Vehicle Standard (Australian Design Rule 80/01 — Emission Control for Heavy Vehicles) 2005

Explanatory Statement

Appendix A

2004 Regulation Impact Statement

(ADR80/01 and other standards)

The attached regulation impact statement was prepared by the Department of Transport and Regional Services to evaluate the impact of the introduction of a range of vehicle emission and fuel standards fro the post 2006 period. It includes an assessment of the delay in application of ADR 80/01.

The Office of Regulation Review has approved the attached RIS as satisfying the Australian Government's requirements for regulation impact statements as set out in the Government's publication *A Guide to Regulation.*

<u>Regulation Impact Statement</u>

for

Vehicle Emissions and Fuel Quality Standards for the Post 2006 Period

Prepared by the

Department of Transport and Regional Services

on behalf of the

Land Transport Environment Committee

December 2004

EXECUTIVE SUMMARY

Context

National actions to strengthen vehicle emission standards and improve fuel quality are accepted as critical steps to reduce urban air pollution and achieve health benefits. This Regulation Impact Statement (RIS) considers the most appropriate Australian vehicle and fuel standards for the latter part of this decade, based on the outcomes of a national Land Transport and Environment Committee (LTEC, previously Motor Vehicle Environment Committee or MVEC) review of these issues throughout 2003 and the early part of 2004. The review involved extensive consultation including:

- public discussion paper – released May 2003;
- a full day seminar for all stakeholders – 19 June 2003;
- public release of a draft RIS – December 2003;
- consultations with key stakeholders – February 2004; and
- consideration of stakeholder submissions to the discussion paper and the draft RIS.

A cost benefit analysis was also commissioned as part of the Review.

Prior to the making of any changes to the fuel quality standards, the Minister for the Environment is required to consult with the Fuel Standards Consultative Committee under the *Fuel Quality Standards Act 2000*. Changes to the vehicle emissions standards proceed through a separate process through the Australian Transport Council prior to being considered by the Commonwealth under the *Motor Vehicle Standards Act 1989.*

Air Quality

While Australian urban air quality is generally good there are still significant concerns in relation to ozone concentrations (photochemical smog). Motor vehicles contribute significantly to air pollution and greenhouse gases, and their numbers and usage continue to rise. The key air pollutants of concern are oxides of nitrogen, hydrocarbons and particulate matter, and the standards considered in this Statement will significantly address the first two of these.

Major improvements in the emissions profile of the Australian vehicle fleet have already been achieved by adoption of earlier *Euro* vehicle standards and fuel quality standards introduced through the implementation of the *Fuel Quality Standards Act 2000*. These standards will lead to increasing improvements in air quality and provide health benefits over the next twenty years as our vehicle fleet turns over and older, more polluting vehicles leave the fleet. While further reducing sulfur levels in fuels will have direct benefits, it is particularly the indirect vehicle technology enabling effects of lower sulfur fuels that are most important.

Vehicle Emissions and Fuel Quality Standards

This Statement considers vehicle emissions standards and fuel quality standards <u>together</u>, as vehicle technology is reliant on fuel of a sufficient quality to operate properly and efficiently. Over the years, standards have become increasingly stringent to address advancing vehicle and fuel refining technology, increasing vehicle fleet size and usage, and mounting concern about air pollution.

The Australian Government has a policy position of international harmonisation of standards for vehicles and fuels, and so the key question for this Statement is not <u>if</u> these international standards will be adopted, but <u>when</u>. This Statement addresses the latest vehicle emissions standards agreed to by the UN Economic Commission for Europe (the so-called *Euro* standards), the US and other OECD countries. A key recurring question for the Australian

Government is the most appropriate length of delay between the introduction of the latest *Euro* standards in Europe and their implementation domestically. The post-2006 vehicle standards being considered for Australia are *Euro 4* for light vehicles and *Euro 5* for heavy vehicles, which are being introduced in Europe in 2005 and 2008, respectively.

Sulfur is the key fuel quality parameter being considered for enabling the new vehicle technologies necessary to achieve compliance with more stringent emissions standards. The sulfur content of fuel in petrol and diesel can adversely affect air pollution and greenhouse gas emissions, by interfering with the operation of catalysts and fuel-efficient engine technologies.

Proposed New Standards

Based on the outcome of its review into vehicle emissions and fuel quality standards for post-2006, LTEC recommends the following packages of standards and timing:

Light Vehicles Package

- *Euro 4* emissions standards for light vehicles in July 2008/2010 supported by a 50ppm sulfur petrol (95 & 98 RON) standard in January 2008; and
- A 10ppm sulfur petrol (95 & 98RON) standard with an indicative introduction date of 2010, but a final decision on timing deferred pending a review by LTEC to be completed by December 2005.

Heavy Vehicles Package

- *Euro 5** emission standards for heavy vehicles in January 2010/11 supported by 10ppm sulfur diesel standards in January 2009

* with US EPA 2007 and Japan 05 Long Term emission standards accepted as alternatives, and US EPA 2008 applying to heavy duty petrol engines.

The proposed standards for petrol only applies to PULP because applying the sulfur limit to regular unleaded or lead replacement petrol is not warranted on cost benefit grounds, as the performance of lower technology vehicles using these grades of petrol would not significantly improve. As with the current supply of lead replacement petrol, fuel retailers' decisions about the provision of unleaded petrol will be based on demand for this product, which is likely to be significant for some time.

Note: The fuel standards proposals outlined above have now been considered by the Australian Government and on 22 July 2004 the Government announced its decision to set a 50ppm sulfur standard for 95 RON and 98 RON petrol from 1 January 2008, and a 10ppm sulfur standard for diesel from 1 January 2009; see http://www.deh.gov.au/minister/env/2004/mr22jul04.html .

The amending instrument and supporting regulation impact statement was tabled in the Commonwealth Parliament on 11 August 2004. No decision was made on 10ppm sulfur petrol. However, as this RIS, and the associated cost benefit analysis, have been prepared as a co-ordinated package of recommendations on both fuel and vehicle standards, the content relating to fuel standards has been retained as this is essential for consideration of issues regarding vehicle standards.

Cost Benefit Analysis (CBA) for more Stringent Standards

Tighter emissions standards for motor vehicles increase per vehicle technology costs, just as tighter fuel standards can lead to increases in the per litre cost of fuel. The CBA sought to measure whether or not any such costs would be outweighed by environmental, health and fuel consumption benefits.

The costs and benefits of a range of four options were assessed, from ‘do nothing’ through to adopting the full suite of new standards as soon as practicable. The ‘do nothing’ approach relies on the existing package of emissions and fuel standards being introduced over the 2002-2007 period. The costs and benefits of all Options were evaluated for the 2000-2020 period.

The CBA concluded that the integrated set of measures in Option 4 (when incorporating the National Average Fuel Consumption target) deliver the largest net benefits. Option 4 embodies the *Euro 4* emissions standards for light vehicles, the *Euro 5* emissions standards for heavy vehicles, and 10ppm sulfur limits for petrol and diesel (with the sulfur levels in petrol being applied in 2 stages – 50ppm and 10ppm). The benefits arise from both health benefits of emissions reductions, and the greenhouse gas and fuel consumption reductions from the improved engine technologies enabled by the 10ppm sulfur fuels. The Australian CBA results are comparable with similar studies in Europe and the US where these studies led to agreement to the new vehicle and fuel standards under consideration in the LTEC review.

The CBA also recognises that significant uncertainty surrounds the estimation of the individual component costings. Within this range of uncertainty it is possible that Option 4 could be in net total benefit within a much shorter time frame than estimated. There were also a number of benefits from strengthening of vehicle emissions standards and improving fuel quality that were not quantified in the CBA. The CBA quantitative results can therefore be considered as understating the net benefits of strengthening standards.

Stakeholder Views

LTEC carried out a comprehensive process to ensure that stakeholders are aware of the standards under review and provided with adequate opportunity to comment.

In general, most stakeholders support a tightening of standards to the level being proposed, but some would prefer the timing of their introduction be delayed by about one year for each of the standards proposed. There is some concern surrounding the *Euro 5* emission standards for heavy vehicles due to uncertainties about costs and technology relating to the likely use of catalysts that require the use of a new reagent (a urea solution). Action has been taken to address those concerns with the LTEC recommendation to delay the start of *Euro 5* by 12 months to 2010/11, and also by the decision of the Australian Government to delay the introduction of the *Euro 4* heavy vehicle standards by 12 months to 2007/8.

There was some stakeholder concern that, depending on timing, the introduction of tightened fuel standards will affect the ability to import fuel at a price that is competitive with domestically sourced fuel. This is in the context of the import share in the Australian petrol market continuing to grow with increasing vehicle use and fuel demand. No evidence was provided to suggest that the proposed standards and timing would cause a discernible price differential between imported and domestic fuel.

Implementation

Motor vehicle emissions standards are national standards under the *Motor Vehicle Standards Act 1989.* It is the responsibility of the National Transport Commission (NTC, formerly the National Road Transport Commission) and the National Environment Protection Council to develop and agree on new emissions standards, with formal endorsement required by the Ministers of the Australian Transport Council for new standards, or for significant changes to existing standards.

Fuel standards are made by Ministerial determinations under the *Fuel Quality Standards Act 2000* after the Minister for the Environment has consulted with the Fuel Standards Consultative Committee.

1. INTRODUCTION & SCOPE

1.1. Background

National actions to strengthen vehicle emissions standards and improve fuel quality are internationally recognized as critical steps to reduce urban air pollution. As stated in a recent World Bank report on reducing urban air pollution (*albeit* primarily directed at cities in developing countries):

> "For gasoline vehicles,…the imposition and enforcement of (vehicle emission) standards have proven a very effective environmental policy in many countries."
>
> and
>
> "The ultimate objective is to adopt a fuel and vehicle system embodying high (vehicle and fuel) standards and best practice technology that have been proven cost-effective in the industrial countries. The question is not *whether* to adopt these standards in developing countries, but *how* and *when* to adopt them."

The NSW EPA in its submission on the draft RIS also notes that while it is taking a number of measures at a State level to reduce vehicle emissions and improve air quality, "the most significant means of reducing air pollution from motor vehicles is through tightening vehicle emission standards and, through their impact on the environmental performance of motor vehicles, fuel quality standards".

There have been a series of legislative actions taken in Australia to this end, including the *Motor Vehicles Standards Act 1989*, the *Road Vehicle (National Standards) Determination No. 2 of 1999,* the *Fuel Quality Standards Act 2000*, the *Fuel Standard (Petrol) Determination 2001* and the *Fuel Standard (Automotive Diesel) Determination 2001*. Significant argument in support of these measures is contained in these instruments' associated explanatory memoranda and Regulation Impact Statements.

During 2003-2004 the LTEC conducted a Vehicle Emissions and Fuel Standards Review (hereafter referred to as the LTEC Review) to assess the most appropriate Australian vehicle emissions and fuel standards for the latter part of this decade. An LTEC Working Group oversaw the Review, with representatives from the Department of Transport and Regional Services (DOTARS), the Department of the Environment and Heritage (DEH), the Australian Greenhouse Office (AGO), the Department of Industry, Tourism and Resources (DITR), the National Transport Commission (NTC), the National Environment Protection Council (NEPC) Service Corporation, the NSW Department of Environment and Conservation, the NSW Roads and Traffic Authority, and EPA Victoria.

The position presented in this RIS is primarily based on the considerations of LTEC and its Working Group, in light of the responses to the Draft Regulation Impact Statement issued in December 2003, the MVEC Discussion Paper issued in May 2003 and associated Seminar held on 19 June 2003.

The LTEC Review and this RIS deliberately consider vehicle emissions and fuel quality standards together. Cleaner fuel allows for the adoption of the latest vehicle technology needed to meet stricter emissions limits. Consideration of vehicle emissions and fuel standards together is normal practice throughout OECD nations to ensure smooth introduction and the best outcomes from new standards.

Standards for the post-2006 period are being considered now to provide for a framework of minimum standards that provide increased certainty for industry.

1.2. Vehicle Standards

Australia regulates its vehicle emissions through Australian Design Rules (ADRs). The ADRs set the standards that new vehicles are required to comply with prior to their first supply to the Australian market. The ADRs are enforced as national standards under the *Motor Vehicle Standards Act 1989* and set standards for both safety and environmental emissions performance.

Australia's motor vehicle emissions standards have been highly effective in reducing pollution for more than 30 years. During the 1960s there was growing international concern over urban air pollution, its detrimental health effects and the contribution of motor vehicles to this problem. This led to vehicle emissions standards being developed first in the United States and subsequently in other nations. Australia first adopted comprehensive emissions standards in 1974 (for petrol passenger cars), initially utilising the United Nations Economic Commission for Europe (UN ECE) approach, then switching to US standards and test methods in 1976. The first comprehensive emissions standards for heavy vehicles were introduced in 1995, and these adopted UN ECE standards, with US and Japanese standards accepted as alternatives.

Since then emissions standards have been periodically tightened due to:

- vehicle technology advances;
- increasing international concern over air pollution problems, as more scientific knowledge has highlighted detrimental effects on human health; and
- increases in the size of vehicle fleets and vehicle usage, with a greater demand from passenger and freight transport.

In recent years there has been a greater international alignment with the vehicle emissions standards set by the UN ECE. The Australian Government has committed to adopting UN ECE standards as this approach provides the desired environmental outcome and facilitates international trade in motor vehicles. The UN ECE, or *Euro*, standards are recognised as the only truly international standards for vehicles under the World Trade Organisation (WTO) rules to which Australia is a signatory. In April 2000, the Australian Government made a commitment to harmonising with UN ECE vehicle standards by acceding to the UN ECE's international agreement on harmonised automotive safety and emissions standards (known as the *1958 Agreement*).

The ADRs for vehicle emissions set limits on emissions of hydrocarbons (HCs), oxides of nitrogen (NOx), carbon monoxide (CO) and, in the case of diesel vehicles, particulate matter (PM).

