | 11 | 10 | 9 | 9 |
| 3700 | 185 | 185 | 93 | 62 | 46 | 37 | 31 | 26 | 23 | 21 | 19 | 17 | 15 | 14 | 13 | 12 | 12 | 11 | 10 | 10 | 9 |
| 3800 | 190 | 190 | 95 | 63 | 48 | 38 | 32 | 27 | 24 | 21 | 19 | 17 | 16 | 15 | 14 | 13 | 12 | 11 | 11 | 10 | 10 |
| 3900 | 195 | 195 | 98 | 65 | 49 | 39 | 33 | 28 | 24 | 22 | 20 | 18 | 16 | 15 | 14 | 13 | 12 | 11 | 11 | 10 | 10 |
| 4000 | 200 | 200 | 100 | 67 | 50 | 40 | 33 | 29 | 25 | 22 | 20 | 18 | 17 | 15 | 14 | 13 | 13 | 12 | 11 | 11 | 10 |
| 4100 | 205 | 205 | 103 | 68 | 51 | 41 | 34 | 29 | 26 | 23 | 21 | 19 | 17 | 16 | 15 | 14 | 13 | 12 | 11 | 11 | 10 |
| 4200 | 210 | 210 | 105 | 70 | 53 | 42 | 35 | 30 | 26 | 23 | 21 | 19 | 18 | 16 | 15 | 14 | 13 | 12 | 12 | 11 | 11 |
| 4300 | 215 | 215 | 108 | 72 | 54 | 43 | 36 | 31 | 27 | 24 | 22 | 20 | 18 | 17 | 15 | 14 | 13 | 13 | 12 | 11 | 11 |
| 4400 | 220 | 220 | 110 | 73 | 55 | 44 | 37 | 31 | 28 | 24 | 22 | 20 | 18 | 17 | 16 | 15 | 14 | 13 | 12 | 12 | 11 |
| 4500 | 225 | 225 | 113 | 75 | 56 | 45 | 38 | 32 | 28 | 25 | 23 | 20 | 19 | 17 | 16 | 15 | 14 | 13 | 13 | 12 | 11 |
| 4600 | 230 | 230 | 115 | 77 | 58 | 46 | 38 | 33 | 29 | 26 | 23 | 21 | 19 | 18 | 16 | 15 | 14 | 14 | 13 | 12 | 12 |
| 4700 | 235 | 235 | 118 | 78 | 59 | 47 | 39 | 34 | 29 | 26 | 24 | 21 | 20 | 18 | 17 | 16 | 15 | 14 | 13 | 12 | 12 |
| 4800 | 240 | 240 | 120 | 80 | 60 | 48 | 40 | 34 | 30 | 27 | 24 | 22 | 20 | 18 | 17 | 16 | 15 | 14 | 13 | 13 | 12 |
| 4900 | 245 | 245 | 123 | 82 | 61 | 49 | 41 | 35 | 31 | 27 | 25 | 22 | 20 | 19 | 18 | 16 | 15 | 14 | 14 | 13 | 12 |
| 5000 | 250 | 250 | 125 | 83 | 63 | 50 | 42 | 36 | 31 | 28 | 25 | 23 | 21 | 19 | 18 | 17 | 16 | 15 | 14 | 13 | 13 |
| 5100 | 255 | 255 | 128 | 85 | 64 | 51 | 43 | 36 | 32 | 28 | 26 | 23 | 21 | 20 | 18 | 17 | 16 | 15 | 14 | 13 | 13 |
| 5200 | 260 | 260 | 130 | 87 | 65 | 52 | 43 | 37 | 33 | 29 | 26 | 24 | 22 | 20 | 19 | 17 | 16 | 15 | 14 | 14 | 13 |
| 5300 | 265 | 265 | 133 | 88 | 66 | 53 | 44 | 38 | 33 | 29 | 27 | 24 | 22 | 20 | 19 | 18 | 17 | 16 | 15 | 14 | 13 |
| 5400 | 270 | 270 | 135 | 90 | 68 | 54 | 45 | 39 | 34 | 30 | 27 | 25 | 23 | 21 | 19 | 18 | 17 | 16 | 15 | 14 | 14 |
| 5500 | 275 | 275 | 138 | 92 | 69 | 55 | 46 | 39 | 34 | 31 | 28 | 25 | 23 | 21 | 20 | 18 | 17 | 16 | 15 | 14 | 14 |
| 5600 | 280 | 280 | 140 | 93 | 70 | 56 | 47 | 40 | 35 | 31 | 28 | 25 | 23 | 22 | 20 | 19 | 18 | 16 | 16 | 15 | 14 |
| 5700 | 285 | 285 | 143 | 95 | 71 | 57 | 48 | 41 | 36 | 32 | 29 | 26 | 24 | 22 | 20 | 19 | 18 | 17 | 16 | 15 | 14 |
| 5800 | 290 | 290 | 145 | 97 | 73 | 58 | 48 | 41 | 36 | 32 | 29 | 26 | 24 | 22 | 21 | 19 | 18 | 17 | 16 | 15 | 15 |
| 5900 | 295 | 295 | 148 | 98 | 74 | 59 | 49 | 42 | 37 | 33 | 30 | 27 | 25 | 23 | 21 | 20 | 18 | 17 | 16 | 16 | 15 |

