GENERAL NOTICE

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FINAL DRAFT

JOINT IMPLEMENTATION STRATEGY FOR THE CONTROL OF EXHAUST EMISSIONS FROM ROAD-GOING VEHICLES IN, THE REPUBLIC SOUTH AFRICA

DEPARTMENT OF ENVIRONMENTAL AFFAIRS AND TOURISM
DEPARTMENT OF MINERALS AND ENERGY

FOREWORD

Emissions from vehicles have been identified as a growing problem in South Africa due to a steady increase in the number of vehicles on the roads and an increase in the annual distance driven. Owing to the absence of vehicle emissions legislation, most vehicles are not equipped with emissions control devices and can thus emit more than ten times the emissions of equivalent vehicles in emissions regulated markets. Combined with the fact that a significant proportion of the vehicles are old and often in poor condition, it has become prudent for government to make an intervention by formalising emissions standards applicable to vehicles and standards for vehicle fuels. The air quality and human health related aspects of fuel specifications have not yet been addressed in legislation, resulting in a situation where existing fuel qualities are out of line with those of emissions regulated markets. Coordinated revision of vehicle emissions legislation together with the revision of fuel specification is accepted practice internationally and has facilitated significant improvement of air quality .

The Department of Minerals and Energy (DME) and the Department of Environmental Affairs and Tourism (DEAI) collaborated in the preparation of this strategy and are grateful for the contributions made by stakeholders, in particular the South African Petroleum Industry and the National Automobile Association of South Africa. The strategy for vehicle emissions will balance conflicting objectives and priorities such as affordability of vehicles, the economics of fuel production and the cost of fuel and air quality standards. This strategy is guided by the following:

- The constitution of the Republic of South Africa (1996)
- The White Paper on Energy Policy (1998)
- Air Quality Management Bill (2003)
- Petroleum Products Act (1997) and the Petroleum Products Amendment Bill (2003)
- White Paper on Integrated Pollution and ,Waste Management Act (2000)
- The National Environmental Management Act (1998)
- The White Paper on National Transport Policy (1996)
- The National Land Transportation Transition Act (2000)

Contents

GLOSSARY OF ACRONYMS AND TERMS

CO	Carbon Monoxide
CPI	Consumer Price Index
CSIR	Council for Scientific and Industrial Research
DEAT	Department of Environmental Affairs and Tourism
DME	Department of Minerals and Energy
DOT	Department of Transport
DTI	Department of Trade and industry
ECE	Economic Commission for Europe
ETBE	Ethyl tertiary butyl ether
Ethanol	Ethyl Alcohol. Produced through fermentation process and synthetically
Euro 1	Emission Standards effective 01 January 1992
Euro 2	Emission Standards effective 1 January 1997
Euro 3	Emission Standards effective January 2000
Euro 4	Emission Standards effective 1 January 2005
EURO 5	Emission Standards effective 1 January 2008
HC	Hydrocarbons
LCV	Light Commercial vehicles
LPG	Liquefied Petroleum Gas
LRP	Lead Replacement Petrol/Contains heavy metals
MMT	Methylcyclopentadienyl Manganese Tncarbonyl /heavy metal that can be used as a substitute for lead in petrol
MTBE	Methyl tertiary Butyl Ether,
NAAMSA	National Automobile Association of South Africa
New Vehicles	All vehicles newly manufactured
Newly Homologated	New vehicle models
NOX	Nitrogen oxide
OEMS	Original Equipment Manufacturers
PM	Particulate Matter
Ppm	parts per million
RON	Research Octane Number
RVP	Reid vapour pressure
TAME	Tertiary amyl methyl ether
ULP	Unleaded Petrol – contains no heavy metals
UNECE	United Nations Economic Commission for Europe
VSR	Valve Seat Recession

By adopting the strategy outlined in this document ,it would be possible to effectively control vehicle emissions in South Africa, particularly in urban areas. It is the intention of the Government through the various interventions described in the strategy, to ensure that the integrity of ambient air and other environmental media are not compromised, while at the same time promoting economic growth. In pursuance of this quest, all interventions recommended in this strategy are informed and guided by the Bill of Rights and the principles contained in the National Environmental Management Act and the Energy Policy White Paper (1998), particularly the precautionary principle or "no regrets" policy.

The strategy sets out a road map for government', the oil industry as well as the vehicle manufacturing industry aimed at achieving improved air quality through the control of vehicle emissions.

The backbone of this strategy is the implementation timetable of clearly defined European standards for vehicle exhaust emissions and apprpriate fuel specifications. Initial vehicle emissions limits began in 2005 for newly homologated vehicles and will come into full effect in 2006 when all new vehicles will be subjected to emisions controls. The fuel specification will change in 2006 when a total ban of the use of lead in petrol will come into effect. Lead is used in petrol to boost octane and also provides "protection" against engine wear in older vehicles. The major challenge posed by the lead phase-out is the identification and use of suitable lead replacement additives. A number of alternatives to met this short-term objective are available and are in use in some countries. However, gaps exits in current knowledge on the long term environmental and health effects of some of these substances. As a consequence of this, this strategy adopts a precautionary approach where issues of human health and the environment are of concern. The long-term resolution of this challenge is the re-configuration of refinery processes in order for the refineries to produce fuels of appropriate quality without the use of heavy metals. This is Government's preferred approach and is the reason for its considered support of financial incentives to the refinery industry. National Treasury is currently investigating the possibility of providing financial incentives to facilitate cleaner fuels investments.

The proposed timetable is summarised as follows:

Vehicle Emissions

Passenger vehicles, light delivery vehicles and heavy vehicles (GVM> 3500 kg).

Phase 1:

January 2004:	Euro 1- All homologated vehicles
January 2006:	Euro 2- All newly homologated vehicles
January 2008:	Euro 2- All newly manufactured vehicles

Phase 2:

January 2010:	Euro 4-All newly homologated vehicles
January 2012:	Euro 4-All newly manufactured vehicles

Fuel Specifications

Petrol Octane

January 2006:	Coastal grades of ULP 95 RON and 91 RON LRP by bottle dosage until 2008
January 2006:	All Inland grades of ULP 95 RON and 91 RON LRP by bottle dosage until 2008
Notes:	Coastal and inland grades of ULP td be 95 RON and 91 RON with LRP available nationally through oltles sold at service station convenience shops. The price of th LRP Bottle additive could be price regulated.

January 2006 The octane grading on pump to reflect super (higher octane) and premium grades (lower octane) of ULP. Actual octane number ratings on pumps would be prohibited to discourage consumer octane waste

Petrol Sulphur

January 2004: Maximum sulphur content of 500 ppm

January 2010: Maximum sulphur content of 50 ppm

Benzene

January 2006: Maximum benzene content of 3%

Future date: Maximum benzene content of 1%

Aromatics

January 2006: Maximum aromatics content of 42%

Future date: Maximum aromatics content of 35 and less

Oxyqenates and Ethers In Petrol

January 2006: Maximum content of ethers and select alcohols to 2.7% (rn/m) of oxygen. Volumetric blending limits on the use of alcohols in line with European fuel specifications will be considered in the future.

Heavy Metal Additives in petrol

January 2006: Lead based additives prohibited. The use of heavy metal based additives in unleaded petrol will be prohitited and only be allowed in Lead Replacement Petrol.

The use of MMT in Lead replacement Petrol will require the marketers of Lead Replacement Petrol containing MMT to post a sign informing the customer about the contents of the fuel. This will become effective in 2006 and a regulation detailing the labelling of petrol dispensing equipment will be promulgated by the Minister of Minerals and Energy.

Government is considering the imposition of a levy on such fuels to fund research work into the health and environmntal consequences, should the need arise.

The definition of clean fuels, as applicable from 2006 is "any fuel that does not contain heavy metals and having a maximum benzene content of 3%, aromatics content of 42%, sulphur level of 500ppm and a maximum oxygenate content of ethers and selected alcohols of less that 2.7 %. Diesel that contains less that 500 ppm of sulphur will also included"

Government is considering investment incentives for local refiners that is in line with this definition and will exclude fuels containing heavy metals.