In 1999, the Australian Government gazetted a package of new emissions ADRs, reflecting recent UN ECE standards, with US standards being accepted as an alternative for heavy duty diesel, LPG and CNG vehicles (see Appendix B for details of the standards). While aligned with the UN ECE standards, Australian emissions standards have delayed introduction dates. This approach to harmonisation enables the technologies required to meet the standards to be tested in the marketplace prior to their adoption in Australia.

The commencement dates for ADRs commonly involve a 1 year phase in (eg 2003-04), which usually requires new models to comply with the standard from the implementation date of 1 January of the first year, with existing models having until 1 January the following year.

In line with the ongoing policy to harmonise Australian vehicle emissions standards with *Euro* standards, this Statement focuses on the merits, and particularly the optimal timing, of adopting:

- *Euro 4* emissions standards for light vehicles[1]; and
- *Euro 5* emissions standards for heavy vehicles[2].

1.3. Fuel Standards

Fuel quality standards have also been crucial for improvements in Australia's air quality by directly removing pollutants from the fuel stream and by enabling advanced vehicle technologies to be introduced. For instance, the removal of lead from petrol enabled catalysts to be effectively added to vehicle exhaust systems, and reducing sulfur levels has improved the effectiveness and durability of emissions control systems. Without sufficiently stringent fuel quality standards, introduction of the vehicle technologies required to meet *Euro 4* and *5* emissions standards may not be possible. In addition, 'cleaner' fuels mean that in-service vehicles built to older standards also improve their emissions performance.

In recognition of the importance of fuel quality in reducing the overall environmental impact of the vehicle fleet, the Australian Government enacted the *Fuel Quality Standards Act 2000*. The Act provides the framework for the establishment of national fuel standards for automotive use. The main objects of the Act are to regulate the quality of fuel supplied in Australia in order to:

a) reduce the level of pollutants and emissions arising from the use of fuel that may cause environmental and health problems;

b) facilitate the adoption of better engine technology and emissions control technology; and

c) allow more effective operation of engines.

The first set of standards, for petrol and diesel, came into effect on 1 January 2002 (see Appendix B). These standards will broadly achieve harmonisation with *Euro 3* fuel specifications by 2006, and adopt the *Euro 4* sulfur level for diesel. It should be emphasised that those standards picked all the 'low hanging fruit' in regards to direct health benefits from cleaner fuels, and the changes being considered in this Statement relate largely to the indirect benefits relating to the uptake of technologies.

This Statement then addresses those fuel parameters that are critical to enabling the adoption of vehicle technology required to meet new emissions standards and greenhouse objectives, particularly sulfur content. Sulfur is a naturally occurring component of crude oil and is found in both petrol and diesel.

The direct impacts from lower fuel sulfur levels arise from the reduction in sulfate and sulfur dioxide (SO_2) emissions, produced by the combustion of fuel in the vehicle engine. Sulfur dioxide is one of the criteria pollutants under the Ambient Air Quality NEPM. Sulfates

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[1] In the context of this Statement, references to the *Euro 4* emission standards for light vehicles cover all 4-wheeled road vehicles ≤ 3.5 tonnes GVM which operate on petrol, LPG or NG. The *Euro 4* light vehicle standards for diesel vehicles have already been adopted under ADR79/01.

[2] In the context of this Statement, references to the *Euro 5* emission standards for heavy vehicles covers all 4-wheeled road vehicles > 3.5 tonnes GVM which operate on diesel, LPG or NG. Petrol engined heavy vehicles are not recognised in the ECE standards (as they are very few in number), and have to date been addressed in the Australian Design Rules by the adoption of US EPA standards.

contribute to total particulate (PM) emissions, and PM is also a criteria pollutant. . While a further sulfur reduction from the levels already legislated will be beneficial, the fuel sulfur reductions embodied in the national fuel quality standards to 2006 will have already delivered the majority of direct air quality benefits available from sulfur reduction.

The indirect impact of fuel sulfur relates to the sulfur sensitivity of certain vehicle technologies that are likely to be employed to meet emissions standards and reduce fuel consumption. It is these indirect technology-enabling effects of low sulfur fuels that are now under consideration.

This Statement focuses on fuel standards for petrol and diesel. A biodiesel standard was gazetted in September 2003, a standard for LPG was gazetted in December 2003, and a standard for CNG is under consideration. The DEH is currently considering the implications of further lowering sulfur levels in the gaseous fuels.

Note: The fuel standards proposals outlined in this RIS have now been considered by the Australian Government and on 22 July 2004 the Government announced its decision to set a 50ppm sulfur standard for 95 RON and 98 RON petrol from 1 January 2008, and a 10ppm sulfur standard for diesel from 1 January 2009; see http://www.deh.gov.au/minister/env/2004/mr22jul04.html .

The amending instrument and supporting regulation impact statement was tabled in the Commonwealth Parliament on 11 August 2004. No decision was made on 10ppm sulfur petrol. However, as this RIS, and the associated cost benefit analysis, have been prepared as a co-ordinated package of recommendations on both fuel and vehicle standards, the content relating to fuel standards has been retained as this is essential for consideration of issues regarding vehicle standards.

1.4. Overall Scope

Given the Australian Government's policy position of international harmonisation of standards for vehicles and fuels, the key question for this Statement is the optimal timing for the adoption of such standards. This Statement seeks to address this question by considering the following key objectives:

- consider whether new vehicle emissions standards are required in Australia;
- consider changes to fuel quality standards that may be required to support such new vehicle standards; and
- consider the costs and benefits of a range of options for new standards for both vehicle emissions and fuel quality.

To achieve these objectives the Statement reports on:

- an evaluation of the emissions and air quality benefits expected from the package of ADRs and fuel standards already gazetted (including those to take effect over 2002-06);
- the additional costs and benefits that would derive from the adoption of more stringent standards, specifically the *Euro 4* and *Euro 5* emissions standards;
- the most appropriate timing for the introduction of any new standards; and
- the impacts any changes to emissions and fuel standards may have on achieving governments' greenhouse objectives.

The following matters are **outside** the scope of this Statement:

- in-service vehicle emissions measures, which are primarily the responsibility of State and Territory Governments ;
- existing vehicle and fuel standards, except to the extent that the benefits of existing standards are evaluated;
- standards for advanced technology vehicles, such as fuel cells, which are not expected to be available in the marketplace in significant quantities for the foreseeable future; and
- requirements for fuels not covered by the *Euro 4/5* emissions standards, eg biofuels.

2. THE PROBLEMS - URBAN AIR QUALITY AND GREENHOUSE GAS EMISSIONS

While urban air quality in Australia is generally good, there are still significant concerns in relation to ground level ozone concentrations, which are used as an indicator of photochemical smog. Motor vehicles are a major contributor to urban air pollution and greenhouse gases, and vehicle numbers and usage continue to rise.

2.1. Health and Other Environmental Effects of Urban Air Pollution

Atmospheric pollutants can cause a range of effects on human health and the environment, with the severity related to the duration of exposure and concentration of the pollutant. These include nuisance effects (eg decreased visibility, odour); acute toxic effects (eg eye irritation, increased susceptibility to infection, reduced respiratory / pulmonary function); chronic health effects (eg mutagenic and carcinogenic actions); and environmental effects (eg material soiling, vegetation damage, corrosion).

There is growing evidence that exposure to air pollutants can have detrimental health effects on urban populations. Dose response relationships have been demonstrated to be significant for PM, nitrogen dioxide (NO_2) and ozone. Ozone is a secondary pollutant formed from the interaction of hydrocarbons (HCs), often referred to as volatile organic compounds (VOCs), and oxides of nitrogen (NOx). There are also strong associations between NO_2 and hospital admissions for asthma, chronic obstructive pulmonary disease and heart disease. There is a lack of knowledge of synergistic (combined) effects of pollutants. For example, recent findings indicate that the synergistic effects of ozone and NO_2 warrant further investigation.

2.2. Ambient Air Quality Standards

In June 1998, the NEPC made the National Environment Protection Measure for Ambient Air Quality (the Ambient Air Quality NEPM), which set Australia's first national ambient air quality standards. The Ambient Air Quality NEPM sets national standards for the six criteria pollutants specified in Table 1. The goals for each pollutant set out in Table 1 apply in the Commonwealth and each State and Territory of Australia and must be met by the year 2008.

Table 1 Ambient Air Quality NEPM Standards

Criteria Pollutant	Averaging Period	Maximum (ambient) Concentration	Goal by 2008 (maximum allowable exceedences)
Carbon monoxide	8 hours	9.0ppm	1 day a year
Nitrogen dioxide	1 hour	0.12ppm	1 day a year
	1 year	0.03ppm	None
Photochemical oxidants (as ozone)	1 hour	0.10ppm	1 day a year
	4 hours	0.08ppm	1 day a year
Sulfur dioxide	1 hour	0.20ppm	1 day a year
	1 day	0.08ppm	1 day a year
	1 year	0.02ppm	None
Lead	1 year	0.50 µg/m3	None
Particles as PM_{10}	1 day	50 µg/m3	5 days a year
Particles as $PM_{2.5}$	1 day 1 year	25 µg/m3 8 µg/m3	Goal is to gather sufficient data nationally to facilitate a review of the standard as part of the review of this Measure scheduled to commence in 2005.

In April 2004, NEPC finalised an Air Toxics NEPM that focuses on benzene, formaldehyde, polycyclic aromatic hydrocarbons, toluene and xylene.

A review of the ozone and SO_2 standards commenced during 2003. The ozone standards review is considering whether there is a need for a stricter standard for ozone. The SO_2 standards review is considering the practicability of developing a 10-minute SO_2 standard.

Table 2 compares Australian standards for key pollutants with a selection of other countries.

Table 2 Air Quality Standards in Other Countries

Country	Air Quality Standards				
	CO	NO_2		Ozone	
	8 hour ppm	1 Hour ppm	Annual Ppm	1 Hour ppm	8 Hour ppm
Australia	**9**	**0.12**	**0.03**	**0.10**	**0.08 (4hr)**
Europe	10	.071	0.026	0.08	0.05
US California	9 9	- 0.25	0.053 -	0.12 0.09	0.08 -
Japan	10 (24hr)	0.06	-	0.06	-
New Zealand	10	0.15	-	0.08	0.05
Hong Kong	9	0.16	0.04	0.12	-
World Health Organisation	10	0.11	0.021-0.026	0.08	0.06

Source: NEPC Air Quality NEPM RIS 1998

2.3. Current Status of Urban Air Quality in Australia

Air pollution is an undesirable by-product or waste from the use of energy in a broad range of industrial, commercial and domestic activities that underpin Australia's modern society. In urban areas, air pollution is produced largely by motor vehicles, domestic and commercial heating and cooking, and industrial activities.

The quality of air in Australian cities is generally improving or stable but some pollutants remain a concern, including some derived from motor vehicle emissions. The status of the Ambient Air Quality NEPM criteria pollutants relevant to the standards being considered in this Statement (CO, NO_2 and ozone) are summarised below. Vehicles are also a significant source of PM, however the only vehicle standards under consideration in this Statement that would impose lower limits on PM emissions, are the US EPA standards for heavy vehicles. That is, by accepting the US EPA 2007 standard as an alternative to *Euro 5*, US sourced heavy vehicles would be meeting a significantly lower PM standard.

While not considered further in this Statement, there is also emerging evidence that reducing sulfur in fuel will reduce the number and mass of ultrafine particle emissions in all vehicles. Ultrafine particles (the fraction of particles generally smaller than $0.1\mu m$) can be inhaled deeper and more efficiently deposited in the lower respiratory tract, and have been implicated in respiratory and cardiovascular morbidity and mortality.

Carbon Monoxide

The CO standard for the Ambient Air Quality NEPM has not been exceeded in Australian cities since 1998, and is now considered a localised problem in parts of some cities.

Nitrogen Dioxide

Trends indicate that NO_2 may no longer be a problem pollutant in its own right in urban Australia. In Sydney, which has historically had the highest levels of NO_2, there have been no exceedences of the NEPM standard in the past four years (see Figure 1). Maintenance of this trend into the longer term will depend on the effective management of growth in total oxides of nitrogen. However, recent research indicates there may be synergistic effects operating between NO_2 and ozone, and therefore NO_2 continues to be of concern.