**How the to use and interpret the table in appendix 10**

**EXAMPLE 1 (DECIDE ON A BLENDING RATE)**

Assume the following: -

| | |
|---|---|
| Product to Client | = Petrol |
| Petrol quality (before blending) | = High enough to be blended into (FBP < 200°C) |
| Flow rate to Client | = 7 300 litres/min |
| Intermixture composition | = 20% diesel and 80% petrol |
| Contaminant | = Diesel |
| Maximum blending rate | = 0,50% pure diesel into petrol |

Obtain the maximum intermixture flow rate from the relevant table.

STEP 1 Use the table for 0,50% max blending rate (first table above).

STEP 2 Locate the line flow rate of 7 300 litres/min in the first column.

STEP 3 Find the max injection rate of 183 litres/min in the 20% column.

Decision

For a petrol delivery to a Client, flowing at 7 300 litres per minute, intermixture containing 20% diesel and 80% petrol, can be blended at a rate of up to 183 litres/min provided the FBP of the petrol, after blending, is not higher than 215°C.

**EXAMPLE 2 (DECIDE ON A BLENDING RATE)**

Assume the following: -

| | |
|---|---|
| Product to Client | = Diesel |
| Diesel quality (before blending) | = High enough to be blended into (Flash Point > 58°C) |
| Flow rate to Client | = 5 730 litres/min |
| Intermixture composition | = 27% diesel and 73% petrol |
| Contaminant | = Petrol |
| Maximum blending rate | = 0,25% pure petrol into diesel |

Obtain the maximum intermixture flow rate from the relevant table.

STEP1 Use the table for 0,25% max blending rate (second table above).

STEP2 Locate the line flow rate between 5 700 and 5 800 litres/min in the first column

STEP3 Find the max injection rate of approx 52 litres/min between the 25% and 30% columns

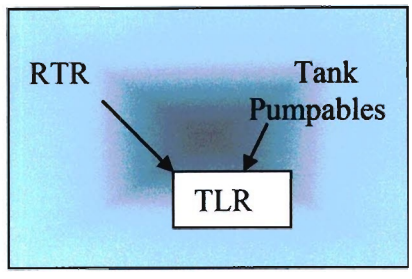
Decision

For a diesel delivery to a Client, flowing at 5 730 litres per minute, intermixture containing 27% petrol and 73% diesel, can be blended at a rate of up to 52 litres/min provided the flash point of the diesel, after blending, is not lower than 55°C.

**Appendix 11**

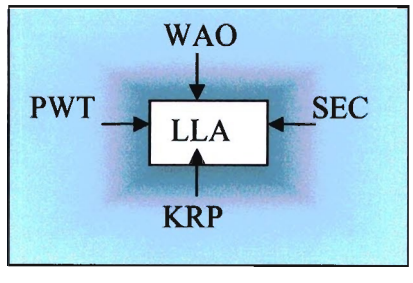
**Intermixture crisis Management**

**03/01/14**



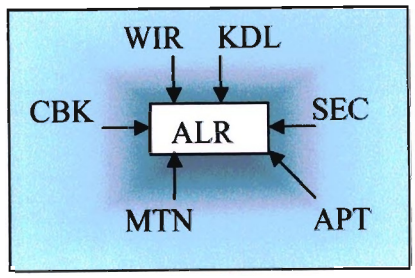

In the event of Rustenberg (RTR) unable to handle their intermixture ullage, Rustenberg can arrange for their intermixture to be road hauled to Tarlton (TLR), where it can be blended, railed or road hauled to a refinery for re-refining.