The regulated price build up for petrol and diesel will be based on cleaner fuels only. Any other additional costs incurred in the marketing or distribution of fuels containing heavy rntals would be excluded accordingly.

Petrol Volatility

January 2006: Maximum petrol RVP o 65 kPa (coastal summer grade). Inland and win$er grades set accordingly. Other volatility parametes will be set to ensure cold starting and that driveabiliy, especially of older cars is not compromised. Further reductions in volatility will be considered for 2010.

Diesel Sulphur

January 2006: Maximum sulphur content of 500 ppm. Second grade of 50-ppm sulphur diesel will be available on a voluntary and selective basis.

January 2010: Diesel with maximum sulphur content of 50 ppm shall be available nationally.

Polycyclic Aromatics in Diesel

January 2010: In line with corresponding European enabling specifications.

CHAPTER ONE

INTRODUCTION

1.1 Vehicle Emissions in the Context of the National Environmental Policy Framework

The Department of Environmental Affairs and Tourism, as lead authority charged with the Constitutional mandate of ensuring an environment that is not harmful to the health and well-being of citizens, has initiated a process to revamp the outdated air pollution legislation and replace it with legislation that will better psition government to fulfil this mandate.

This legislation is informed by the White Paper on Integrated Pollution and Waste Management for South Africa, and indeed gives effect, to this policy document. The White Paper cites vehicle emissions as a significant contributor to air pollution, which in turn exacerbates health and environmental problems. This new law will address emissions from both mobile and stationary sources and entails the setting and enforcement of ambient air quality standards for 'priority', pollutants. Some of these are emitted in significant quantities by motor vehicles.

The National Land Transportation Act (Act 22 of 2000) advocates public awareness programs to foster energy awareness for the users of land transport systems. The National Road Agency also promotes environmental avareness through policy that incorporates environmental education, pollution control and the promotion of sustainable development in the Transport Sector. In Section (2) (v) the Minister "promote the efficient use of energy resources, and limit adverse environmental impact in relation to the land transport"

As stated, the foremost consideration, which underpins this strategy, is the Constitutional mandate to ensure an environment that is' not harmful to the health and well being of all South Africans. It is therefore critical, hat in assessing the various options outlined in this strategy, the potential costs ~nd benefits of the different available alternatives are considered in the context of this mandate primarily, while ensuring as far as possible the integration of other aspects of sustainable development, such as economic development. It is vital that these must not be seen to supersede the imperatives of protecting health and the environment.

1.2 The Need for a National Vehicle Emissions Strategy

The contribution of motor vehicle emissions to the urban air pollution load in South Africa can no longer be ignored. With the increase in the number of motor vehicles on our roads as well as the increase in distance's being travelled each year, the ambient air pollution problem is rapidly worsening, arid with it the health problems associated with air pollution.

Emissions from petrol and diesel driven vehicles contribute significantly to the air pollution load, especially in urban areas. When considering the fact that most local vehicles emit approximately ten times more emission than equivalent vehicles in cities where emissions are regulated, it can be deduced that vehicles contribute significantly to air pollution in South Africa. This fact has hitherto been overlooked. This was partly because of the manner in which the legislation addressed this issue. Other possible reasons range from total lack of interest by all concerned to critically look at the problem and to develop strategies to address it, are assertions that as a developing country the number of vehicles on South Afican roads is not sufficient to contribute significantly to air pollution or that addressing the problem was at economic odds with the goal of economic development and vehicle affordibility

Confusion regarding the relative differences between the benefits of basic emissions control devices and advanced emissions control technology, and the fuels required for these respective technologies have resulted in debate being dominated by the fuel requirements of advanced emissions control technology, thus delaying the implementation of basic emissions control solutions. The fact that basic emissions control technology can reduce vehicle emissions by an order of magnitude without placing excessive demands on fuel quality has not been appreciated to the same extent in other developing economies. As a result, much attention has been directed at the provision of the fuels required by advanced emissions control technology, which only yields incremental benefits relative to the: basic technology, while demanding more expensive fuel.

The average age of the South African vehicle fleet is old by developed world standards, and many of these are arguably poorly maintained. Of critical importance is the fact that the vast majority of vehicles in South Africa were manufactured without legislation limiting emissions and thus do not have emissions control devices fitted and thus have high emissions. For these reasons the need for cleaner fuels is greater than in other countries where the replacement of the vehicle fleet by newer vehicles with better emissions technologies happens more quickly. These reasons are also a good indicator that pollution from vehicles is an issue to be addressed aggressively and urgently. It is thus critical that to effectively address this issue the primary goal will be to set appropriate vehicle tailpipe emission and fuel quality standards.

Even in the absence of local vehicle emissions legislation, there are a number of vehicles on the roads in South Africa, which conform to emissions standards. The total number of vehicles is small but growing. The optimal requirements in terms of fuel specifications for non-emissions controlled vehicle, basic emissions controlled vehicles and advanced emissions controlled vehicles re in some instances different. Furthermore, the implementation of fuel specifications to meet the requirements of advanced emissions controlled vehicles requires Significant investment and will increase the cost of fuel production. These factors were considered in selecting the appropriate timescales for the implementation of the various fuel specifications.

South Africa's vehicle manufacturing industry is increasingly producing models for exports. An example of this is the manufacturing of a! right hand drive 3-series BMW models in South Africa. These vehicles are designed to meet stringent vehicle emissions standards in Europe, the USA and elsewhere where significant cleaner fuels are available than is currently the case in South Africa.:The vehicles designed for such export markets are also sold on the domestic market and require cleaner fuels. Without cleaner fuels sophisticated vehicle emissions technologies cannot operate property and can be damaged resulting in repair costs for vehicle owners or more worryingly, the complete removal from the vehicle of such technology resulting in the regression to even worse emissions.

1.3 Health and Environmental Considerations

As previously stated, the main objective of vehicle emissions regulation is to reduce the impact of vehicle emissions on human health arid the environment in general. It is obviously desirable to set appropriate legislation, which has the maximum benefit in terms of risk to human health, without being over restrictive on the vehicle and fuel manufacturers and which will have significant economic impacts. Pollutants from the hydrocarbon fuel cycle and specifically from vehicle emissions contribute to a general onslaught on the human body's ability to cope with the environmental exposure and challenge.

The relationship between lead and ill health has been well known, well researched and understood for a long time. The effects of lead ire most felt by poorly nourished children. A well – documented body of research has Lstablished an irrefutable case for the removal of lead from petrol. It is for this reason that the World Bank and the Unites States Environmental Protection Agency are very active in promoting the removal of lead from petrol.

Linking exposure to other emissions to burden of disease has been shown to be very difficult and to prove causality or to prove the degree of contribution is even more so. This is due to the complexity and variability of exposure, the large number of confounders and the tremendous expenditure, in time and resources, needed to do the epidemiological studies. Most of the health impact follows from airborne exposures with the respiratory system being the primary target. Individuals with existing respiratory or cardiovascular disease are the most sensitive to such acute exposures. Asthmatics, especially in children, show a higher level of response to such exposures. A further complication is that epidemiological studies, are usually focused on individuals with "normal health" and thus the information on the health impact of individuals pre-existing conditions is often not well known.

Studies have been undertaken internationally, and thus there is merit in South Africa adopting internationally accepted vehicle emissions legislation and fuel specifications. It leaves only the selection of the appropriate level of these regulations for local implementation. Further study of the impact of vehicle pollution in a South African context will be undertaken to ensure that appropriate legislation is set in the future.

Governments will adopt a precautionary approach. This is clearly entrenched in the NEMA Act section (4) (Vii):

'that a risk averse and cautious approach is applied which takes into account the limits of current knowledge about the consequences of decisions and actions

1.4 **Economic Considerations**

Regulatory intervention for environmental and health reasons has costs and benefits. Ideally these costs and benefits should be compared in order to assess the net benefits to society associated with the regulatory intrventions. The costs typically are private costs (faced by industry, consumers, etc.) whilst the benefits result from the positive externalities associated with the regulatory intervention.