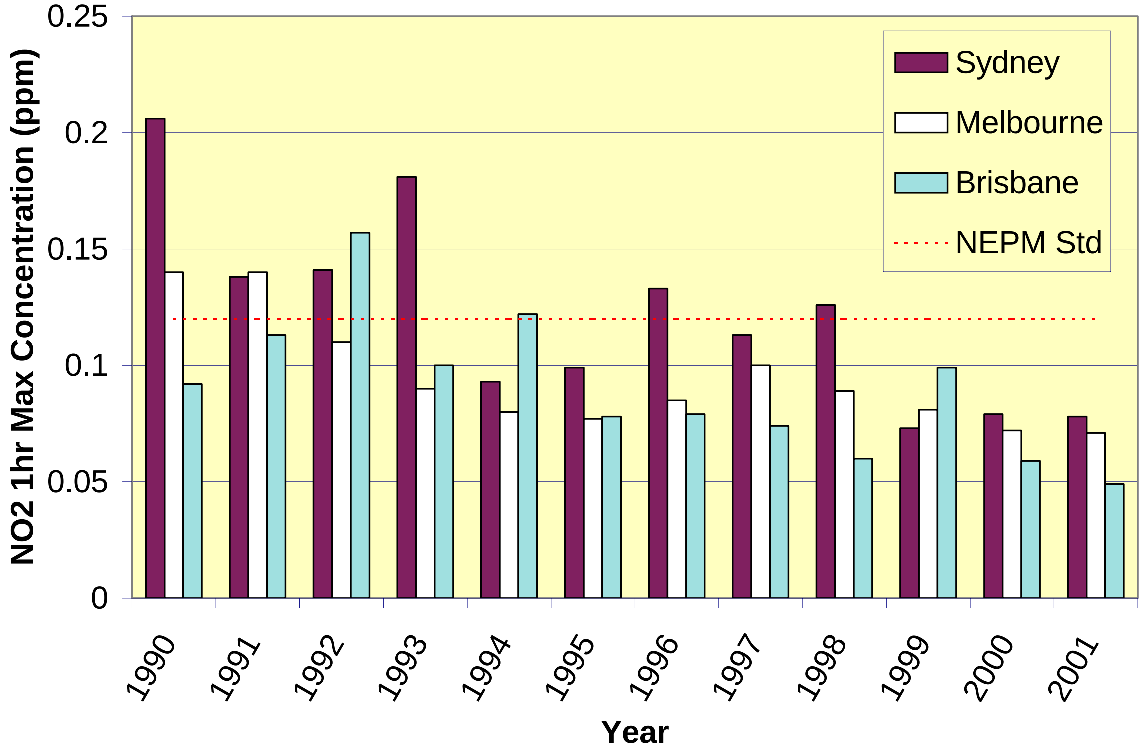


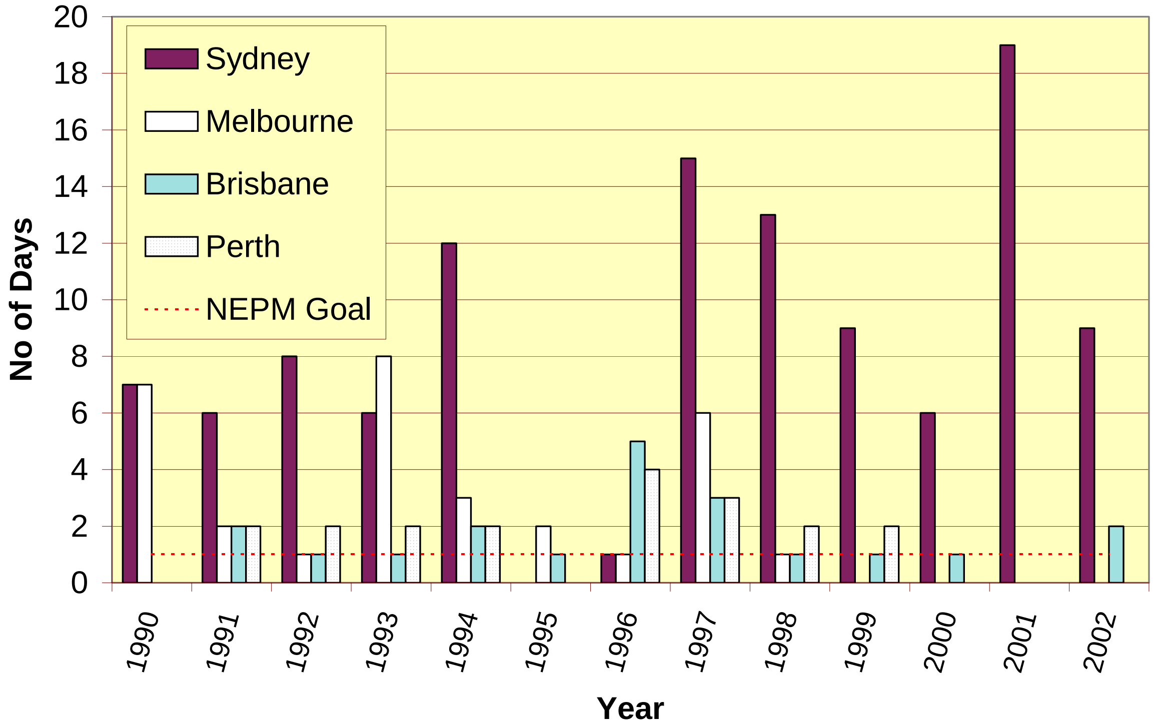
Figure 1 **NO_2 Maximum Concentrations in Sydney, Melbourne and Brisbane Compared to NEPM 1hr NO2 Standard**

Ozone

High radiation levels, high summer temperatures and location in coastal basins surrounded by hills make Australia's largest urban areas susceptible to photochemical smog and to its recirculation over areas of the airshed. Ozone concentrations are monitored under the Ambient Air Quality NEPM as an indicator of photochemical smog. Ozone is not directly emitted from motor vehicles, but direct emissions of HCs and NOx react in the presence of sunlight to form ozone. Ozone levels in our largest cities continue to be a problem.

Compliance with the Ambient Air Quality NEPM goal for ozone requires that by 2008, the 1 hour and 4 hour standards are exceeded on no more than one day per year. To a large extent, the frequency of exceedences from year to year is dependent on the seasonal summer conditions. Hot stable weather will produce higher ozone levels, while cooler wetter summers lead to reduced levels. Under unfavourable meteorological conditions, Sydney, Melbourne, Brisbane and Perth all experience ozone levels above the NEPM standards.

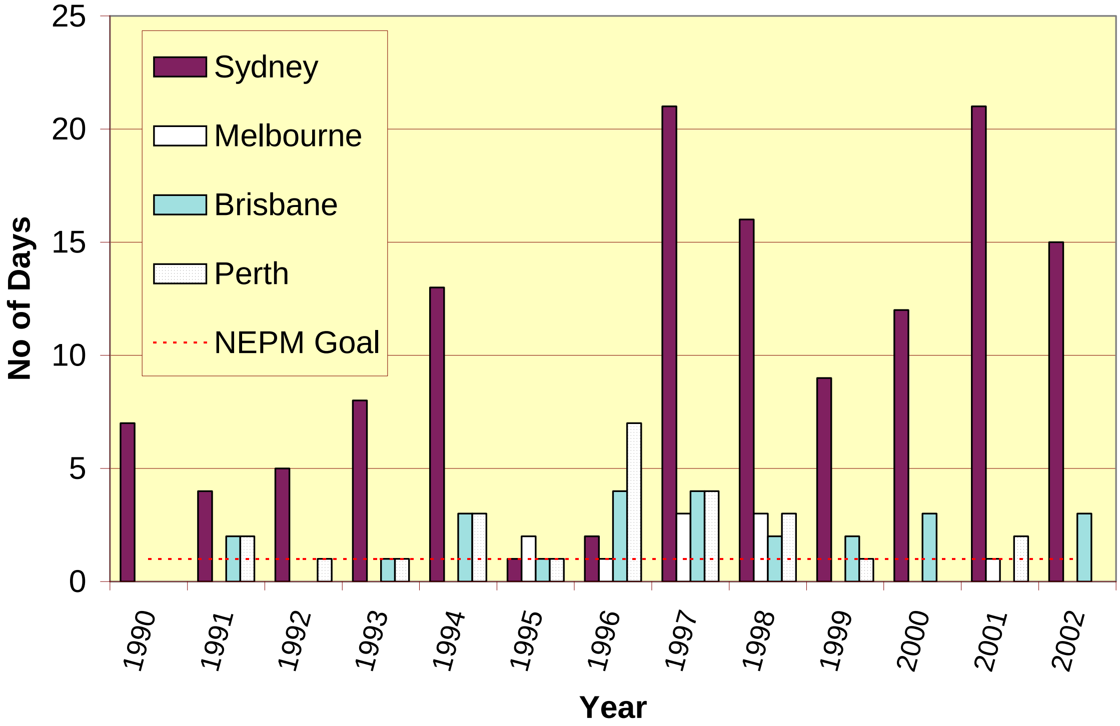
As shown in Figure 2, the Sydney region in particular faces a significant challenge in complying with the NEPM goal for ozone, as it experiences a significant number of exceedences of the 1-hour standard each summer. In 2002 for example, exceedences of the 1 hour standard were recorded on 11 days in the Sydney Greater Metropolitan Region, which includes the Illawarra and the lower Hunter. When the peak concentrations averaged over 4 hours are considered, there appears to be no downward trend. Modelling suggests that while there will be significant improvements, exceedences are still likely even with the reductions envisaged under the *Euro 4* and *Euro 5* proposals proposed in this Statement (see Appendix C).



Note: Data not available for Melbourne 1990-4 & 2002

Figure 2 Number of Days NEPM 1hr Ozone Standard (0.10ppm) Exceeded in Four Australian Cities

Similar to the 1 hour standard, Sydney continues to record a high number of exceedences of the 4-hour standard each year (see Figure 3). In 2001 for example, there were 19 days on which the 4-hour standard was exceeded in the Sydney GMR.



Note: Data not available for Melbourne 1990-4 & 2002

Figure 3 Number of Days NEPM 4hr Ozone Standard (0.08ppm) Exceeded in Four Australian Cities

Data from Melbourne indicate that while the number of days on which the 4 hour standard is exceeded is relatively low compared to Sydney there can be a significantly higher number of days in the summer months where the peak ozone levels approach the 4 hour standard, even in years where the standard is not actually exceeded. In 2001 in South East Queensland, the ozone standards were met, but maximum concentrations were up to 94% of the standard. These results highlight the ozone potential of these cities and point to the likelihood of exceedences in future summers where the meteorological conditions are favourable to ozone formation.

Summary

The 2004 State of the Air Report found that while there has been a dramatic reduction in lead and significant decreases in carbon monoxide, sulfur dioxide and to a lesser extent in nitrogen dioxide, ozone and particle levels remain at or above the air quality standards, and are showing no consistent downward trend.

2.4. Contribution of Motor Vehicles to Air Pollution

Motor vehicles are a ubiquitous and growing feature of Australian cities. In 1971, there was one passenger vehicle for every 3.3 persons. By 2001, this had increased to one vehicle for every 1.9 persons, with a total of 10.1 million passenger vehicles. Over this period, the motor vehicle fleet has increased by 151%, while the population has increased by 50%. Along with the increase in the number of vehicles has come a steady increase in vehicle kilometres travelled (VKT) from around 85 billion kilometres in 1979 to over 155 billion kilometres in 2001.

Motor vehicles are one of the major emitters of air pollutants in urban Australia, contributing more than 80% of the CO emissions, 60-70% of the NOx and up to 40% of the HCs. Light petrol vehicles are the major transport contributors to CO, HC and NOx emissions, with diesel vehicles making a disproportionate contribution to NOx emissions (e.g. in the Sydney airshed, diesel vehicles make up only 8% of the fleet, but are responsible for an estimated 22% of NOx emissions from transport). While vehicles are not the major source of particle emissions in most urban airsheds, fuel combustion sources such as motor vehicles are a significant contributor to $PM_{2.5}$. Emissions from motor vehicles are also a significant source of air toxics such as benzene.

The absolute contribution that vehicles make to urban air pollution is determined by the total emissions from the vehicle fleet and the complex interaction of those emissions with each city's meteorological, topographical and other urban design features. When considering the emissions component of this interaction, the key factors are the:

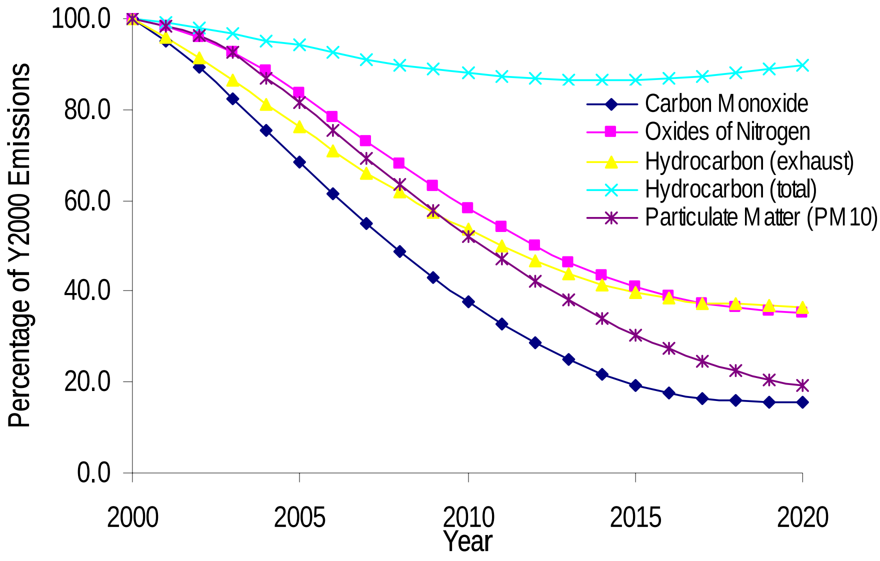
- distribution of vehicles in the fleet meeting certain emissions standards;
- age profile of the fleet (incorporating the impact that deterioration of emissions control systems has on emissions of individual vehicles) and the original standards to which they were built;
- total VKT of the vehicles in each of these age/emissions standard groups in the fleet; and
- parameters of the market fuels.

While this Statement does not explore measures to address the age and replacement rate of vehicles in the Australian vehicle fleet, these factors need to be recognised. The penetration rate of new vehicles into the fleet results in a lag of approximately 10 years before the effects of new emissions standards begin to be substantively realised.

2.5. Future Trends

Although there have been considerable improvements in emissions performance of the vehicle fleet in Australia, motor vehicles continue to be an ongoing threat to Australian urban air quality, principally due to the growth in vehicle numbers and use. Recent Bureau of Transport and Regional Economics (BTRE) base case projections have all vehicles VKT increasing by 46% for 2000-2020, comprised of an increase of 36% for cars, 107% by light commercial vehicles (LCVs), and 120% by articulated trucks. This VKT growth is expected to occur even though projections of car ownership rates (number of cars per person) are predicted to essentially plateau by around 2015. Some urban regions face more rapid growth rates (see discussion below), with increasing VKT putting pressure on the capacity to meet NEPM air quality standards in certain urban airsheds.

Figure 4 describes the significant effect that the existing *Euro* package of emissions and fuel standards that has been put in place for the 2002-07 period will have on emissions. While improvements in emissions are partly offset by increases in vehicle travel rates, dramatic reductions in average rates of emissions of each pollutant are still achieved by 2020.



Source: Coffey Geosciences, 2003.