**03/01/14**



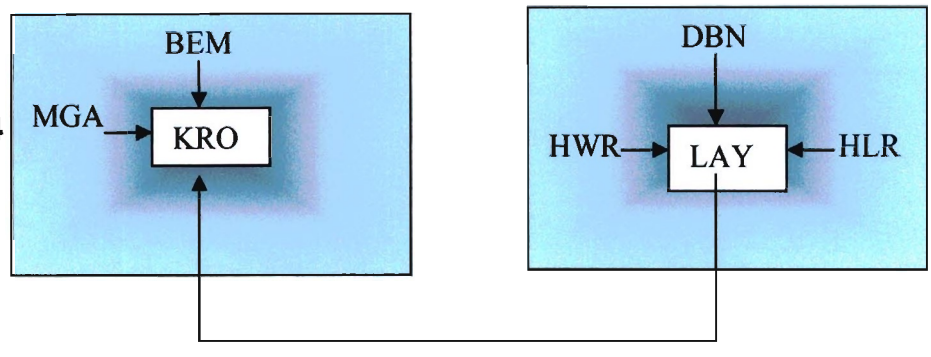

Langlaagte (LLA) will act as a receiving depot, to receive intermixture from Waltloo (WAO), Secunda (SEC), Klerksdorp (KRP) and Pretoria West (PWT)