Methodologies are not well developed in SA to explore externality benefits for vehicle emissions reduction. It is fair to assume that the benefits of cleaner air justify most private costs that are incurred in the process. It is possible however to estimate the net impact in economic terms of vehicle exhaust emissions regulations.

1.5 **Structure of the strategy document**

This strategic document is essentially a time-bound implementation programme that clearly indicates the steps or actions to be taken; by the Government, the motor manufacturing industry and the petroleum industry to respond at a national and local level to the challenges of vehicle emissions in our urban areas.

Chapter 1 sets the Constitutional and legislative context as well as the rationale behind the need for a strategic approach in addressing vehicle emissions.

Chapter 2 outlines the roles and responsibilities of various role players, including DEAT as lead agent and DME in the area of fuel reformulation. The role and responsibility of the liquid fuels refining industry and the vehicle manufacturers to enable compliance with emission standards is also outlined.

Chapter 3 provides a summary of key challenges

Chapter 4 gives background to the various aspect of vehicle emissions legislation and specifically describes the European ECE regulations, which it is proposed that

South Africa adopt with modifications. Finally, the implementation timetable for the various stages of the emission standards is provided.

Chapter 5 presents an economic analysis and;

Chapter 6 provides conclusions and a way forward

1.6 Strategy Development Process

The following process will be followed:

1. Final Draft Emissions Strategy version 03 November 2003 to be released for comment to relevant stakeholders.

2. Invitation for stakeholder comments on ttje strategy. The comment period is restricted to 30 days (the month of November 2003) due to the urgency surrounding the release of this strategy. Threafter comments will be considered and amendments made, where necessary, before final Cabinet approval is sought

3. Appointment of an Implementation Project theering Committee, led by the DME to focus on all the issues about cleaner fuels and related matters. This is to ensure a smooth implementation. The project team Jiould simply implement the decisions made in this strategy.

1.7 Consultation

Due process has taken place in terms of consultation of affected and interested parties and the stakeholders in the industry. Government has carefully applied the highest level of consideration to all the concerns and submissions with regards to the process. The consultation process started with the formulation of the fuel reformulation task team in 1999 chaired by the DME in collaboration with DEAT. The fuel reformulation task team constituted a forum made out of the DME, NAAMSA and SAPIA.

Stakeholder consultation happened via the above workshops and through written comments regarding content of the Draft Concept document.

Due to the submissions of the earlier drafts of the strategy, an initiative to make the process more inclusive and consultative will ensure that the strategy is gazetted and widely publicised for further comments. Since vehicle emissions control is dependant on the adoption of various levels of technology, both in the vehicle manufacturing industry and the fuel industry, consultation and the sharing of ideas and information with these stakeholders will be an on-going process

The following principles are thus important:

- **National Consultation and Dialogue:** Continued open and transparent consultation and dialogue between the government and relevant stakeholders to define solutions to the challenge of vehicle emissions control.
- **Awareness Creation:** Vigorous public awareness`and outreach programs initiated by government and industry stakeholders in partnership with civil society formations will be initiated and maintained to promote understanding of the environmental threats posed by vehicle emissions: This would include information to show the effectiveness and impacts of the propcsed solutions.
- **Local Government:** Air pollution control is defined in the National Constitution as a local government competence. In this regard the implementation of this strategy can best be achieved by active involvement of local authorities together with stakeholders at local level. This strategy therefore also serves as a guide for local authorities to draw up their own practical strategic for achieving the objectives of this strategy and the broader requirements of the national air quality legislation.

This Strategy document is a product of extensive consultation, which began with two national workshops hosted by DEAT and attended, by representatives of the oil refineries, vehicle manufacturers, civil society groups and government departments including DME, DoT and DTI.

The first workshop was held in Durban on May 2002, with the objective of informing stakeholders of DEATs intention to:

- Regulate vehicle emissions
- Adopt EU tailpipe emission standards as the primary tool for this purpose.

The proposal to adopt the EU suite of emission stan dards follows from the fact that the vehicle fleet and the motor vehicle manufacturing industry in South Africa is styled after and follows European trends. Moreover, South is a signatory to the United Nations 1958 Agreement concerning the harmonisation of standards pertaining to the construction and use of motor vehicles. These UN European based standards are increasingly being adopted worldwide and can be considered to be representative of international best practice. Current South African automotive industry standards are aligned with UN European standards. It is therefore appropriate that South African vehicle emission standards follow those of the United Nations Economic Commission for Europe (UN ECE).

The workshop agreed that a Concept document for the National Strategy be drafted as a basis for discussion. This was done and circulated

The second workshop was held at the CSIR in Pretoria on 25 July 2002 with the objective of discussing the Draft Concept document and chart the way forward in translating it into a national strategy.

This Strategy document covers a 7 year period beginning in January 2004, with all homologated vehicles meeting Euro 1 emission standards and extends to 2012, by which time the Euro 4 level of emissions standards may be enforced. The strategy is therefore an implementation program for the proressive enforcement of stringent tailpipe emission standards to assist the impovement in urban air quality. Simultaneous with the implementation of vehicle emissions limits is the need for fuels of appropriate quality, and the strategy document also lays out an implementation program for the adoption of these fuel specifications.

CHAPTER TWO

ROLES AND RESPONSIBILITIES

2.1 Government roles and responsibilities

In executing the objectives of this strategy, the Deartment of Environmental Affairs and Tourism will provide guidance and leadership to the relevant national, provincial departments and municipalities. In this regard the Department of Environmental Affairs and Tourism will be the lead agency for the regulation of vehicle emission standards in terms of the soon-to-be-enacted Air Quality Management legislation, which will introduce ambient air quality and tailpipe emission standards for motor vehicles. The department will also ensure that there is adequate air quality monitoring in place to be able to quantify the relative impact of this legislation that is vital for the appropriate setting of future legislation. The department will institute a program to continuously review the situation with the view to setting the future course of legislation. This will be based on the analysis of air quality data together with vehicle technology trends that influence vehicle emissions.

Regulations pertaining to fuel quality will be developed and implemented by the Department of Minerals and Energy in terms of the Petroleum Products Act. In conjunction with the Department of Environmental Affairs and Tourism, the Department of Minerals and Energy will institute a program to continuously review fuel specifications with the aim of ensuring that the appropriate fuel quality is available.

2.2 Liquid Fuels Industry responsibilities

This industry has a primary responsibility of ensuring The supply of fuels of appropriate quality to the country to enable the South African vehicle fleet to meet emission levels as set out in the standards. This requires that the fuel industry must be ready to meet the legislative requirements around fuel quality' while not compromising the environmental and health requirements that these products must meet in order to assist the government' imperatives of ensuring imroved air quality for all South Africans. The major challenge in this regard is the capital investments that may be required to strike this balance.

2.3 Vehicle manufacturers responsibilities

The vehicle manufacturers must ensure that vehicles leaving their plants are fitted with devices suitably appropriate to reduce exhaust emissions. These technologies must be suitable not only for South African conditions to ensure that they benefit the consumer as well as environmental requirements, but must also be on par with the best available technology internationally.

European emissions legislation calls for vehicie manufacturers to demonstrate that the emissions control devices are durable and function adequately for the expected useful life of the vehicle. The legislation also slipulates that the manufacturer retains responsibility for the emissions of vehicles throughout their useful life. This is achieved by requiring the manufacturer to demonstrate this by undertaking ongoing in-service conformity testing. This concept of responsibility throughout a products life cycle is encapsulated in the National Environmental Management Act (NEMA).

It is also the responsibility of the vehicle manufacturers to engage with their clients and to encourage them to use the required octane fuels. Vehicle handbooks should reflect the recommended octane grades and not the optimal grades.