Figure 4 **Projected Emissions For Key Pollutants – Existing Measures**

While the above vehicle emissions projections demonstrate the benefits of new vehicle emissions standards, the pattern and scale of urban development in parts of Australia, and the resultant growth in vehicle use, will place increasing pressure on the challenge to maintain improvements in urban air quality, particularly ozone. Urban areas are expanding such that the extremity of one urban area is combining with its neighbour to form a much larger urban area. For example, the Melbourne "megalopolis" stretches from Geelong in the West to the Latrobe Valley in the East, and the Sydney Greater Metropolitan Region (GMR) stretches from Port Kembla in the South to Newcastle in the North and includes the Hunter Valley. Such areas effectively operate as a single airshed within which generation and transportation of pollutants contribute to the overall air quality of the area and nearby regions. For example, transport of ozone precursors generated in Sydney itself can contribute to ozone levels in airsheds in other areas of the GMR. Similarly, high ozone levels have been observed in the Latrobe Valley, which have been attributed to interregional transport of ozone precursors from Melbourne.

The NSW EPA has concluded that the Sydney GMR faces a challenge in meeting the Ambient Air Quality NEPM standards for ozone in the future because of the pressures of population growth, urban expansion and the associated increase in motor vehicle use. Sydney's population is expected to reach 4.5 million by 2010 and 6 million before 2040, with population growth also expected in the Illawarra and the lower Hunter. Between 2002 and 2020, VKT in the Sydney GMR are expected to increase by over 30%. Notwithstanding the expected reduction in emissions from the vehicle fleet, these growth trends will continue to place pressure on air quality in the GMR. Modelling undertaken by the NSW EPA (see Appendix C) concludes that further tightening of vehicle emissions for both heavy and light vehicles and fuel quality standards will be required to reduce the potential for ozone formation in the Sydney GMR. The modelling also indicates that while exceedences of the ozone standards are still likely with the adoption of *Euro 4* and *Euro 5* emissions standards and associated fuel standards, the potential for ozone formation is reduced by the adoption of these new standards.

South East Queensland is also predicted to experience significant growth over the next 20 years, with 1996 population in the region of some 2.3 million increasing to 3.8 million by 2021. This is predicted to be accompanied by dramatic growth in transport activity, which the Queensland EPA concludes is likely to reduce air quality even allowing for advances in vehicle technology. This is reinforced by the latest estimates for the SE Qld region that expect VKT to increase at more than twice the rate of the population, principally because of trends to greater use of private vehicles, lower vehicle occupancies and longer trip lengths. The Queensland EPA also concludes that while there have been no exceedences of the ozone standards since 1998, under more conducive meteorological conditions the SE Qld region could fail to comply, particularly with the increasing pressure on the airshed from rapidly increasing population and resultant vehicle use.

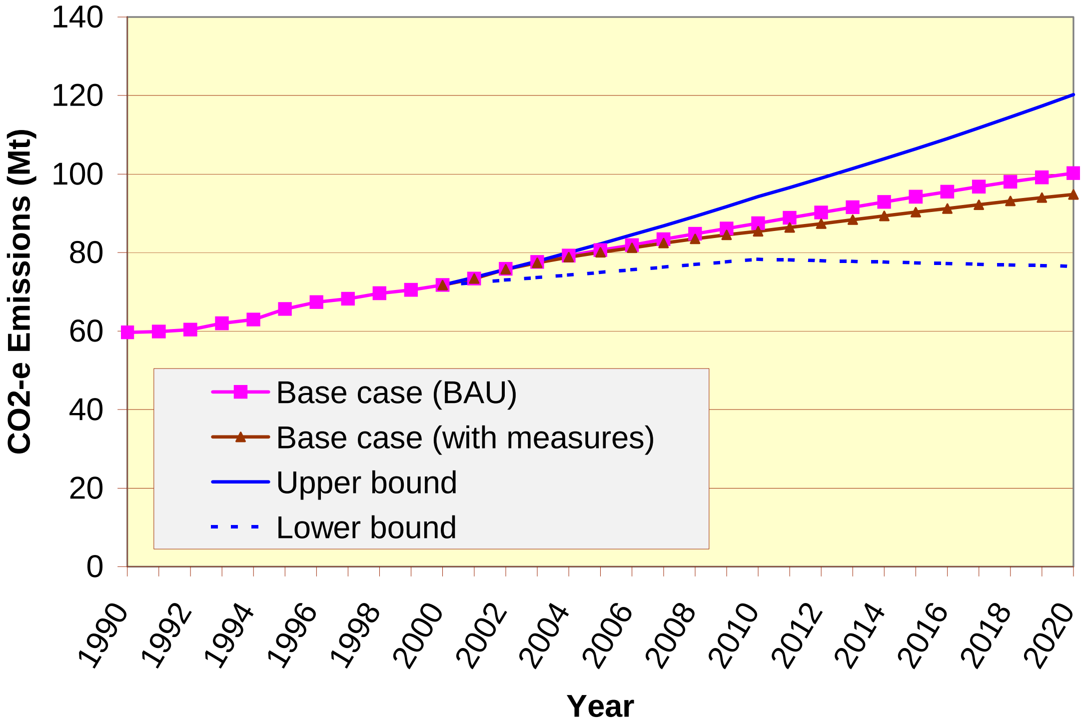
Perth is on the threshold of an air quality problem, with summer ozone levels tending to remain high, approaching or exceeding the NEPM standard. The Western Australian Department of Environmental Protection (DEP) has found that motor vehicle emissions are the single largest contributor to air pollution in Perth. The DEP predicts that VKT will continue to increase at a greater rate than the projected population growth, as low-density urban development expands in the outer-metropolitan region.

In summary, total emissions from motor vehicles are expected to decline steadily over the next twenty years with improving vehicle technology and more stringent fuel standards, but will remain high due to increasing traffic and a growing population.

2.6. Greenhouse Gas Emissions from Transport in Australia

The 2001 Third Assessment Report of the Intergovernmental Panel on Climate Change (IPCC) concluded that there is new and stronger evidence that most of the warming of the Earth's surface over the last 50 years is attributable to the increase in greenhouse gas concentrations in the atmosphere resulting from human activities. The IPCC also reported that climate models show the globally averaged surface temperature increasing by between 1.4 – 5.8^{o}C by the end of this century. In Australia, the CSIRO has predicted that the likely impacts of climate change for Australia by 2030 include a notably warmer and drier climate with enhanced extremes such as hot days, cyclonic activity, droughts and floods. These changes could lead to heightened risk of adverse health impacts, infrastructure damage and reduced agriculture and forestry production.

Transport is a major source of Australian greenhouse gas emissions and the contribution from transport is predicted to increase significantly over the short to medium term. CO_2 is the major greenhouse gas from the transport sector. In 2001, the transport sector in Australia was estimated to contribute around 13% of Australia's total net greenhouse gas emissions. Road transport is responsible for around 88% of the transport sector emissions. In 2020 the transport sector emissions are expected to be almost 70% higher than in 1990 (see Figure 5). The BTRE expects that over the 2000-2020 period the relative contribution from passenger vehicles will fall, as car ownership approaches saturation levels and emissions from freight vehicles increase.



Source: BTRE, 2002c

Figure 5 Projected growth in greenhouse gas emissions from the transport sector

Total fuel consumption, based on VKT and fuel consumption rates of passenger vehicles, is the primary driver of greenhouse gas and other emissions in the transport sector. Petrol powered vehicles (primarily passenger cars) account for over half of Australia's annual consumption of 30 billion litres of fuel used for transport. While the extent of the transport task is beyond the control of vehicle manufacturers, vehicle design plays a key role in fuel economy. The total volume of transport services consumed generally increases in step with population growth. Latest estimates have total passenger car VKT growing at around 1.8% per annum to be just over 180 billion kilometres by 2010.

While greenhouse gas emissions are not directly addressed by the adoption of vehicle emissions standards, the adoption of tighter fuel sulfur standards enables the adoption of vehicle engine technologies that improve fuel efficiency.

As a general rule, smaller, lighter vehicles with smaller engine capacity have better fuel consumption. New technology vehicles, however, have the potential to reduce fuel consumption without compromising on vehicle size. Information from Europe suggests that new motor vehicles produced to *Euro 4* standards will be able to make a 3% reduction in fuel consumption with a reduction of sulfur in fuel from 50ppm to 10ppm. The Federal Chamber of Automotive Industries' (FCAI) commitment to National Average Fuel Consumption (NAFC) target of 6.8km/L for the year 2010 is based on an assumption that 10ppm sulfur 95RON petrol will be available.

3. VEHICLE EMISSIONS STANDARDS

As described above, Australia adopts international vehicle emissions standards in the form of the UN ECE standards, which are commonly referred to as the Euro standards. For heavy duty vehicles, US standards have also been accepted as an alternative. Australia is some years behind Europe in its adoption of most emissions standards. The *Euro 4* light vehicle standard tightens pollutant limits for CO, HC and NOx. The *Euro 5* heavy vehicle standard tightens only the NOx limits, while the comparable US EPA standards also tighten PM emission limits.

3.1. Vehicle Emissions Standards in Australia

Australian vehicle emissions standards have always been based on overseas standards. Globalisation of the motor vehicle industry, and the small size of the vehicle market in Australia make the development of unique Australian standards undesirable from both a government and manufacturing perspective.

As a signatory to the General Agreement on Tariffs and Trade (GATT), Australia has undertaken to adopt international standards rather than develop unique standards, unless there are compelling reasons to do otherwise. Such reasons may include peculiar environmental or social conditions that could not be addressed by international standards. The Australian Government strongly supports the international harmonisation of vehicle standards.

In terms of the vehicle emissions standards, Australia gave effect to its intention to harmonise with the UN ECE regulations with the gazettal of the ADR emissions package in 1999 (see Appendix A). The current heavy vehicle standards rely principally on the UN ECE standards, but allow alternative compliance with the US EPA standards, in recognition of the stringency of the US standards and the adverse financial, emissions and fuel consumption impacts that would arise from requiring US engines to comply with the ECE standards.

It is not proposed to revisit the arguments regarding the decision to align with UN ECE standards, as this was well aired in the 1999 RIS accompanying the package of standards now in place. However, in examining the adoption of the *Euro 5* heavy vehicle standards, consideration is being given to allowing US EPA 2007 and Japanese standards as an acceptable alternative. For the Australian heavy duty fleet, these standards have previously been accepted as an alternative to the UN ECE standards on the grounds of equivalent emissions performance and reduced compliance cost. However, in the current 2002-06 sets of standards, only the US EPA standards were adopted as alternatives, because the PM limits in the Japanese standards were not considered to provide an equivalent level of emissions control to that of the UN ECE standards. .

3.2. Vehicle Emissions Standards in the International Context

Europe, the US and Japan, and to a lesser extent Korea, are the major vehicle producing regions of the world.

3.2.1. UN ECE/Europe

Given Australia's policy to harmonise with UN ECE vehicle standards, the emissions standards in place and planned for Europe are of most interest in the context of this Statement. Table 3 below shows when the various *Euro* standards were or will be introduced in Europe.

Table 3 Implementation Dates for *Euro* Standards in Europe

Standard	Implementation Date
Euro 1	1992
Euro 2	1996
Euro 3	2000
Euro 4	2005
Euro 5 (heavy vehicles only)	2008

The focus of this Statement is on the *Euro 4* standards for light vehicles, and the *Euro 5* standards for heavy vehicles. Table 4 below shows the reduction in emissions limits in the *Euro 4* light vehicles standard relative to *Euro 3*. In addition to the lowering of the emissions limits by around 50%, the durability requirements have been increased to 100,000km (from 80,000km in *Euro 3*).

Table 4 Comparison of *Euro 3* and *Euro 4* for light petrol, LPG & NG vehicles

Standard	Limits on Emissions *			
	CO (g/km)	HC [exhaust] (g/km)	NOx (g/km)	HC [evaporative] (g/test)
Euro 3	2.3	0.2	0.15	2
Euro 4	1.0	0.1	0.08	2

* Limits for "standard" passenger cars

Table 5 shows the reduction in emission limits in the *Euro 5* standards for heavy vehicles relative to the *Euro 4* standards. As can be seen from the comparison, the *Euro 5* heavy vehicles standard involves tightening of the NOx emissions limit only.

Table 5 Comparison of *Euro 4* and *Euro 5* for heavy diesel, LPG & NG vehicles

Standard	Limits on Exhaust Emissions			
	CO (g/kWh)	HC (g/kWh)	NOx (g/kWh)	PM (g/kWh)
Euro 4	1.5	0.46	3.5	0.02
Euro 5	1.5	0.46	2.0	0.02

3.2.2. United States & Japan

Table 6 provides a comparison of the emissions limits that apply under future US and Japanese standards with those of the *Euro 5* standards. Due to differences in the test cycles, a direct comparison between the emissions limits cannot be made, and the differences can have a significant impact on the level of NOx and PM emissions in particular. Nevertheless, the comparison provides some indication of the relative emissions levels from the various standards.

Table 6 Comparison of US and European Heavy Vehicle Standards

Standard	Limits on Exhaust Emissions		
	HC (g/kWh)	NOx (g/kWh)	PM (g/kWh)
Euro 5	0.46	2.0	0.02
US EPA 2007*	0.19	0.27	0.013
Japan JE05 Long Term	0.17 (NMHC)	2.0	0.027

*To allow for comparison with UN ECE standards, US EPA limits are converted from g/bhp-hr to g/kWh.

It is important to note that the emissions limits quoted for the US and Japanese standards are those applicable to these standards when they are fully implemented. In the case of the US 2007 standards, LTEC understands that the NOx standards are being phased in on a percentage of sales basis with 100% compliance not required until 2010. The US Engine Manufacturers Association estimates that over the 2007-2009 period, most engines will be certified in the range of 1.3 - 1.6 g/kWh for NOx, while meeting the 0.013 g/kWh standard for PM. In the case of the Japanese JE 05 Long Term standards, new models are expected to comply in Sept/Oct 2005, while all models will comply by Sep/Oct 2007. In the context of this Statement, any reference to US 07 and JE 05 is to be taken as a reference to a vehicle covered by the appropriate certificate of compliance with the nominated standard at the time of certification.