**03/01/14**
**08**
**(K12,13,15,10)**



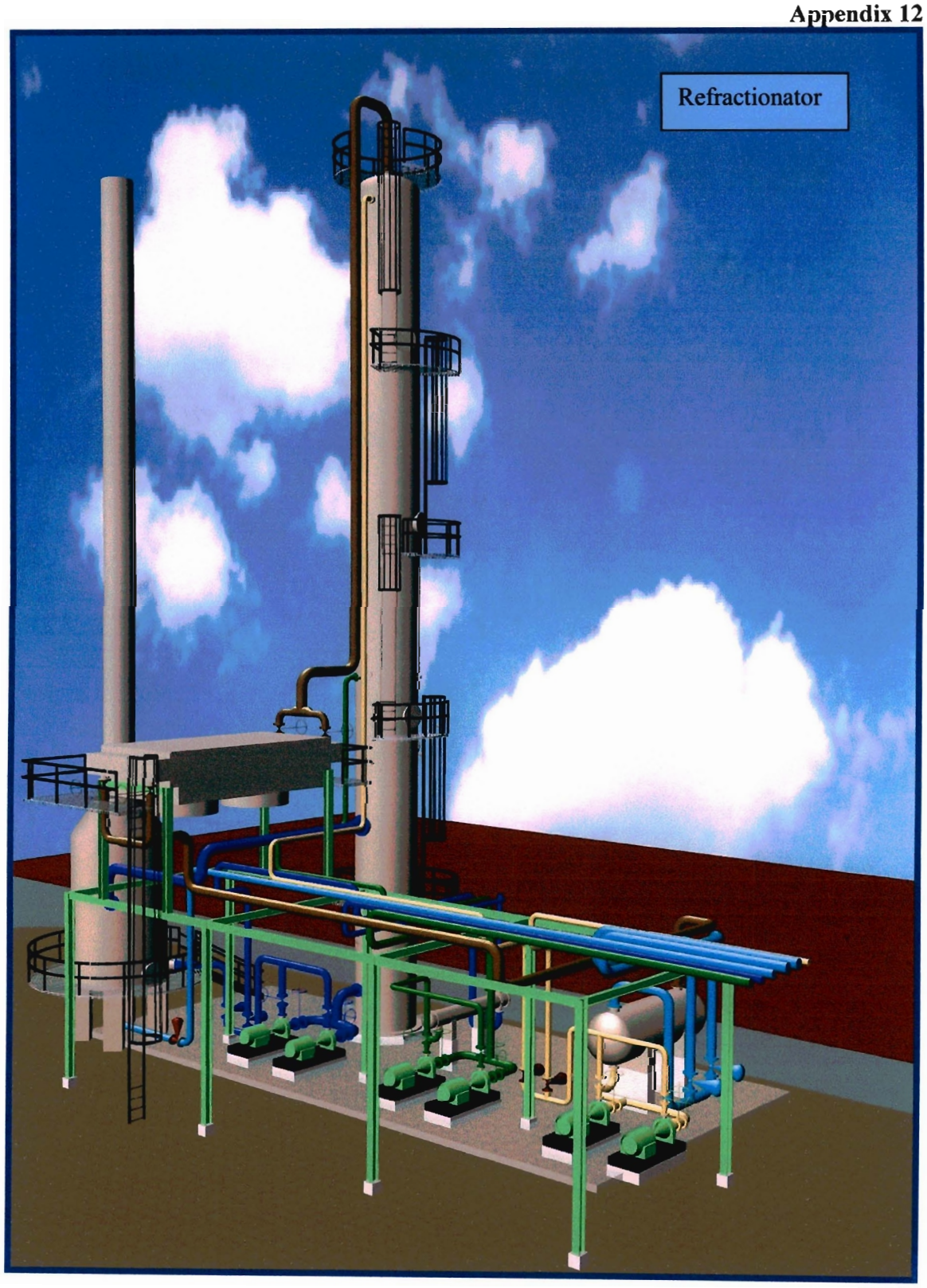

Alrode (ALR) will act as a receiving depot to take any excess intermixture from Witbank (WIR), Kendal (KDL), Secunda (SEC), Airport (APT), Meyerton (MTN) and Coalbrook (CBK)

**03/01/14**




In this setup, Ladysmith (LAY) will receive any excess intermixture from sump tanks from Durban (DBN), Hillcrest (HLR) and Howick (HWR). Once Ladysmith's intermixture tanks run into excess, transfers can then be made from Ladysmith to Kroonstad. Kroonstad (KRO) will receive excess intermixture from Bethlehem (BEM) and Magdala (MGA).

**Appendix 12**



**Appendix 13**

**Photograph: Kroonstad Depot**

Kroonstad Depot is the area marked in black. There are 4 intermixture tanks on site that have a total holding capacity of 3,2 million litres. To the right of the Petronet depot is the mothballed Total site. This site is currently not in use by the Total. As discussed in one of the options, Petronet can approach Total to either buy or lease one or two of the tanks. This would enable Petronet to but additional intermixture capacity but more importantly be able to use the road and rail facility that is available at the site. Across the road is one of Petronet's client Engen. Petronet deliver directly of the mainline to the clients when they delivery is scheduled. Whilst delivering to the client, Petronet blend some of the intermixture from any of the 4 tanks at a predetermined rate, ensuring that the delivered product is still within delivered specification.