2.4 The role of civil society and non-governmen organisations

Vehicle owners will be required to maintain vehicles in such a manner as to ensure that the vehicles do not generate emissions in excess of the legislation prevailing at the time of vehicle manufacture. This responsibility will be in line with the obligation on vehicle owners to ensure the roadworthiness of their vehicles. NGO's can play a critical role in the education and the dissemination of information about the phase out of lead. It is for this reason that the NGOs will be invited to participate in the Communication sub-committee of the project implementation team.

CHAPTER THREE

AN OVERVIEW OF THE KEY ISSUES

3.1 Key Issues and challenges

In order for the objectives of this strategy to be met a number of issues and challenges had to be addressed. These range from potential economic implications of the strategy on the South African economy and specifically South African motorists to fuel quality matters such as lead replacement options and to vehicle manufacturing cost implications. This chapter describes these challenges and evaluates the option available to address them.

3.2 Availability of Appropriate Fuels to Support Vehicle Emissions Control

For any vehicle emission control initiative to be effective, fuels of appropriate quality must be available. This has two distinct aspects: firstly the fuel quality should not have any negative impact on the emissions control systems of vehicles equipped with such systems, and secondly the fuel should be so formulated so as to limit the emissions of undesirable compounds from all vehicles. The first of these is mainly targeted towards any fuel compounds, additives or contaminants that may damage the catalysts or other emissions control systems, as well as fuel specifications that will improve catalyst efficiency.

The second of these is mainly targeted at limiting specific compounds such as lead and benzene in petrol and sulphur in diesel that promote the formation of air pollutants including toxics. Reduction of these compounds should effect the emissions of vehicles fitted with emissions control devices as well as those existing vehicles without such devices. Lead and benzene are known to have negative health impacts and are emitted by all vehicles that use petrol containing lead additives, benzene and other aromatic compounds. Diesel sulphur is known to increase the emissions of particulates. Appropriate fuel quality is therefore fuel that best meets all these requirements.

While lead in petrol renders emission control device ineffective, it has historically been used as a fuel additive and has some appealing properties in this regard. It has anti-valve seat recession properties and is also an octane booster. However, lead is undesirable for health reasons as well as for the fact that its presence in fuel impacts negatively on emission control devices. The ban ton the use of lead in petrol raises a need for refiners to provide substitutes, which will give petrol the desired properties. The number of vehicles currently operating in South Africa that actually require lead to protect the valve seats has been shown to be small and this protection can be provided to the motorists that require it without specific addition of appropriate additives to the petrol. The occurrence of valve seat recession in older vehicles using ULP has been viewed as inconsequential in some countries.

As a first step in this direction, a program to completely phase out lead in South African fuels has begun. A total ban on the use of lead in petrol will come into effect in January 2006, as approved by Cabinet. The major challenge posed by the lead termination is the need for the refineries to meet: the octane requirements without the octane enhancing properties of lead additives. This may take the form of alternative additives, blending with high-octane blend -stocks or refinery reconfiguration. A number of alternative additives are available which provide octane enhancement and valve seat protection, (alleged by some to be of no consequence) and are in use in some countries.

However there exist gaps in current knowledge on the long term environmental and health effects of these substances. The White Paper on Energy Policy (1998) sets out the short - term policy priorities, one of which is following a "no regrets" approach on energy environment decisions.

As a consequence of this, this strategy discourages the use of these substances. The long-term resolution of this challenge seems to be the re-configuration of refinery processes in order for the refineries to produce fuels of appropriate quality. This is the Governments preferred and recommended appoach to the challenges of phasing in cleaner fuels.

3.3 Octane structure

Petrol octane is a critical fuel quality parameter or satisfactory vehicle operation. The latest vehicle technologies, including the use, of closed loop ignition control and supercharging and turbo-charging, place different constraints on the octane grade structure, especially in terms of the interaction 'with altitude. As these technologies become prevalent in the vehicle parc, meeting their specific needs becomes more important. Furthermore, it is in the national interest have an octane grade structure that is most efficient in terms of energy utilisation and thus to overall cost to the economy.

A comprehensive study, jointly funded by DME, SAPIA and NAAMSA, has been undertaken to determine the post lead phase out optimum octane grade structure for South Africa. The study considered the vehicle parc, technical octane requirements, the current refinery configurations and the required refinery expenditure to meet various octane scenarios. The study included a cost-benefit analysis of the various scenarios and an optimum octane grade structure for the future was proposed.

3.4 Lead Replacement Options

3.4.1 Organo-metallic Compounds as Octane Boosting Additives

Some common lead replacement additives are organic compounds containing heavy metals. Some of the heavy metals, although relatively abundant in the environment and essential to human health at low or moderate levels, are toxic at high concentration. Moreover, in compound form they may be toxic and in the final form after combustion (usually metal oxide) the metal containing compounds may have severe respiratory and neurotoxin health impacts.

Metals may have a range of effects, including cancer, neurotoxicity, immunotoxicity, cardiotoxicity, and reproductive toxicity. Biological half -lives of metals vary greatly, from hours to years. The following are some of the metallic additives considered as possible lead replacement options:

- **Methylcyclopentadienyl Manganese Trcarbonyl (MMT):** MMT is a manganese-based organic substance. It is an attractive lead replacement additive to both refiners and to fuel marketers because it is said to provide a modest octane boost as well as anti valve seat recession (AVSR) properties.

  The use of MMTmay result in manganese containing compounds entering the atmosphere. The human health response to manganese compounds appears to be sensitive to the route of exposure. Studies have shown relatively low toxicity to ingested manganese, however there is less data available for the risk factors for inhaled manganese. It is possible however that inhaled manganese may have neurotoxin effects and that the human ability to eliminate inhaled manganese may be less effective than for ingested manganese. It appears that there is insufficient scientific evidence to clearly understand the relative toxicity of inhaled manganese. Major health studies are underway by the producers of MMT and the Environmental Protection Agency in the USA. A specific study for RSA has yet to be conducted, if at all necessary. Governments approach to the use of MMT is a precautionary one allowing the customer to make an informed decision.

The local vehicle manufacturing industry objects to the use of manganese additives with claims that they have negative effects on emission control devices and on-board diagnostic systems. bertain oil companies are not willing to market petrol containing MMT.

- **Ferrocene:** Ferrocene is an organic compound containing iron and is used as an anti-knock and AVSR additive in petrol and as an additive to diesel fuel to facilitate trap regeneration.

  Since iron is also a heavy metal like lead and manganese, there are also concerns about its potential toxicity, particularly as a result of its tendency to bio-accumulate, although it has been classified as low toxicity according to the German Chemicals Act. It has also been acknowledged by the Swedish EPA that PLUTOcene, a form or Ferrocene, presents no additional environmental hazard over conventional unleaded petrol.

  The vehicle manufacturing industry objects to the use of iron additives with claims that they have negative effects on emission control devices and reduces the life of sparkplugs. Increases rates of engine wear are also reported to be caused by these additives.

- **Potassium:** Potassium based additives are reported to have some valve seat recession protection properties, but are not reported to have any significant octane enhancing properties and are thug not likely to be used in unleaded petrol but may be used in lead replacement petrol.

3.4.2 Oxygenated Compounds as Octane Boosting Additives

Oxygenated compounds, particularly ethers are blended with petrol to increase the octane. They function in two ways, namely:

1. They have high blending octane, and so can replace high-octane aromatics in the fuel, or be used in place of octane enhancing additives.

2. Oxygenates also cause engines without sophisticated engine management systems to operate with a lean mixture, thus reducing emission of CO and HC, although in some cases increased NOx emissions may occur as well as some toxics and HC

The oxygenates often used in petrol include the following:

- **Methyl Tertiary Butyl Ether (MTBE)**
- **Ethyl Tertiary Butyl Ether (ETBE)**
- **Tertiary Amyl Methyl Ether (TAME)**
- **Ethyl alcohol (ETHANOL)**

The ethers are preferred to alcohols for a number of reasons including material compatibility and the ozone forming potential of the exhaust emissions that are lower for ether containing fuels than alcohol containing fuels.

MTBE is probably the most commonly used octane enhancing oxygenate, however its high solubility in water has lead to groundwater contamination from spill or leaks from storage facilities. While it renders water unpalatable and is an environmental risk, it is said not to pose a health risk in this regard.