3.2.3. Other Countries

Table 7 illustrates that a significant and growing number of *1958 Agreement* non-signatory countries in our region have now aligned their emissions standards with the UN ECE Regulations (or the equivalent EU Directives), albeit on a slower timeframe than in Europe. Interestingly, Thailand has already mandated *Euro 4* to commence from 2007 and a number of other countries have publicly stated that they are currently considering accession to the *1958 Agreement* in the next few years, including Korea, Thailand, Singapore (2005), Malaysia (2006) and Indonesia (2010).

Japan, like Australia, is a relatively recent signatory to the *1958 Agreement* however it appears that in the short-medium term, at least, Japan will be maintaining its own unique standards for emissions control.

Table 7 Non-European Countries Applying Euro Standards for Light Vehicles

Country	*Euro* Standard Adoption Date			
	Euro 1	***Euro 2***	***Euro 3***	***Euro 4***
Hong Kong	1995	1997	2001	-
India	2000	2001 (4 cities)	2005 – proposed (7 cities)	-
Indonesia	-	2007	-	-
Malaysia	1997	2000	-	-
China	2000	2004	-	-
Singapore	1994	2001	-	-
Thailand	1996	1999	2002	2007
Australia		2002	2005	-

Source: Asia Development Bank (2002)

3.3. New Vehicle Standards

The only UN ECE emissions standards that have not yet been adopted in Australia are the *Euro 4* standards for light petrol, LPG and NG vehicles, and the *Euro 5* NOx standards for heavy vehicles. As summarised in Table 8 (which includes for comparative purposes the current emissions standards), adoption of the *Euro 4* light vehicle standards would lead to significant reductions in emissions of all three pollutants (CO, HC and NOx) from new light vehicles, with the most important being the reductions in HCs and NOx, which are the precursors of photochemical smog (measured as ozone).[3] Table 9 illustrates the benefits in NOx reduction from heavy vehicles that would flow from the adoption of the *Euro 5* standards.

Table 8 Emissions Reduction from Adoption of *Euro 4* Light *Vehicle* Standards

EMISSIONS REDUCTION (%)*					
Euro 2* 〉 *Euro 3			***Euro 3* 〉*Euro 4***		
CO	**HC**	**NOx**	**CO**	**HC**	**NOx**
No Change	No Change	40	55	50	50

* To nearest 5%

** *Euro 2* has a combined HC + NOx limit, comparison assumes 50:50 split.

[3]Note that detailed emissions data on the in service emissions from Australia's vehicle fleet is currently based on the 1996 National In-Service Vehicle Emissions (NISE) Study prepared by the Federal Office of Road Safety. The DEH will commence a major 'NISE2' project in 2004.

Table 9 Emissions Reduction from Adoption of *Euro 5* Standards for Heavy Vehicles

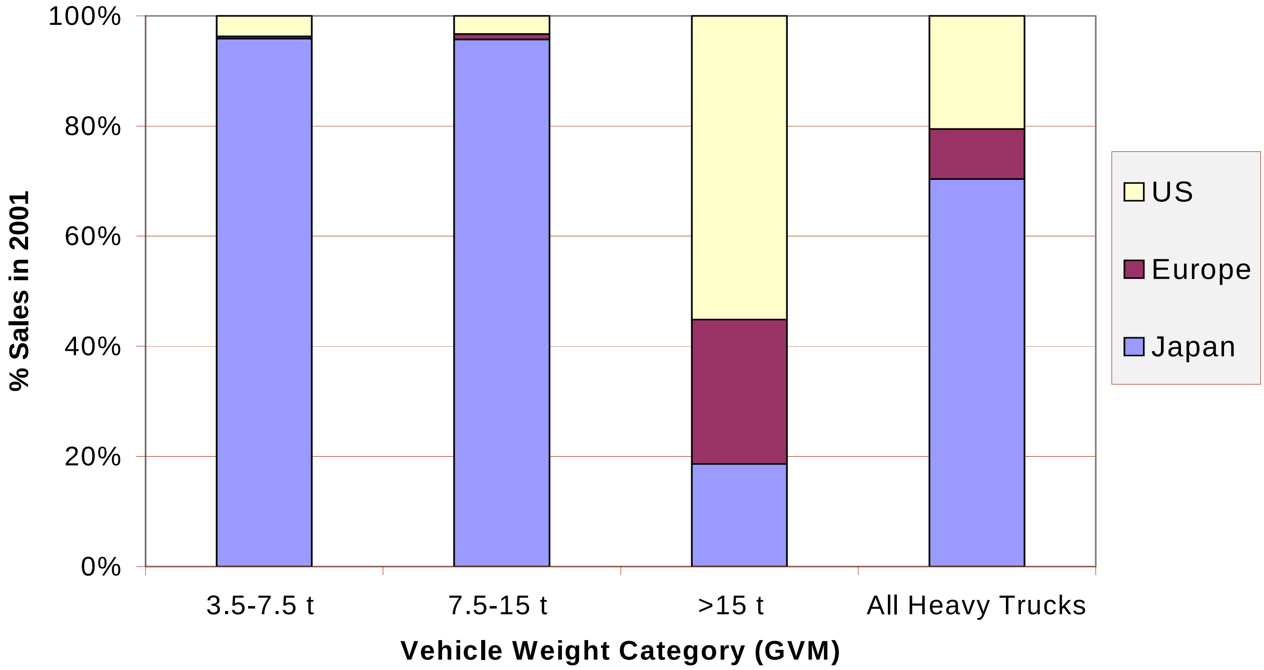
EMISSIONS REDUCTION (%)*			
Euro 3 〉 Euro 4		*Euro 4 〉Euro 5*	
NOx	**PM**	**NOx**	**PM**
30	80	45	No change

* To nearest 5%

Adoption of the *Euro 4* standards for light vehicles and their petrol quality requirements can be considered separately from the *Euro 5* heavy duty vehicle standards and their diesel quality requirements, as there is little interdependence between the two.

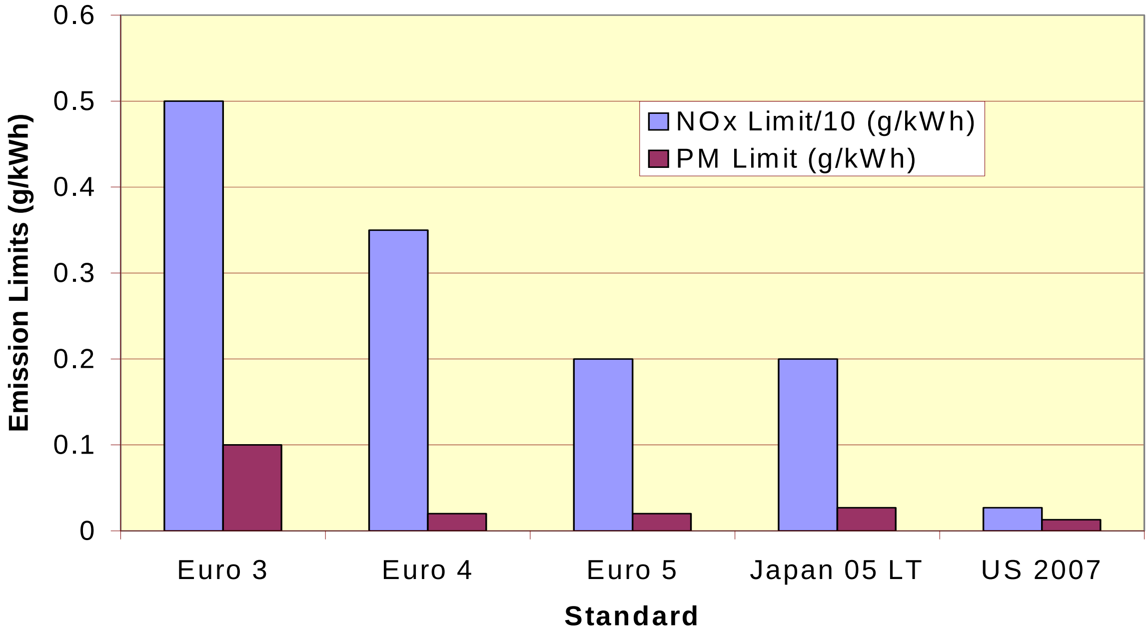
If adoption of *Euro 5* is warranted, then the appropriateness of continuing the practice of accepting US EPA and Japanese standards as an alternative also needs to be considered. As indicated in Figure 6, Japan is the principal source of heavy trucks in the Australian market, except for the above 15 tonne group, where around 55% are imported from the US. The 3.5-15 tonne sectors also account for around 65% of heavy vehicle fleet sales.

In summary, there is a convergence of the heavy vehicle emissions standards under *Euro 5*, US2007 and Japan 05 as illustrated in Figure 7.



Source: VFACTS, 2002

Figure 6 **Distribution of Heavy Trucks (>3.5 tonnes) Sold in Australia in 2001 by Country of Origin**



Note: for ease of comparison, the NOx limits have been divided by 10

Figure 7 **Relative Emissions Limits for Heavy Vehicles under Euro 3, 4 and 5, US2007 and Japan 05 Standards**

There are relatively few petrol engined heavy vehicles operating in the Australian market, where diesel fuel is the overwhelming fuel of choice, and natural gas satisfies some niche markets. This situation is mirrored in other comparable countries. The ECE standards do not even recognise the existence of heavy duty petrol vehicles and as a consequence do not set any standards for such vehicle engine types. In the US there are standards for heavy duty petrol engines, but they are quite separate from the main standards for diesel and the gaseous fuels. In the current set of Australian Design Rules for heavy vehicles (ADR80/00 and ADR80/01) this omission in the ECE system has been addressed by adopting the US EPA standards for heavy petrol engines. It would appear logical to continue this practice, to ensure there are no standard-free “loopholes” in the standards, while recognising that very few heavy duty petrol vehicles will be supplied to the market. Under this arrangement the latest US EPA standards for petrol vehicles are those set down for 2008 (which largely mirror the US EPA standards for heavy duty diesel vehicles).

3.4. Timing of New Vehicle Standards

It is important to consider the possible timing for the introduction of the above standards.

As indicated earlier, the *Euro 4* light vehicle emissions standards take effect in Europe in 2005, and the *Euro 5* heavy vehicle standards in 2008. For Australia, a balance needs to be found between the earliest possible introduction, which would maximise emissions benefits, and a delayed introduction, which allows vehicle manufacturers sufficient time to amortise their investment in achieving compliance with one standard before being required to upgrade to meet the next. Similar constraints apply to the petroleum industry in meeting the associated fuel standards.

In relation to light vehicles, Australia has already committed to adopting the *Euro 3* standards in 2005 (ADR79/01), so clearly there needs to be some delay in the adoption of the *Euro 4* standards which apply from 2005 in Europe. In considering the balance question, it would appear that 2008 would be a feasible date for mandating compliance with the *Euro 4* light duty vehicle standards.

In relation to heavy vehicles, there is much closer symmetry between the timing in Europe and Australia, with Australia adopting the *Euro 4* heavy vehicle standards in 2006, just three months later than in Europe[4], [5]. Given that *Euro 5* will be introduced in Europe in 2008, an implementation date of 2010 for Australia may be considered appropriate.

[4]Unlike Australia’s implementation date of 1 January, European standards normally commence on 1 October of the designated year.

[5] In August 2004, the Australian Government agreed to delay the adoption of the *Euro 4* standards in Australia until 2007.

4. FUEL QUALITY STANDARDS

New vehicle emissions standards require suitable quality fuel in order to deliver reductions in emissions. Tightened fuel standards will deliver benefits across the fleet as a whole, not just from new vehicles.

In line with the policy to harmonise with UN ECE vehicle standards, Australia has commenced harmonisation with European fuel standards. By 2006 Australian fuel standards will largely reflect the fuel standards equivalent to *Euro 3* for petrol and diesel vehicles, and adopt the *Euro 4* sulfur limit for diesel. The fuel parameter of key importance to this Statement is the sulfur content of both petrol and diesel standards.

4.1. Fuel Quality Standards in Australia

The *Fuel Quality Standards Act 2000* (FQS Act) provides the framework for making fuel quality standards in Australia. Australia's policy to harmonise with UN ECE vehicle emissions standards, gave rise to the premise that Australian fuel specifications should be harmonised with the corresponding European Directives for market fuel specifications.

The first set of standards under the FQS Act for petrol and diesel came into effect on 1 January 2002. Australia has adopted sulfur limits that link to *Euro 3* sulfur limits for petrol (150ppm) from 1 January 2005 and the *Euro 4* sulfur limit for diesel (50ppm) from 1 January 2006, to support the introduction of the equivalent vehicle emissions standards. Details of the limits for the various fuel parameters under the existing standards are outlined in Appendix B.

The focus of this Statement is on those parameters that need to be changed if tighter vehicle emissions standards were to be introduced or more fuel efficient vehicle technology was required. The sulfur content of both petrol and diesel has direct and indirect impacts on emissions.

The role of higher octane petrol (95RON) also needs to be recognised given its impacts on engine operation. Engines with high compression ratios requiring higher-octane petrol are generally more fuel-efficient than conventional engines with lower compression ratios. Consequently, vehicles with high compression ratios running on higher octane petrol produce lower emissions of noxious and greenhouse gases than vehicles running on lower octane petrol, for a given vehicle type and operating conditions.

The key area of interest in relation to 95RON fuel is market share and price, rather than a mandated standard, as existing premium unleaded petrol already has to meet a minimum 95RON. Vehicle manufacturers suggest that 95RON petrol will need to be available at a retail price not dissimilar to standard 91RON unleaded petrol in order for them to consider optimising and marketing their mass market models for 95RON petrol. Nonetheless, manufacturers are likely to commence tuning their vehicles for 95RON petrol, rather than the current 91RON, after *Euro 3* standards apply from 2005. As with the current supply of LRP, fuel retailers' decisions about the provision of 91RON unleaded petrol will be based on demand for this product, which is likely to be significant for some time given the relatively high average age of the current domestic car fleet that overwhelmingly use non-PULP fuels.