**Appendix 14**


**Photograph: Alrode Depot**

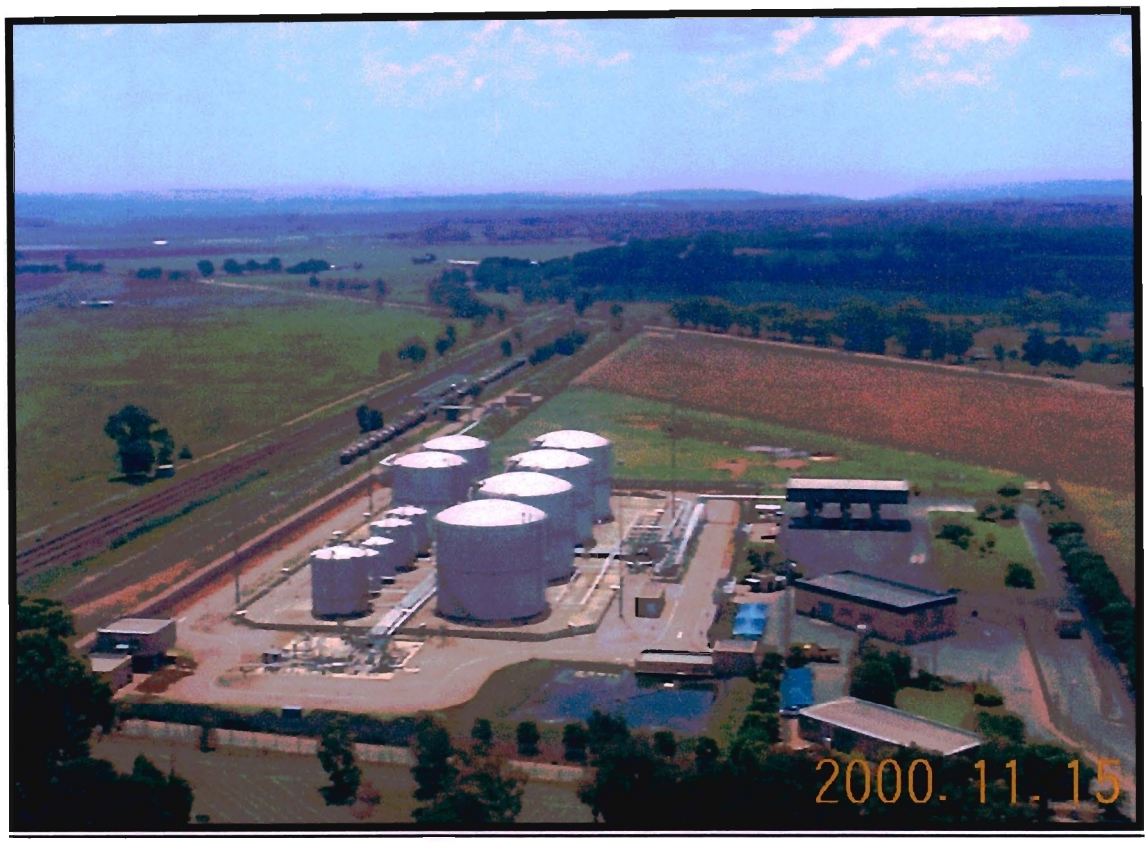
The area marked in black is the Alrode depot. This depot is bigger than Kroonstad depot and has 4 intermixture tanks which are situated on the right side of the photograph and 4 accumulator tank situated on left of the depot. The accumulator tanks stores good product and is used to store product for the clients. Due to this depot having intermixture and accumulator tanks, there exists the ability for the depot to blend and test internally before delivering to client. In this way, the chances of putting a clients' tank off spec is negative.

**Appendix 15**


**Photograph: Langlaagte Depot**

The area marked in black is the Langlaagte depot. This depot has 4 intermixture tank and 2 accumulator tanks.

**Appendix 16**




**Photograph: Tarlton Depot**

Tarlton depot is a unique depot in Petronet due to its recent construction which includes a rail and road handling facility. This depot has accumulator and intermixture tanks which makes it an ideal depot to handle short, medium and long term solutions as discussed in this research.

**BIBLIOGRAPHY**


- Energy White Paper, Dec 1998
- Draft paper on the Petroleum Pipelines Bill,2002
- South African Bureau Of Standards for petroleum products
- Sapref website htpp//www.sapref.com
- Peabody's control of pipeline corrosion A. W. Peabody 2001 2nd ed.1
- Annual report: Long-term reliability of gas pipeline repairs by reinforced composites Gas Research Institute, 1993
- Pipeline construction - I.P.L.C.A, 3rd Ed.
- The Pipeline glossary and directory - C.D. Shann 1st Ed.
- Pipeline safety regulations
- Land pipeline and slurry systems projects Snamprogetti S.P.A.
- Pipes & pipelines principles and practice K. Myles and associates
- 0il and gas pipeline fundamentals John L Kennedy
- Handbook of pipeline engineering computations Alex Marks
- Pipeline risk management manual : a tested and proven system to prevent loss and access risk W. Kent Muhlbauer 2nd Edition
- Basic pipeline engineering manual John L. Cranmer Jr
- Petronet Weekly Intermixture reports
- Petronet Conveyance Agreement, 1965
- Petronet Reconciliation procedure, working papers
- Pipeline route diagram and photographs: Petronet Drawing Office
- Monthly petrol price changes in South Africa
  Department of Minerals & Energy Pretoria, Dec 1999