Ethanol can be derived from vegetable matter and in such cases can be classified as a renewable energy source. Alcohol is also produced from synthetic fuel production. Higher alcohols (with more than 2 carbon atoms) re avoided due to material compatibility concerns.

3.5 Refinery Process Reconfiguration Option

South African refineries are configured to manufacture both leaded and unleaded petrol and thus with the removal of leaded petrol from the market, other than use of octane enhancing additive or high octane blending components such as aromatics and oxygenates, increased levels of refining are required to meet the octane requirements. The South African refineries are well placed, in terms of basic configuration, to make the required octane grades, although significant capital expenditure will be needed. This option is the best from an urban air quality point of view and is therefore the best long-term option.

Governments approach will be to actively encourage investments in refineries.

3.6 Petrol Specifications

Petrol Sulphur

It is well known that sulphur reduces the efficiency of three way catalysts, which is the most important aspect of the technology used to reduce tailpipe emissions to meet the regulated limits. This effect is also known to be reversible, although affected catalysts may never fully regain their efficiency loss. The European vehicle emissions regulations require that an ageing test be performed which determines the deterioration factor at 80 000 km, which is then applied to the emissions test results which must comply with the specified limits to attain homologation - in other words the vehicle must demonstrate that it meets the emissions limits after 80 000 km of typical driving. The ageing test specifications stipulate the use of suitable commercial fuel. The implication of the sulphur level being high is thus the long - term degradation of the catalyst efficiency implying that the vehicle manufacturer must apply higher levels of emission control to meet the durability requirement.

Petrol Benzene and Aromatics

Aromatics and benzene are high - octane petrol components, and are thus desirable from a refining perspective. However, these compounds are limited in petrol to directly limit the release of benzene, a known carcinogen, into the atmosphere. The reduction of benzene in fuel will reduce the emissions of benizene from all vehicles, emissions controlled and non-emissions controlled, by reducing both the exhaust and evaporative emissions of this compound. Benzene is the base Molecule for all aromatics and thus partially combusted aromatics often contain high levels of benzene. Furthermore, heavy aromatics are known to promote engine deposits that can lead to increased emissions. It should be noted that the fitment of basic emissions control apparatus would reduce emissions of all hydrocarbons by more than 90%, including benzene and aromatics.

Petrol Volatility

Petrol volatility needs to be carefully controlled to ensure acceptable cold starting and driveability, while preventing hot fuel handling issues: High volatility leads directly to increased evaporative emissions, throughout fuel distribution and storage, and in vehicle use - especially with vehicles not fitted with evaporative control measures. In terms of evaporative emissions, the Reid Vapour Pressure MP) is the important parameter and limiting this will reduce evaporative loss - especially from older, non-emissions controlled vehicles and the distribution system.

The most significant issue surrounding the reduction of the RVP specification of petrol is the net effect that this has on the production of the lighter refinery streams, namely liquefied Petroleum Gas (LPG). Reduction in RVF specification will result in the increase in production of LPG, for which a ready market must be found. Fortunately, LPG is a useful automotive fuel for specially developed or converted vehicles, However, LPG is a less efficient fuel than petrol, which in turn is less efficient than diesel. Consequently, for economic reasons the use of LPG is not encouraged as a transport fuel.

The total volume of LPG that can be economically manufactured is however limited. Thus, there may not be the incentive to create a county - wide distribution network, or for this fuel to become a fuel of choice for all applications. It is a useful fuel to be used in captive fleets such as taxis, delivery and service vehicles. Taxation and other issues surrounding LPG use will be reviewed by government and a clear policy position developed for the use of LPG as an automotive fuel if at all this is deemed safe and efficient.

3.7 Diesel Parameters

Sulphur

The grounds for profound reductions in the regulated national diesel sulphur level rest on both the direct effect of sulphur on particulate emissions and the fuel requirements of the technology likely to be employed to meet Euro 4 and Euro 5 emissions limits for heavy-duty diesel engines. The effects of diesel sulphur, on diesel particulate emissions are well researched such that there are a number of simple mathematical expressions in the literature in good agreement with each other. Reductions in PM emissions of the order of 18% may be expected from heavy - duty vehicles for a drop from 3000 ppm to 500 ppm. Smaller improvements of only 4% cab be expected from a further reduction from 500 ppm to 50 ppm. The reduction in diesel sulphur to 50 ppm is thus more important as an enabling measure for Euro 4 and Euro 5 engine technology. The following technologies are especially sensitive to diesel fuel sulphur:

Exhaust Gas Recirculation (EGR) entails diverting a portion of the exhaust gas, up to a maximum of about 40%, into the air intake. The high specific heat capacities of the CO2 and water in the exhaust reduce the peak combustion temperature and thus NOx, emissions. The very nature of this process however facilitates acid build up in the intake system and the lubricant via the piston ring blow-by. This is exacerbated by fuel sulphur and can reduce the life of the lubricant such that the vehicle's operational capability is compromised.

Selective catalytic reduction (SCR) involves the injection of urea, which selectively reduces NOx to N2. This allows the engine to be optimised for low particulate emissions without NOx penalties and thus indirectly deceases particulate emissions. 50-ppm sulphur fuel is required or the reduction reaction is poisoned.

Continuously regenerating traps (CRT) are used to trap particulate matter (PM) in a monolith. The trap is regenerated by using the oxygen-rich exhaust of the diesel engine to oxidise the PM by a process of combustion, enhanced usually by oxidation with NO2 rather than oxygen. An upstream oxidation catalyst produces the N02. Thus this trap can operate for an extended period withbut any maintenance being required to prevent blockage. 50-ppm sulphur fuel is required or both the upstream oxidation trap and the oxidation in the monolith are poisoned. This can result in the exhaust system clogging up which can have serious consequences for the engine.

Polycyclic aromatics

Studies have shown polycyclic aromatics to have a significant effect on diesel particulate matter emissions although this was 'small relative to the sulphur effect, a 3.5% reduction in PM being observed for a reduction in polycyclic aromatics from 8% to 1% of the fuel by mass. Other research is less clear and given the complex and variable chemistry involved, a definite fuel property- emissions relationship is by no means clear.

Of greater concern is the threat to human health of these compounds. Many polycyclic aromatics are known carcinogens and their emission is of grave concern, not only in unburned form but also as adsorbed onto particulate matter. Solid particulate matter emitted from a diesel engine tends to absorbunburned hydrocarbon molecules onto the surface of the particulates during the exhaust process. These absorbed hydrocarbons typically account for about 15% to 30% of the mass of PM and can be even greater. The particulate matter itself is well beldw the sub-10 micron size level, having a typical aerodynamic diameter of around 20d nm and is thus breathable into the deepest regions of the human lung. Given that the absorbed hydrocarbons tend to be the heavier molecular weight components of the fuel like polycyclic aromatics, a definite risk is posed for the deposition of carcinogenic material in the lung .

3.8 <u>Vehicle Technology Issues</u>

The registered vehicle fleet in South African averages 10.5 years in age. However, if based on annual distance travelled then the average age could be far lower as it is well known that older vehicles typically cover lower annual distances; than newer vehicles. A substantial proportion of these are older type modell not fitted with emission control devices.

While the availability of environmentally friendly fuels such as ULP and low sulphur diesel may minimise the problem of vehicle emissions, he potential gains attainable by altering the fuel specifications are small compare to the gains achievable by implementing vehicle emissions regulations .

The strategy therefore considered various options as a means to overcome this challenge:

Option 1: Maintain the Status Quo

In the context of the tact that unregulated vehicles emit more than ten times as much pollutant as equivalent emissions controlled vehicles, maintenance of the existing status quo is not an option in South Africa. Air quality in South African cities has been shown to be sufficiently poor to necessitate corrective action.