The other parameter of interest is aromatics in petrol. The aromatics content of petrol has a direct effect on tailpipe carbon dioxide and benzene (even in benzene free petrol). Aromatics are a good source of octane in petrol. The current Australian standard for aromatics is 42% from 1 January 2005, but unlike Europe, Australia has an 'effective ban' on the octane enhancer methyl tertiary-butyl ether (MTBE) from 1 January 2004, due to concerns about its potential to adversely affect groundwater. It appears groundwater contamination is not as significant an issue in the European context. There is currently a debate in the US about their continued use of MTBE and the possible use of ethanol as an octane enhancer. LTEC has decided to defer any decision on revising the aromatics limits that take effect from 1 January 2005; see notes to Table 11.

4.2. Fuel Quality Standards in the International Context

The current and proposed European standards are outlined in Appendix D. In relation to sulfur, the European fuel standards currently specify a sulfur limit of 50ppm to support the *Euro 4* emissions standards for both petrol and diesel vehicles. In 2002, the European Parliament endorsed a proposal to lower the sulfur level in both petrol and diesel to 10ppm, and this level will be mandated from 1 January 2009 (with member states being required to make quantities of 10ppm available from 2005), to support the uptake of advanced engine technologies. Fuels with 10ppm sulfur levels are sometimes referred to as near-zero sulfur fuels and represent the limits of current technological capacity for lowering sulfur.

With regard to octane levels in petrol, *Euro 3* specifies 95RON minimum in all petrol. This standard is not changed in *Euro 4.* Table 10 describes the sulfur standards in petrol and diesel for countries in the Asian region, as well as the US and the EU.

Table 10 Sulfur Standards in Asian Countries, the US and the EU

SULFUR (ppm)

			CURRENT							
PETROL	2002	2003	**2004**	2005	2006	2007	2008	2009	2010	2011
Australia	500	**500**	**500**	**150**	**150**	**150**				
China	800	800	**800**	*500*	*500*	*500*	*500*	*500*	*500*	*500*
Hong Kong	150	150	**150**	150	*50*	*50*	*50*	*50*	*50*	*50*
India	1000	1000	**1000**	500	500	500	500	500	150	150
Japan	100	100	**100**	*50*	*50*	*50*	*10*	*10*	*10*	*10*
South Korea	130	130	**130**	130	50	50	50	50	50	50
Malaysia	1500	1500	**500**	*500*	*500*	*500*	*500*	*50*	*50*	*50*
New Zealand	350	350	**350**	350	150	150	*50*	*50*	*50*	*50*
Singapore	1000	1000	**150**	*150*	*150*	*150*	*150*	*150*	*150*	*150*
Taiwan	180	180	**180**	180	180	50	50	50	50	*30*
Thailand	1000	500	**500**	500	500	500	500	500	*50*	*50*
USA #	300	300	**120**	90	30	30	30	30	30	30
USA (California) @	30	30	**15**	15	15	15	15	15	15	15
EU	150	150	**150**	50	50	50	50	10	10	10
DIESEL	2002	2003	**2004**	2005	2006	2007	2008	2009	2010	2011
Australia	3000	**500**	**500**	**500**	**50**	**50**	**50**			
China	2000	2000	**500**	500	500	500	500	500	500	500
Hong Kong	50	50	**50**	10	10	10	10	10	10	10
India	2500	2500	**2500**	500	500	500	500	500	350	350
Japan	500	500	**500**	500	50	50	10	10	10	10
South Korea	500	500	**500**	500	30	30	30	30	30	30
Malaysia	3000	3000	**500**	500	500	500	500	50	50	50
New Zealand	3000	3000	**600**	600	50	50	50	50	*10*	*10*
Singapore	500	500	**500**	500	*50*	*50*	*50*	*50*	*50*	*50*
Taiwan	350	350	**350**	350	350	50	50	50	50	*30*
Thailand	500	500	**350**	350	350	350	350	350	*50*	*50*
USA ~	500	500	**500**	500	15	15	15	15	15	15
USA (California)	50	50	**500**	500	15	15	15	15	15	15
EU	350	350	**350**	50	50	50	50	10	10	10

NB: Information as at 11 May 2004. Shaded cells indicate future proposed or already agreed changes. Italicised text indicate proposed changes to fuel specifications

^ Industry limits

\# 30 ppm average sulfur, 80 ppm cap

@ 15 ppm avg - 60 ppm cap from 2004, 30 ppm cap from 2006

~ 80% of on-road diesel at 15 ppm from 2006, 100% from 2010. 20% can be produced at 500 ppm, but must be segregated and only used in pre 2007 technology vehicles.

Source: International Fuel Quality Centre

4.3. Rationale for Lowering Fuel Sulfur

This section explores the evidence regarding the impact of fuel sulfur on the engines and emissions control systems that would be likely to be supplied to the Australian market to meet the *Euro 4* light or *Euro 5* heavy duty vehicle emissions standards. The discussion draws heavily on the work undertaken by the European Commission to examine the implications of a shift from 50ppm to 10ppm sulfur limits.

As discussed, the principal benefit from a reduction in fuel sulfur is to enable better engine technologies for stricter emissions standards and fuel consumption targets. Concawe[6] concluded that in Europe, the direct impact of a reduction in sulfur from 50ppm to less than 10ppm would be "negligible" compared to the reduction from 3000ppm in 1990 to 50ppm in 2005. However, in the case of diesel vehicles there would be some direct benefits from a reduction from 50ppm sulfur to 10ppm, with one estimate putting the reduction in PM emissions flowing from such a reduction at around 5%. This overall scenario is likely to be mirrored in Australia. As our fuel standards progressively reduce the sulfur content from 500ppm in 2002 to the *Euro 3/4* levels of 150ppm (petrol) and 50ppm (diesel) in 2006 there are likely to be some direct benefits in terms of lower PM emissions.

Internationally, vehicle manufacturers have the dual objectives of meeting more stringent emissions standards and producing vehicles with lower CO_2 emissions. Meeting both of these objectives places limits on suitable technologies, and fuel sulfur levels significantly impacts on available choices. See Appendix E for a more detailed discussion on the technical rationale for lowering sulfur for technology enablement.

In relation to petrol, which is essentially used in passenger and light commercial vehicles, the key conclusions are:

- 50ppm sulfur petrol is necessary to ensure ongoing compliance with *Euro 4* emissions standards; and
- 10ppm offers the capacity to adopt vehicle technologies which can maximise fuel consumption benefits, while still ensuring compliance with the *Euro 4* standards.

In relation to diesel, which is used largely in heavy trucks and buses, and some light commercial vehicles, the key conclusions are:

- 50ppm is likely to be adequate for ensuring compliance with *Euro 4* standards in both light and heavy vehicles, but this is somewhat uncertain because individual manufacturers' technology choices and their sulfur sensitivity, will vary;
- 50ppm is less likely to be adequate for ensuring compliance with the *Euro 5* NOx standards for heavy diesel vehicles; and
- 10ppm would ensure compliance with *Euro 5* and provide fuel consumption benefits in diesel vehicles meeting *Euro 4* or *Euro 5*.

4.4. Timing of New Fuel Standards

The implementation date for any new fuel standards is linked to the applicable dates for the new vehicle standards. It is clearly desirable that the standards considered necessary to support particular vehicle standards are put in place by the time the new vehicle standards become mandatory, at the latest. The United States approach to introducing the *Euro 5* equivalent diesel standard was to introduce it seven months prior, ie their diesel standard applies from 1 June 2006 and the vehicle standard from 1 January 2007.

Thus if the timing outlined in section 3.4 was adopted for the *Euro 4* light vehicle standards and the *Euro 5* heavy vehicle standards, then the mandating of 50ppm sulfur petrol and 10ppm sulfur diesel should occur at or before 1 January 2008 and 1 January 2010, respectively.

[6] The oil companies' European association for environment, health and safety in refining and distribution.

5. DESCRIPTION OF OPTIONS

When considering a possible approach for Australia, the options range from maintenance of the status quo (the "do nothing" option) through a range of regulatory combinations of vehicle emissions and fuel standards.

Four options were presented in the MVEC Discussion Paper issued in May 2003 as follows:

- Option 1 was the baseline "Status Quo" option.
- Options 2, 3 and 4 presented a range of regulatory packages covering vehicle emissions and fuel standards. They are cumulative options, with Option 3 building on Option 2, and Option 4 building on Option 3.

Each of the Options is discussed in detail in sub-sections 5.1 – 5.4 and summarised in Table 11. These options also formed the basis of the cost benefit analysis that is discussed in Section 6 of this Statement.

Since the release of the discussion paper, and the draft RIS, a number of changes to existing standards for heavy vehicles have also been proposed which are related to the consideration of the *Euro 5* standards for heavy vehicles under this review. For completeness, these complementary changes are set out in sub-section 5.5.

Table 11 Future Vehicle Emissions and Fuel Standards – Summary of Options 1-4

Option	Vehicle Emissions Standards	Timing	Fuel Standards	Timing
1	Euro 3 for light petrol, LPG, NG *Euro 4* for light and heavy diesel	2005/06 2006/07	Broadly Euro 3 petrol Broadly Euro 3 diesel + 50ppm sulfur	2005 2006
2	*Euro 4* for light vehicles	2008/09	50ppm sulfur petrol (95RON grade only)	2008
3	*Euro 4* for light vehicles *Euro 5* for heavy vehicles	2008/09 2009/10	50ppm sulfur petrol (95RON grade only) 10ppm sulfur diesel	2008 2009
4	*Euro 4* for light vehicles *Euro 5* for heavy vehicles	2008/10 2009/10	50ppm sulfur petrol (95RON grade only) 10ppm sulfur petrol (95RON grade only) 10ppm sulfur diesel	2008 2010 2009

Notes to Table:

1. In the MVEC Discussion Paper issued in May 2003, Options 2-4 also included a proposal to vary the Australian aromatics standard. LTEC has decided to defer any decision on revising the aromatics limits that take effect from 1 January 2005. The cost benefit analysis estimated that the high refining cost associated with reducing aromatics would result in only minor health benefit (less than 1% of Option 4). In addition, the petroleum industry advises that it would not be feasible to produce a high share (more than 15%) of premium grade unleaded petrol in association with implementation of a limit of 35% in aromatic content (the *Euro 4* level) without the use of octane enhancing substances such as MTBE. The Australian Government has already determined that an effective ban will be placed on the use of MTBE from 1 January 2004.
2. As noted earlier, in the context of these options, references to the *Euro 4* emissions standards for light vehicles cover vehicles that operate on petrol, LPG or CNG. The *Euro 4* light vehicle standards for

diesel vehicles have already been adopted under ADR79/01. References to the *Euro 5* emissions standards for heavy vehicles cover vehicles that operate on diesel, LPG or CNG. Petrol engined heavy vehicles are not recognised in the UN ECE standards, and have to date been addressed in the Australian Design Rules by the adoption of US EPA standards, and it is intended to continue this practice if *Euro 5* was adopted.

3. The dates referred to in the Table under the "Timing" heading are to be interpreted as follows:
   - The 2 year date combinations for the vehicle standards refer to the dates applicable to new model vehicles and all model vehicles, respectively. For example, in the case of 2008/09, this means that from 1 January 2008 any new model first produced with a date of manufacture after 1 January 2008 must comply with the ADR, and from 1 January 2009 all new vehicles (regardless of the first production date for that particular model) must comply.
   - The single year dates for fuel standards mean that the fuel standard would apply from 1 January of the nominated year.

5.1. Option 1: Status Quo

A status quo or "do nothing" approach would simply rely on the existing package of emissions and fuel standards being introduced over the 2002-2007 period to deliver lower fleet emissions and improvements in air quality. This package will deliver significant reductions in those emissions which contribute to air pollution, with the most significant being the:

- reduction in NOx and PM emissions from the introduction of *Euro 3* and *Euro 4* standards for diesel vehicles; and
- reduction in NOx and HC emissions from the introduction of the *Euro 3* standards for petrol engined cars and light commercial vehicles.

This package of standards may be insufficient in the longer term in delivering reductions in levels of photochemical smog (measured as ozone), under a scenario of significant increases in vehicle numbers and vehicle kilometres travelled, particularly in our largest cities. While this package of standards will clearly provide long term air quality benefits, particularly in PM emissions, in our largest cities it may be insufficient to deliver reductions in levels of photochemical smog.

In the absence of any new vehicle standards, a proportion of imported vehicles will comply with the more stringent European or US standards in place at the time of their manufacture, even though they have not been adopted in Australia. Thus Australia will benefit, to some extent, from the more stringent overseas standards, even without adopting them in Australia. The magnitude of this "free ride" benefit is difficult to measure, as it depends on decisions by individual manufacturers on the economics of "de-specifying" and re-certifying a model for the Australian market. The level of sulfur mandated in Australian fuels will increasingly influence this decision making process. Some manufacturers may not supply their best performing vehicles due to concerns about adverse impacts of running these vehicles on high sulfur fuels.

While a "do nothing" approach would deliver reductions in noxious emissions, the maintenance of the current fuel sulfur settings (150ppm sulfur in petrol, 50ppm in diesel) would appear to reduce the durability of emissions control technologies and inhibit the capacity to deliver greenhouse reductions from the new vehicle fleet. As discussed in section 6.3, the main benefits of a shift to a "near zero" (≤ 10ppm) sulfur environment are the fuel consumption (and greenhouse gas) reductions which are achievable from the technology which is available for use in that very low sulfur environment. Maintenance of the current settings would inhibit the technology choices for vehicle manufacturers, thus reducing their capacity to deliver fuel consumption improvements except via significant shifts in the model mix to smaller or diesel vehicles.

5.2. Option 2: *Euro 4* & 50ppm Sulfur Petrol

- **Mandate *Euro 4* emissions standards for light vehicles**
- **Mandate 50ppm sulfur limit for petrol**
- **Status quo for heavy vehicle emissions standards and diesel fuel standards (*Euro 4* and 50ppm sulfur)**

***Timeframe*: 2008/09**

In terms of air quality, the adoption of the *Euro 4* light vehicle standards would build on the benefits of the status quo scenario outlined in Option 1. The petrol engined light duty fleet is the predominant source of transport contributions to photochemical smog, and adoption of the *Euro 4* standards would lead to a halving of HC and NOx emissions from new models relative to *Euro 3*. *Euro 4* would also require manufacturers to improve the durability of their emissions control systems. European Commission estimates suggest that the costs of compliance relative to *Euro 3* are likely to be low – in the order of less than 1% of the vehicle cost. The presence of a large number of *Euro 4* certified vehicles currently on the UK and European market, where *Euro 3* is the minimum standard, lends credence to these estimates. The new Australian Green Vehicle Guide[7] confirms that there are a range of imported vehicles on the Australian market which are certified to *Euro 4* , including some in the high volume sector of the market.

An analysis of the *Euro 4* certified models supplied to the UK market indicates that more than 40 models (from 22 manufacturers) that are exported to the Australian market are certified in the UK to *Euro 4*. Some of these models are high volume models competing in market segments where purchase price is critical. An indicative analysis of current sales data for the Australian market (based on VFACTS data for October 2003) illustrates that models that are certified to *Euro 4* in the UK (and potentially supplied to Australia in the same configuration[8]) represent approximately:

- 40% of total sales in the light vehicle group (light vehicle group represents 13% of market);
- 50% of total sales in the small vehicle group (30% of market); and
- 40% of total sales in the medium vehicle group (8% of market).

Euro 4 certified models are also well represented in the smaller prestige and luxury groups.

In terms of greenhouse, the principal benefits of this option would arise from the technology enabling impacts of the lowering of petrol sulfur levels to 50ppm – this would enable the adoption of fuel economy technologies that would be precluded in a 150ppm sulfur environment.

[7] Guide is at : www.greenvehicleguide.gov.au

[8] It needs to be recognised that although these models are certified in Europe to *Euro 4* they are not necessarily supplied in that configuration to the Australian market. Limited emission testing undertaken in Australia indicates that some of these models have emissions performance consistent with a *Euro 4* specification, however many of the models covered by *Euro 4* certification in the UK have not been emission tested in Australia. In addition, there is currently no capacity in the Australian certification system to certify to the *Euro 4* emission standards, as that standard has not yet been adopted in the ADRs.

The lowering of the petrol sulfur level would lead to some reductions in particle emissions (relative to Option 1), arising from a drop from 150ppm to 50ppm. However, the reductions are likely to be small as diesel vehicles are the principal source of PM emissions from the transport sector, and the larger fuel sulfur reductions embodied in Option 1 will have largely delivered the PM reductions from lower sulfur levels in petrol.

5.3. Option 3: Option 2 + *Euro 5* & 10ppm Sulfur Diesel

- **Mandate *Euro 4* for light vehicles**
- **Mandate 50ppm sulfur limit for petrol**
- **Mandate *Euro 5* for heavy vehicles**
- **Mandate 10ppm sulfur limit for diesel**

***Timeframe*: 2008/09 (*Euro 4*) & 2009/10 (*Euro 5*)**

In terms of light vehicle standards and petrol standards, this option is identical to Option 2.

Adoption of the *Euro 5* heavy vehicle standard would lead to a 45% reduction in NOx emissions from new heavy vehicles, relative to Options 1 and 2. Heavy diesel vehicles are a significant, if not dominant, source of NOx emissions in most urban airsheds. This option will only lead to reductions in particle emissions (relative to Option 2) if the US standard is used as an alternative, as the *Euro 5* standard does not change the PM emissions limits. While there is still some debate, the conclusion from the extensive examination commissioned by the EC is that 10ppm sulfur diesel is necessary to ensure compliance with the *Euro 5* standard.

In terms of greenhouse emissions, availability of 10ppm sulfur diesel for *Euro 5* vehicles would also increase the available technological options to reduce fuel consumption, but will only directly effect some earlier technology vehicles. The European Commission concluded that the increase in CO_2 emissions at the refinery to produce 10ppm sulfur diesel, was more than offset by the lower CO_2 emissions from the heavy vehicle fleet expected from the adoption of new vehicle technologies.

On the cost side, the major costs will be in reducing the diesel sulfur level to 10ppm and upgrading after-treatment technologies to enable compliance with the *Euro 5* standards. The European Commission has concluded that this increase in fuel production costs would be more than offset by lower fuel costs for vehicle operators, arising from the fuel consumption improvements delivered by the adoption of technologies enabled by the 10ppm environment. On the vehicle side there appear to be few published estimates of the cost of compliance with *Euro 5* standards, with US estimates for compliance with the comparable US 2007 standards suggesting an increase in truck prices of 1-2%.

5.4. Option 4: Option 3 + 10ppm Sulfur Petrol

- **Mandate *Euro 4* for light vehicles**
- **Mandate 50ppm sulfur limit for petrol in 2008**
- **Mandate 10ppm sulfur limit for petrol in 2010**
- **Mandate *Euro 5* for heavy vehicles**
- **Mandate 10ppm sulfur limit for diesel**

***Timeframe*: 2008/09 (*Euro 4*) & 2009/10 (*Euro 5*)**

This Option is identical to Option 3, except that the sulfur level in petrol is ultimately set at 10ppm instead of 50ppm, via a two step process. The significant potential benefits of Option 4, relative to Option 3, are in reduced fuel consumption (and greenhouse emissions) from the light duty fleet (cars and light commercial vehicles), which contributes around 70% of transport greenhouse emissions. The availability of 10ppm sulfur petrol enables the adoption of a wider range of vehicle technologies which can maximise fuel consumption benefits, while still ensuring compliance with the *Euro 4* standards. However, as 10ppm-sulfur petrol is generally accepted as not being essential for *Euro 4* compliance, it is not essential to align the timing of a 10ppm requirement with the *Euro 4* standards implementation. Thus Option 4 proposes that following the setting of a 50ppm sulfur limit in line with the *Euro 4* vehicle standards timing (2008), a 10ppm sulfur limit be mandated in 2010.

The European Commission estimates that 10ppm petrol provides the capacity for fuel consumption benefits in the order of 1-5%, relative to 50ppm. The Commission also concluded that the increase in CO_2 emissions at the refinery to produce 10ppm sulfur petrol was more than offset by the lower CO_2 emissions from the light vehicle fleet expected from the adoption of these new vehicle technologies.

The additional costs of Option 4 relative to Option 3 relate to the costs to refiners to reduce the sulfur level in petrol to 10ppm. The European Commission has estimated these costs are more than offset by the financial savings from reduced fuel consumption arising from adoption of the new vehicle technologies.

5.5. Complementary Changes to Existing Heavy Vehicle Standards

As discussed later in this RIS (see 6.9.3, 7.4 and 8.3), the consideration of *Euro 5* emission standards for heavy vehicles and the associated technology and compliance questions, has led to a number of requests from the truck and bus industry to delay the implementation of ADR80/01 (*Euro 4* emission standards) and ADR83/00 (noise standards) for heavy duty vehicles. On 12 August 2004, the Australian Government announced its agreement to delay the implementation of ADR80/01 by 12 months to 2007/8.

The European Commission is also currently finalising requirements for durability, on-board diagnostics (OBD) and related matters for inclusion in the *Euro 4* and *Euro 5* standards. These requirements were envisaged at the time of the making of the standards and should be incorporated into ADR80/01 and (if agreed) ADR80/02 when available.

6. COMPARATIVE ANALYSIS OF OPTIONS

To assist LTEC's assessment of the implications for strengthening vehicle emissions and fuel quality standards post-2006, Coffey Geosciences was commissioned by the Australian Department of the Environment and Heritage to carry out a cost benefit analysis (CBA) for Options 1-4 as described above. The Coffey CBA can be found on the LTEC website in the 'news' section at http://www.ephc.gov.au/mvec/.

The CBA was a comprehensive study modelling the effect of these Options on air pollutants, health effects and greenhouse gas emissions, and on the Australian oil industry, vehicle manufacturers and consumers. The study involved the following activities:

- consultations with stakeholders, including the fuel and motor vehicle industries;
- review of literature in relation to emissions and control technology, especially European Union publications;
- review of background studies of emissions and air quality in Australian capital cities;
- calculation of emissions for each capital city to 2020 for each option;
- assessment of air quality impacts in each capital city under each of the nominated options; and
- assessment of health related benefits on a city by city basis.

6.1. Vehicle technology costs

6.1.1. Light vehicles - *Euro 4*

In the case of petrol vehicles, the European Commission estimated the average per vehicle cost in going from *Euro 3* to *Euro 4* at 0.2 – 0.8%. The CBA estimated costs of the order of $250 per vehicle to meet these standards. Evidence from testing programs indicates that there are already *Euro 4* passenger vehicles on the Australian market (where *Euro 2* is the current minimum standard). Some of these are high volume models, indicating that the additional cost of complying with *Euro 4* does not have a significant impact on sales.

6.1.2. Heavy vehicles - *Euro 5*

In the case of heavy diesel vehicles, the CBA estimated costs of the order of $2,500 to $3,600 per vehicle to meet *Euro 5* standards.

6.2. Fuel standards costs

6.2.1. Fuel standards costs

There are significant refinery capital costs associated with reducing fuel sulfur content. Table 12 outlines the estimates of these costs used in the CBA.

Table 12 ESTIMATED PRODUCTION COST FOR CLEANER FUELS

Fuel Quality Improvement	Australian Refining Industry Capital Cost ($M)	Australian Refining Industry Operating Cost (c/L)	Combined Capital and Operating Cost of Production (c/L)
Sulfur reduction in diesel from 50ppm to 10ppm	140	0.4	0.7
Sulfur reduction in 95RON petrol from 150ppm to 50ppm	238	0.475	1.0
Sulfur reduction in 95RON petrol from 150ppm to 10ppm	560	0.65	1.9

Source: Coffey Geosciences, 2003.

Since the completion of the CBA, the *APEC Clean Fuels Study* has estimated that the most likely investment scenario for the Australia and New Zealand refining system for 2006 would see an investment of around $300m, which would allow it to meet 100% of its diesel demand and 94% of petrol with domestic production. This cost estimate is similar to that identified in the CBA.

It is anticipated that increases in refining costs would be passed on to consumers through the pump price of fuel.

6.2.2. 2003 Budget Announcement – Incentives for Cleaner Fuels

Measures are currently in place to encourage use of low sulfur diesel and under measures announced in the May 2003 Commonwealth Budget, grant payments will be made to support introduction of 10ppm sulfur diesel and 50ppm sulfur petrol. These incentives are:

- An excise differential of 1c/L for diesel with sulfur above 50ppm from 1 July 2003, increasing to 2c/L from 1 January 2004. This excise differential will apply until 1 January 2006 when sulfur content will be regulated at a maximum of 50ppm.
- Production subsides of 1.1c/L from 1 January 2006 to 31 December 2007 for 95RON petrol produced or imported with sulfur less than 50ppm. This subsidy will be funded by an increase in excise of approximately 0.06c/L on all grades of petrol.
- Production subsides of 1.0c/L from 1 January 2007 to 31 December 2008 for diesel produced or imported with sulfur less than 10ppm. This subsidy will be funded by an increase in excise of approximately 0.7c/L on all diesels.

These measures deliver on the Government's commitment in the *Measures for a Better Environment* package to provide encouragement for the conversion to cleaner fuels. The measures will encourage the production of higher quality fuels before they are mandated, bringing forward the benefits arising from the early use of these fuels as described throughout this statement. The measures are also intended to support industry in making the transition to the new fuel standards.

6.3. Health Benefits

6.3.1. Fuel quality

Benefits from fuel quality improvements accrue from improved health outcomes and from reductions in fuel consumption. The fuel quality improvement will have a large immediate effect, while the benefits associated with changes in emissions standards rely on the turn over of the existing vehicle fleet, and thus increase over time.

The CBA estimated that a reduction in diesel sulfur content to 10ppm, would deliver an immediate 5% reduction in particulate emissions from the diesel vehicle fleet for existing pre-*Euro 4* diesel vehicles.

In the case of reductions in sulfur content in 95 & 98RON petrol there would be a small reduction in emissions of hydrocarbons and oxides of nitrogen. Health benefits are less sensitive to emissions of oxides of nitrogen, hydrocarbons and carbon monoxide compared with emissions of particulates so direct health benefits associated with improved petrol quality are not as great as those associated with improved diesel quality. In the case of petrol, the reduction in sulfur content from 150ppm to 50ppm and to 10ppm will result in reductions in emissions of oxides of nitrogen, hydrocarbons and carbon monoxide of 2% to 3% and 13%, respectively. However, these improvements will be limited to those pre-*Euro 4* vehicles using 95 & 98RON grade fuels.