Option 2: Implement Vehicle Emissions Regulations with Appropriate Fuel Specifications

This option implies that by a certain date all new vehicles being sold will be emissions controlled, and thus as these vehicles penetrate the national vehicle fleet, the total vehicle related emissions will decrease. Currently more than 30% of vehicles sold are emissions controlled, so to some extent this process is occurring, however the full benefit will only occur once all new vehicles are compliant. Dramatic improvements in vehicle related pollution could be expected from this step. This is the preferred option.

Option 3: Implement Vehicle Emissions Regulations and Provide Incentives for Owners to replace existing Vehicles with New Emissions Controlled Models

The objective of this option is to speed up the penetration of the emissions controlled vehicles into the national fleet. Given that the natural cycle of vehicle scrapping and replacement with new vehicles is occurring, the added cost to the economy of the incentives to scrap vehicles sooner than the natural, process could be high. The potential benefits from this option over option 2 are not significant enough to warrant the economic implications. There may be some Lenefft for such schemes for controlled fleets that cover high annual distances such as buses, taxis and other vehicle categories. This is more easily justified and undertaken for the controlled fleets than for the general public.

3.8.1 Inspection and Maintenance

International experience has shown that in vehicle fleets conforming to emissions regulations, a relatively few vehicles with malfunctioning emissions control systems are responsible for the majority of the vehicle related air pollution. As part of the emissions legislation, the manufacturers are required to demonstrate that the emissions control systems are durable and are able to maintain the vehicle emissions below the legislated limits for the useful life of the vehicle European legislation requires demonstration of this to 80 000 km, and more recently to 100 000 km). However, once the vehicle is sold, it is no longer in the direct control of the manufacturer and damage to, or malfunctions of, parts of the emissions control system can result in individual vehicles resulting in high emissions. In order to minimise this risk, it is vital that vehicles are subjected to a regular test to ensure that 'the systems are functional. In the case of malfunction, the owner should be required by law to repair the fault and have the vehicle retested.

3.8.2 Enforcement and Compliance Challenges

In terms of enforcement of vehicle emissions regulatiors, and following the European emissions regulations that will be adopted with modifications, the manufacturer is responsible for having all testing performed by accredited laboratories. Two such facilities exist in South Africa capable of performing the tests on passenger cars and light delivery vehicles (as stipulated in the emissions regulations), one of which is capable of performing the evaporative testing. One of these facilities is also capable of performing the testing of engines for the heavy - duty veicles. These facilities fulfil the requirements for type approval (hornologation) testing; conformity of production and conformity of in service vehicles.

The only challenge in enforcement and compliance lies in the development of the inspection and maintenance (annual roadworthy) and road - side testing (for heavy duty vehicles). The regulations stipulate that all vehicles be subjected to regular testing to ensure that the emissions control devices remain functional. There is currently no regular roadworthiness testing requiremnts for passenger and light delivery vehicles, and the roadworthiness test as required when vehicle ownership changes do not currently require an emissions test. Also the roadworthiness test required for heavy- duty vehicles does not stipulate an emissions test.

Thus, firstly the regulations governing vehicle licensing and roadworthiness testing will be reviewed to enforce regular roadworthiness testing for passenger and light delivery vehicles and roadworthiness testing will have to include the necessary emissions tests. DEAT will continue to liase with the Department of Transport to bring these matters to finality.

In terms of fuel specifications, the fuel industry is currently governed by SABS specifications that are voluntary. Mandatory standards are required. The Minister may, in terms of the Petroleum Products Amendments Bill, currently before Parliament set fuel specifications.

In order for informed decision making for future emissions regulations and fuel specifications, it is vital that an ongoing process be Lindertaken to constantly monitor the impact on urban air-quality in South Africa. The major centres in the country do currently have air quality monitoring capacities and capabilities.

While monitoring is useful on it's own, it is by itself insufficient for the needs of regulation setting, and the monitoring will be conducted in conjunction with detailed urban atmosphere air quality modelling

Challenges in terms of compliance fall to the motor land petroleum industries. On a technical level, there are no challenges to meeting vehicle emissions regulations as the technical solutions have been fully developed to 'meet the much more stringent regulations applied internationally. On a practical level, however, there may be some challenges. Particular vehicle model variants being produced locally may not have equivalent variants that have ever been subjected to emissions regulation, and hence no engineering solution exists. The options in such a case include undertaking the engineering development, transplanting an already engineered engine and emissions control solution from other model variants or discontinuing the model. While it is technically feasible to perform the engineering development, this may not be possible or practical for a number of reasons including the high cost of such an exercise .

From the perspective of the fuel refining industry, 'there is a need to upgrade the existing refineries to meet the fuel specifications. The South African refineries are well placed, from a base refinery configuration point of view, to manufacture the necessary fuel to the required specifications, however there will have to be significant capital infrastructure investment to do so. The refining industry has been given sufficient notice to ensure that a smooth transition ensues.

CHAPTER FOUR

THE EUROPEAN SPECIFICATIONS

4.1 Motor Vehicles

Background to emissions regulations - passenger jars and commercial vehicles with a reference mass less than 3 500 kg

Vehicle homologation, or type approval, where emissions legislation exists, requires a number of examples of standard production vehicles to be subjected to and pass a number of different tests. These tests are designed to check for compliance to the emissions limits and other aspects of the legislation. As discussed, South Africa intends to base its vehicle emissions legislation on the European ECE regulations, ECE Regulation No. 83 (ECE R83) and its various amendments. These regulations are extremely complex in the detail, and they are summarised in this section. The tests include the following:

- Type I (verifying the average exhaust emissiond after a cold start),
- Type II (carbon monoxide emission at idling sped),
- Type III (emission of crankcase gases),
- Type IV (evaporation emissions),
- Type V (durability of anti-pollution devices),
- Type VI (verifying the average low ambient temperature carbon monoxide and hydrocarbon exhaust emissions after a cold start),
- On Board Diagnostics (OBD) test

Implementation program for phasing in of exhaust emission standard

It is recognised that vehicle emissions contribute to air quality degradation. Important pollutant species present in vehicle emissions include; heavy metals such as lead, oxides of sulphur, oxides of nitrogen, carbon monoxide and un-burnt hydrocarbons. Secondary pollutants formed as a result of vehicle emissions are also important and include: ground level ozone as a result of the photo-chemical reaction of oxides of nitrogen and hydrocarbons and acidic aerosols formed from the reaction of the oxides of both sulphur and nitrogen with water. It is the intention of this strategy to ensure the protection of the health of South Africans and the environment from potential harm by these substances.

In this regard government, in considering the suitability of the available options around lead replacement additives and other options as well as available vehicle technology, has made a concerted effort to ensure the ustainability and long - term environmental viability of each option. Effort was not spared in striking a balance between environmental considerations and economic and social issues. In considering all the options outlined above, there was a conscious need for government to ensure the primary purpose of this strategy - namely the protection all South Africans from the well known effects of air quality degradation.

In response to the potential impact of vehicle emissions on health and the environment, Government has adopted a national implementation strategy for the control of exhaust emissions from road going vehicles in South Africa. The implementation dates are outlined below and summarised in table one as attached.

Passenger Vehicles and Light Delivery Vehicles (GYM less than 3.5 Tonnes) – Positive Ignition and Diesel Vehicles

Phase 1

January 2004: Euro 1 All homologated vehicles

January 2005: ECE R83 Euro 2: All newly homologated passenger and light commercial vehicles.

January 2006: ECE R83 Euro 2: All newly manufactured passenger and light commercial vehicles.

Phase 2

January 2010: ECE R83 Euro 4: All newly homologated passenger and light commercial vehicles.

January 2012: ECE R83 Euro 4: All newly hmologated passenger and light commercial vehicles.

Heavy Vehicles (GVM more than 3.5 Tonnes)

The legislative situation as regards heavy vehicles in this country differs somewhat from passenger cars with regard to the scale of local production. With the closure of Atlantis Diesel Engines in 1999, engines for the heavy-duty market ceased to be manufactured in South Africa. Imports from European and US OEMs now dominate the medium and heavy commercial vehicle market. Therefore most new engines in South Africa are already comfortably at a "Euro 2" level, witl the introduction of "Euro 3" technology underway, or pending for most OEMs. Tiers of technology beyond "Euro 4" will however most likely require enabling fuel before they can be introduced.

In contrast to the passenger car situation, the proposed legislation is likely to have little medium term impact on the current heavy-duty emissions status quo. While it is fortunate that the heavy-duty vehicle market for new vehicles has largely made the necessary technological transition prior to the implementation of legislation, the serious public health implications of particulate matter emanating from the larger vehicle parc, is a cause for concern. Legislative complacency in this regard would not be supported by air quality data from our cities.

Appropriate measures to regulate in-service emissions from heavy vehicles are thus justified. An existing framework of legislation as contained in the UNECE 1997 Vienna Agreement can be applied to this task in similar fashior to the "Euro" regulations for new models as contained in the UNECE 1958 Geneva Agreement. The principle barrier is the enabling task of equipping the local authoriiy vehicle testing stations that perform roadworthy inspections with the necessary equipment. Another unique aspect to the regulation of heavy-duty vehicle emissions is the vary large potential reduction in particulate emissions possible with the substitution of diesel engines by positive-ignition engines fuelled by natural gas and liquid petroleum gas. This technology, while well established in Europe, is in its infancy here and règulatory concessions are an appropriate incentive to promote the use of gas as a heay-duty fuel.

An implementation schedule based on the above is set out below:

January 2005: ECE A 49-02, Euro 2": All newly homologated vehicles of GVM greater than 3.5t (Gas-fuelled vehicls exempt)

January 2006: ECE R 49-02, "Euro 2": All new vehicles of GVM greater than 3.5t (Gas-fuelled vehicles exempt)

January 2010: ECE R49-04, "Euro 4": All newly homologated vehicles of WM greater than 3.5t (Gas-fuelled vehicles exempt)

January 2012: ECE R49-04, Euro 4: All new vehicles of GM greater than 3.5t (Gas fuelled vehicles exempt)

4.2 Fuel specifications

The following specific requirements should be noted:

PETROL

1. **Sulphur.** The maximum sulphur content of unleaded petrol shall reduce to 500 ppm from 2004 and to 50 ppm from 2010.

It is well known that sulphur poisons three way catalysts, which is the most important aspect of the technology used to reducetailpipe emissions to meet the regulated limits. This effect is also known to be reversible, although poisoned catalysts may never regain their efficiency loss fully. The vehicle emissions regulations require that an ageing test be performed (Type V Test) which determines the deterioration factor at 80 000 km, which is then applied to the Type I test, results which must comply with the specified limits to attain homologation - in other words the vehicle must demonstrate that it meets the emissions limits after 80 000 km of typical driving. The ageing test specifications stipulate the use of suitable commercial fuel. The implication of the sulphur level being high is thus the long- term degradation of the catalyst efficiency implying that the vehicle manufacturer must apply higher levels of emission control to meet the durability requirement.

The effect of sulphur reduction in petrol will only significantly influence the emissions of vehicles fitted with catalysts.

2. **Benzene.** The maximum benzene content in petrol will be 3% from January 2006 and 1 per cent from 2010 (when the date is to be determined)

The motivation for limiting benzene in petrol is to directly limit the release of benzene, a known carcinogen, into the atmosphere. The reduction of benzene in fuel will reduce the emissions of benzene from all vehicles, emissions controlled and non-emissions controlled, by reducing both the exhaust and evaporative emissions of this compound. The additional costs to immediately apply the Euro 4 specifications exceeded the benefits that would immediately accrue. The strategy proposes a gradual move to Euro 4 on condition that the current levels of Benzene are capped at 3 %.

3. **Aromatics.** The maximum aromatic content (n petrol would be 42 per cent from January 2006.

Aromatics in the fuel are undesirable from an environmental perspective as they form benzene in the exhaust due to partial combustion. Furthermore, heavy aromatics are known to promote engine deposits that can lead to increased emissions. The use of aromatics in fuels is desirable from a fuel manufacturing perspective, as they are high-octane components. The Euro 4 specification is envisaged in the future and the level of aromatics would be reduced accordingly.

4. **Ethers.** The use of ethers such as MTB (methyl tertiary butyl ether), ETBE (ethyl tertiary butyl ether) and TAME (tertiary amyl methyl ether) will be allowed to a maximum oxygen content of 2,7 per cent.

Ethers are oxygen -containing compounds used in petrol primarily as an octane increasing blend stock and in some cases to induce a leap shift in the engine operation and thus reduce emissions of CO and hydrocarbons. Ethers are preferred to alcohols for a number of reasons including material compatiblity and the ozone forming potential of the exhaust emissions.

5. **Heavy metal additives.** The addition of lead based additives to petrol will be prohibited from 2006. Similarly, given the uncertainty surrounding the potential long term environmental and health impacts of heavy metallic additives, the government will exercise the precautionary principle and seek to encourage refinery

investment to get octane as apposed to the use of any additives containing heavy metals, in all fuels in the Republic.

5. Volatility From January 2006 the maximum RV' should be 60 KPA (Coastal petrol summer grade). The inland and coastal grades; should be set accordingly. Other volatility parameters will be set to ensure that cold starting and driveability, especially of older cars is not compromised. Further reductions will be considered for 2010 after more studies are conducted.

DIESEL

1. **Sulphur** The maximum sulphur content of diesel will be reduced to 500 ppm from 2006 and a second diesel grade with a maximum sulphur content of 50 ppm will be made available on a voluntary and selective basis. Diesel with a maximum sulphur content level of 50 ppm shall be nationally availtabte by 2010.

2. **Polycyclic aromatics.** Will be in line with corresponding European enabling specifications from 2010.

CHAPTER FIVE

THE ECONOMIC IMPACTS OF INTRODUCING CLEAN FUELS

5.1 Implications for the Motor Industry

An estimate of the impact on the economy of the phased approach to implementing vehicle emissions regulations as above has been undrtaken. The analysis, which can be regarded as a worst-case scenario, has shown that the motor manufacturing industry will face substantial costs in order to implement the necessary vehicle technologies to meet the legislation. This could lead to some escalation in vehicle prices, especially at the more affordable end of the market It should be noted that, even in the absence of local legislation, many vehicles sold currently are emissions compliant. These include fully imported vehicles that originate in markets where emissions regulations are enforced, and local production that, for reasons of commonality of production, are manufactured with the necessary technology installed.

The costs of implementing the emissions legislation are estimated to amount to some R123 million at the outset, escalating to R2 468 million in 2012 and R2 537 million in 2020 (all costs are discounted to 2002 equivalent costs). In the initial years of the implementation (2005 to 2007), the annual costs may average R320 million which amounts to 0.8% of the new passenger and LCV pales revenue for 2002. This escalates to 2.8% in the intermediate years (2008 to 2011) and 5.2% in the latter years (after 2012). These numbers are only indicative.

The increased prices may reduce the demand for neji vehicles and this may further impact the industry. Using estimates of the price elasticity of new car sales indicates that in the early years there is almost insignificant decreases in new vehicle sales demand (less than 1%).

The impact on inflation has been shown to be limited with the overall impact between 2004 and 2012 being 0.44% Producer Price Index (PFI) and 0.8% on (CPI), while the maximum year on year impacts will be less than 0.17% for PPI and 0.3% for CPI.

The costs on the heavy - duty vehicle sector are considered to be less significant. Many of the engines sold in heavy - duty vehicles (VM > 3 500 kg) in South Africa currently are already capable of meeting Euro 3 or Euro 4 standards. Most of these engines are imported and thus are manufactured for countries with stringent emissions standards and are thus designed to comply with these standards. Some engines, however, would not be capable of meeting such standards and thus more expensive engines would have to be sourced for those products. Typically, turbocharged and inter -cooled engines are required to meet Euro 3 or Euro 4 standards. However, the relative impact on the industry will be less significant than for passenger cars as the cost of the engine is small in comparison to the vehicle purchase price combined with the operational cost.

5.2 COST AND ECONOMIC IMPLICATIONS FOR THE REFINING INDUSTRY

Appropriate fuel quality is a prerequisite for the realisation of effective tailpipe emission limits and the reduction of transport related air pollution. In the context of a South African strategy to reduce the impact of vehicle emissions on the environment and to meet the needs of the South African motor industry the oil industry will be required to provide fuels of a suitable quality that are compatible with the vehicles available on the market and that will ensure the attainment of the regulated emission standards. This means that fuels of a quality that will enable vehicles to meet emission standards, without necessarily meeting the European suite of fuel specifications.

It is estimated that the capital expenditure required to meet the various fuel specifications is of the order of R10 billion to R15 billion. This expenditure will be undertaken over the next few years. This is additional to the industries expenditure on fixed investment over this time (fixed expenditure reported to be R2.6 billion in 2001). This is in the order of 6% to 6.5% of manufacturing fixed investment and 1.5% of national gross domestic fixed investment.

This fixed investment expenditure could be put into the following perspective :

Refiners' fixed investment expenditure amounted to R2.6 billion in 2001 (SAPIA Annual Report, 2002). Assuming a 15% increase in 2002 (in line with the actual increase in aggregate gross domestic fixed capital formation), the capital expenditure required to meet the fuel quality standards amounts to around 0% of annual fixed investment expenditure by the industry. In a broader perspective, it amounts to more or less 1.6% of manufacturing fixed investment and 0.4% of natinal gross domestic fixed investment (2002 terms).

The effect of this on the consumer is difficult to judge, primarily because the petrol price is regulated and diesel prices are not. In the current regulation there is no provision for extraordinary capital investment recovery. Furthermore, the proposed change in the octane grade structure will result in significant sales of cheaper, lower octane petrol as well as the more expensive higher - octane fuel. Government supports differential pricing to incenivise premium (91) octane fuel to avoid octane waste by motorists and to limit oil imports. The Octane study recommends a significant differential. Thus the inflationary aspects of these costs oi the economy are difficult to estimate, but it is thought that changes to the fuel price structure will not have a significant knock on inflationary effect.

Given 10.3 billion liters of petrol sales in 2002, the increase in the petrol price could (had we been in a non-regulated market) amount to between 5 c/l – 7 c/l and approximately 1.5%. This, in turn, could add to or replace around 0.6% of annual household expenditure on fuel. The higher petrol price could also have had an impact on business. However, business is in a position to recover the increased cost by way of higher product prices. The direct inflation impact is fairly small - about 0.1% added on to CPI. Even when the indirect effects are considered, the overall inflation impact is likely to be fairly limited·

The 1.5% increase in the petrol price could have a negative bearing on industry petrol sales. The long-term price elasticity of the demand for pe}rol is estimated to be in the order of 0.5%, which suggests that petrol sales volumes could decline by 0.8% over the long-term in the event of a 1.5% increase in the petro' price. These are indicative numbers and are included to confirm that Govemment has indeed reviewed the economic implications of the clean fuels program.

The additional fixed investment expenditure will directly add to economic growth. However, as this is a technology investment, employment benefits and therefore the indirect economic benefits will be of a limited nature. Furthermore, to the extent that the capital equipment is imported, the economic growth benefits will be cancelled.

Capital equipment imports also imply that there should be some impact on the balance of payments. However, given the size of the annual associated financial flows, this is likely to be of a limited nature (in calendar 2002, Inational annual import payments amounted to R280 billion).

5.3 The impact on the consumer

This report has so far highlighted the costs faced by the refining and the motor industries associated with the implementation of fuel emission standards in South Africa. What remains, is to highlight the possible impact on the SA consumer. The likelihood is that business will pass any cost increases onto the consumer in the form of higher product prices but this would be mitigated by regulated fuel prices and the phased implementation of emissions controls and cleaner fuels. Consequently, inflation impact is expected to be limited.

Final household consumer expenditure on vehicles (R22.8 billion) and petroleum products (R24.4 billion) amounted to R47.2 billion in 2002.Including expenditure on vehicle parts & accessories and transport services, annual household expenditure on transport is estimated at R106.5 billion (SA Reserve Bank Quarterly Bulletin, June 2003). Assuming in a worst-case scenario, where 100% of the costs associated with emissions regulation faced by industry is passed onto consumers, this could eventually add a total of R3.1 billion (2002 prices) over period 2004-2012, to annual the household expenditure on transport. The maximum impact only materializes towards the end of the implementation period. At the macro level the significance reduced as it amounts to only 0.5% of aggregate final household expenditure in 2002. Given general household budget constraints in the SA conext ft is likely that households will either finance these costs by shifting expenditure or by restricting expenditure on transport.

5.4 Impact on inflation

As the case is regarding the impact on new vehicle demand, the impact on inflation will also be mitigated due to the phasing in nature of the program. However, as inflation is defined as a general increase in prices over a period of time, the phasing-in element o

The regulations does lead to secondary inflationary consequences rather than being a one-off lift in vehicle prices or increase in inflation.

However, only a certain portion of the new vehicle market is subject to emissions -related cost/price increases each year, which obviously limits the overall impact on inflation. Furthermore, once a model has been homologated and is in production, it continues to incur the cost penalty in subsequent years; however, the impact on inflation is felt mainly in the first year. The inflation impact is therefore calculated from the additional/incremental number of new vehicles incurring the cost penalty in any particular year.

The direct impact on inflation is of a limited nature. In line with the cost impact escalating in 2010/12, the inflation impact is also more visible in these years (0.2% to 0.3% added to PPI/CPI) respectively. The cumulative direct increase in PPI and CPI inflation over the implementation period is 0.4% and 0.8% respectively. Being an end product, the indirect impact on inflation is also likely to be of a limited nature.

CHAPTER SIX

CONCLUSION AND WAY FOWARD

This strategy is a result of many consultations land workshops. It is Governments intention to bring this matter to finality. Written comments are invited by 30 November 2003.The Department of Minerals and Energy and the Department of Environmental Affairs and Tourism will jointly review the comments received and incorporate them, if appropriate.

A joint Cabinet submission would then be prepard in December 2003 and Cabinet's final decision would then be communicated to all stakeholders accordingly.

Once approved by Cabinet, regulations enforcing the standards outlined in the strategy will be promulgated in terms of The National Environmental Management Air Quality Act of 2003, to enable relevant authorities to effectively enforce the objectives of the strategy. The fuel specification regulations will1 be promulgated in terms of the Petroleum Products Act.

All written submissions are to be directed to

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Table of Fuel Specifications for South Africa

Oct-03

Paramater	Unit		RSA 2003	RSA 2006	RSA 2008	RSA 2010+	Euro 1 (Jan 93)	Euro 2 (Jan 98)	Euro 3 (Jan 00)	Euro 4 (Jan 05)
			South African Fuel Specifications				European Specifications			
PETROL							Maximum	Maximum	Maximum	Maximum
Octane		Coast	97L 95/97 ULP	91/95 ULP	91/95,ULP	91/95 ULP	RON (min) 95	RON (min} 95	95/98 (min)	95/98 (min)
		Inland	93L 93 ULP	91/95 ULP	91/95 ULP	91/95 ULP	MON (min) 85	MON (min) 86		
Raid vapour pressure (RVP)	Kpa		W 80/S 65*	65		tbd	70	70	60	-
Aromatics	% v/v		42	42	42	tbd		-	42	35
Benzene	% v/v		3	3	3	tbd	5	5	1	-
Sulphur (max)	ppm		500-800	500	500	50		max 0.05 % m/m	150	50
Lead (max)	g/l		0,4	nil	nil	nil	0.013	max 0.013	0.005	-
Metal additives (MMT)	PPM		18,0	***	***	***	Country Specfic	Country Specific	Country Specific	Country Specific
Ethers and selected alcohols	mm		<10%ULP	2.70%	tbd	tbd				
DIESEL										
Sulphur	ppm		500	500	50	50				

*Winter and Summer levels on Coast

**Review of progress towards Euro 4 specs

***Will potentially depend on outcome of study

tbd - to be determined