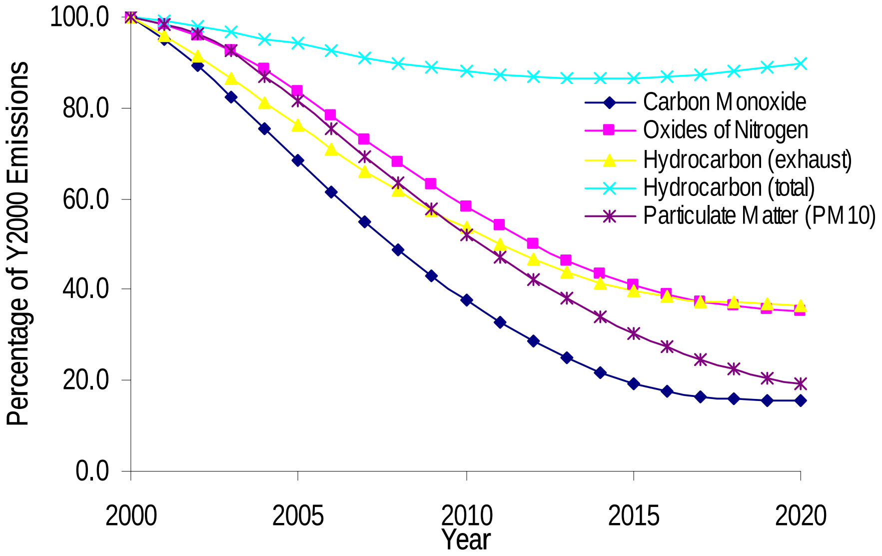
6.3.2. Emissions standards

The CBA modelling indicated that introduction of *Euro 4* vehicle emissions standards for petrol vehicles (under Options 2, 3 and 4) would ultimately result in a substantial reduction in the emissions of carbon monoxide (23% reduction in 2020), hydrocarbons (6.5% reduction in 2020) and oxides of nitrogen (14% reduction in 2020). These reductions in emissions commence from a zero base in 2007 (immediately prior to implementation of *Euro 4* standards) and would increase approximately linearly as *Euro 4* vehicles replace earlier vehicles. This delay of several years to receive significant benefits resulting from more stringent vehicle emissions standards has occurred following previous changes in emissions standards. For example, the benefits from implementation of ADR 37/00 which involved introduction of catalysts for petrol vehicles in 1986 will continue to be felt until the last of the pre-1986 vehicles are replaced (less than 1% of passenger vehicle travel is projected to occur from pre-1986 vehicles by 2006). Health benefits associated with introduction of *Euro 4* vehicle emissions standards are assessed to increase from $6M in 2008 to $176M in 2020, and will continue to grow beyond the end date modelled in the CBA (2020).

Similarly, the CBA assessed benefits associated with introduction of *Euro 5* standards for heavy diesel vehicles (under Options 3 and 4) would commence from 2009 and increase with time. *Euro 5* standards involve a reduction of 43% in emissions of oxides of nitrogen compared with *Euro 4* standards. Around 28% of the long term benefits associated with improved heavy diesel emissions standards would come from adoption of US 2007 standards as an alternative to *Euro 5* for vehicles sourced from the United States. The US 2007 standard calls for an 80% reduction in particulate emissions compared with the preceding US 2004 standard. Health benefits associated with introduction of *Euro 5* heavy vehicle standards (together with US 2007 as an alternative) are assessed to increase from $11M in 2009 to $256M in 2020. These estimates do not take into account the possible adoption of the Japanese JE05 standards, although as these standards have comparable limits to the *Euro 5* standards, it is unlikely these estimates of benefit would change significantly.

6.3.3. Combined Effects of New Vehicle Emissions and Fuel Standards

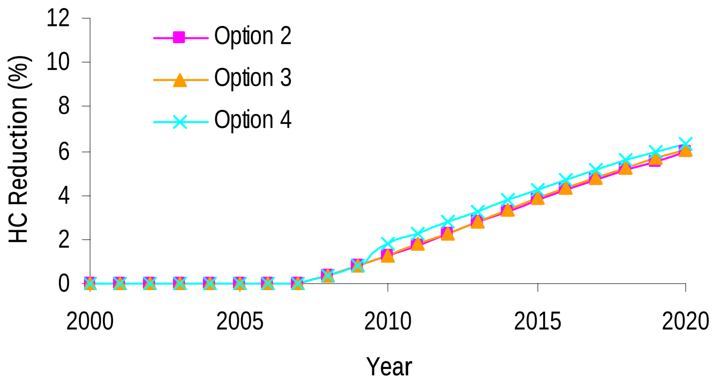
The CBA estimated the emissions impacts of Options 2, 3 and 4 relative to the status quo Option 1. As illustrated in Figure 8, the existing measures to be introduced over the 2002-6 period will deliver significant emissions reductions.



Source: Coffey Geosciences, 2003.

Figure 8 Projected Emissions For Each State And Territory Capital (Option 1)

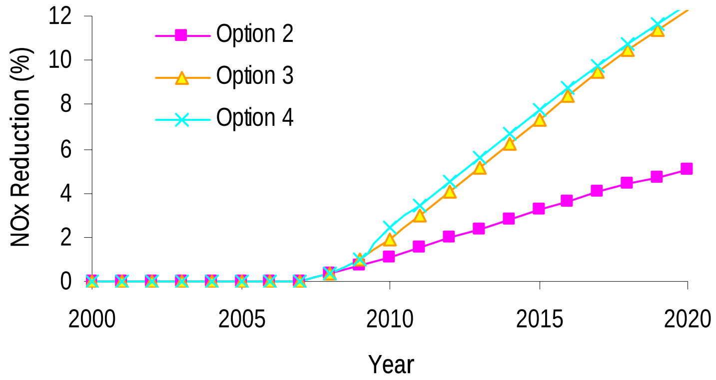
The introduction of the *Euro 4* and *Euro 5* standards, and associated fuel changes, are predicted to deliver additional benefits as illustrated for HC and NOx emissions in Figures 9 and 10 below:



Source: Coffey Geosciences, 2003

Figure 9 Reduction in HC Emissions Relative to Option 1 as a Percentage of Year 2000 Emissions

The benefits in HC reductions stem almost entirely from the introduction of the *Euro 4* emissions standards for light vehicles, and as these standards form part of Options 2, 3 and 4 there is little difference between the options. The minor differences are related to fuel quality and vehicle technology effects associated with the introduction of 10ppm sulfur petrol in Option 4.



Source: Coffey Geosciences, 2003

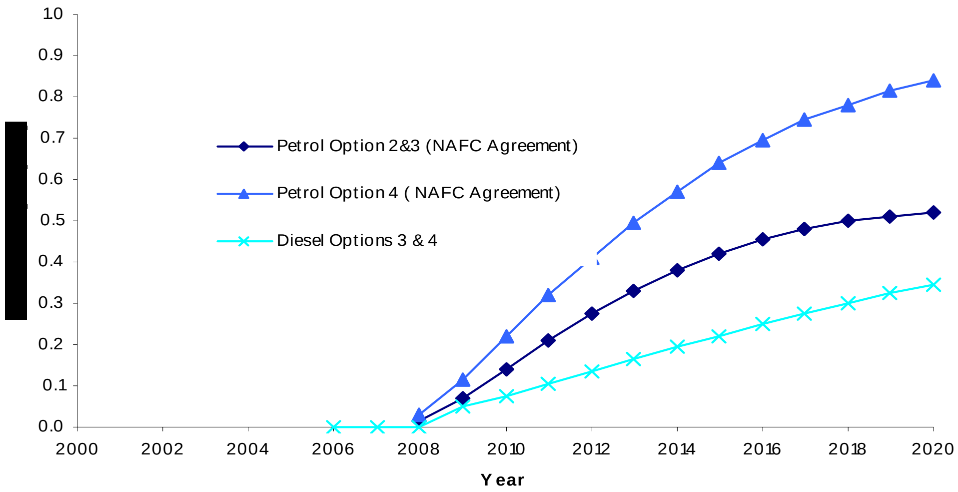
Figure 10 **Reduction in NOx Emissions Relative to Option 1 as a Percentage of Year 2000 Emissions**

Unlike HC emissions, the reductions in NOx emissions result from the introduction of both the *Euro 4* standards for light vehicles and the *Euro 5* standards for heavy vehicles, hence the increased benefit of Options 3 and 4 over Option 2. The small difference between Option 3 and 4, relates to the fuel quality and vehicle technology effects from the introduction of 10ppm sulfur petrol.

Chapters 4 and 8 of the CBA provide a detailed explanation of how health benefits were monetised.

6.4. Fuel efficiency benefits

Fuel efficiency benefits of 2% (diesel) and 3% (petrol) are associated with reduction in sulfur content from 50ppm to 10ppm in fuel for *Euro 4* petrol and diesel vehicles. These benefits are linked to the use of NO_x storage traps that are expected to be used for *Euro 4* light petrol and diesel vehicles to control emissions of oxides of nitrogen. Vehicles with NO_x storage traps are more fuel efficient for very low sulfur content fuels. As illustrated in Figure 11, the magnitude of these benefits will increase with time as the number of *Euro 4* (and *Euro 5*) vehicles increases (under Options 2, 3 and 4).



Source: Coffey Geosciences, 2003.

Figure 11 Projected Fuel Savings Due to Improved Fuel Efficiency under Various Options

In monetary terms, the fuel savings attributable to fuel quality improvement (reduction in sulfur from 150ppm to 50ppm in PULP) are assessed to increase from $12M in 2008 to $261M in 2020 for *Euro 4* petrol vehicles (Option 4 compared with Option 2). In the case of diesel vehicles fuel savings are assessed to increase from $38M in 2009 to $271M in 2020 for diesel vehicles (Options 3 and 4) resulting from a combination of efficiency improvement in *Euro 4* light vehicles using 10ppm sulfur fuel (as opposed to 50ppm sulfur fuel) and reduced fuel consumption from *Euro 5* heavy vehicles (compared with *Euro 4* heavy vehicles).

6.4.1. Effect of National Average Fuel Consumption (NAFC) Target

The CBA also analysed the effect of the NAFC that was announced in May 2003 and is being implemented by the Australian automotive industry under a Voluntary Code of Practice. The implementation of the NAFC would see the average fuel consumption reduced to 6.8L/100km for new passenger vehicles by 2010. The CBA concluded that compliance with NAFC would result in an increase in manufacturing costs in the order of $650 per vehicle. This cost increase would apply to new vehicles and would be in addition to cost to meet emissions standards. The CBA assessed that the annual costs associated with this change would gradually increase from $479M in 2010 to $501M in 2020 as the number of petrol passenger vehicles increases with increasing population.

Fuel savings associated with the NAFC agreement will gradually increase from $179M in 2010 to $687M in 2020 as the number of vehicles meeting the agreement increases with time. The annual benefits will relate to the total number of vehicles on the road meeting the agreed target while the annual costs will remain relatively stable. Thus, initially the NAFC agreement would result in a net annual cost (excess of vehicle technology cost over fuel consumption savings) which would gradually reduce with time from a deficit of $300M in 2010, reaching break even by about 2015 (assuming 10ppm sulfur in petrol) and subsequently resulting in a net benefit of $186M in 2020. The timing of the break-even point will depend upon the sulfur content of petrol.

The CBA notes that the achievement of the NAFC is strongly linked to the sulfur content of petrol and that the vehicle manufacturing industry (represented by the Federal Chamber of Automotive Industries) is strongly of the view that the NAFC target can not be achieved without 10ppm sulfur petrol. As 10ppm sulfur petrol is a component of Option 4 only, the CBA assumes that fuel consumption under Options 2 and 3 (where the sulfur level in petrol is 50ppm) will be compromised, and, increases the fuel consumption values to 3% greater than the NAFC target for these options to take account of this impact. .The NAFC costs and benefits are not assessed for Option 1, given the more severe compromise of fuel consumption that would result with the 150ppm sulfur limit for 95 RON petrol considered under this option.

6.5. Summary of net benefit for Options 2 to 4

6.5.1. CBA quantitative results

The results of the CBA (summarised in Table 13) show a net cost for the first 9 years of the 15 year study period. The trends, however, are positive and beyond 2020 the benefits of strengthened standards significantly outweigh costs, especially under Option 4, and continue to increase over time.

TABLE 13 SUMMARY OF NET BENEFIT FOR OPTIONS 2 TO 4 ($M)

Year	Without NAFC			With NAFC		
	Option 2	Option 3	Option 4	Option 2	Option 3	Option 4
2006	-119	-189	-350	-119	-189	-350
2007	-119	-189	-350	-119	-189	-350
2008	-231	-231	-231	-217	-217	-204
2009	-223	-231	-231	-404	-413	-374
2010	-213	-196	-194	-577	-560	-494
2011	-202	-155	-155	-512	-465	-376
2012	-191	-114	-116	-452	-374	-264
2013	-180	-72	-74	-397	-289	-155
2014	-168	-27	-33	-348	-207	-56
2015	-156	15	8	-305	-134	37
2016	-146	56	47	-268	-66	122
2017	-136	97	86	-239	-7	197
2018	-127	137	123	-216	48	266
2019	-118	174	158	-198	93	325
2020	-110	208	190	-186	132	376
Net Present Value						
Unadjusted	-2439	-717	-1122	-4557	-2837	-1300
5% pa discount	-1725	-801	-1145	-3171	-2248	-1441
10% pa discount	-1281	-780	-1085	-2304	-1805	-1394

Since Options 2 – 4 are cumulative, the significant benefits relating to measures contained in Options 3 and 4 are outweighed by the significant costs associated with Option 2, and this balance is only reversed six to seven years after the standards for these options begin to take effect (ie ‘break even point’ on a yearly basis for Option 4 is in 2015). The major costs contained in Option 2 are the upfront capital associated with refinery investment, which has been estimated at $238M, and the estimated $210M annually attributed to vehicle emissions technology. On a net present value basis for the period to 2020 for Option 3, there are large negative magnitudes ranging from -$1.80bn to -$2.25bn with NAFC and, to -$780m to -$800m without NAFC for 10 and 5% discount rates, respectively for each alternative. Given the strong linkage between achievement of the NAFC and sulfur content of petrol (see section 6.4.1), the net benefits of Options 2 and 3 under the “with NAFC” condition are severely compromised as the CBA still assigns the full vehicle technology costs associated with meeting the NAFC, but applies a reduced fuel consumption benefit. This scenario is questionable in reality as manufacturers are unlikely to commit to invest in technology to achieve the NAFC unless the sulfur limit is set at 10ppm (as per Option 4). Thus in considering Options 2 and 3, the “no NAFC” estimates are the more realistic.

6.5.2. CBA – other factors

In relation to costs, the CBA assumed that large up front technology costs for emissions control technology for vehicles and refinery ongoing operating costs would not diminish over time. The CBA acknowledges that experience with catalyst technologies has shown that a rapid decline in unit costs is very likely as technology matures and production volumes increase, resulting in lower overall costs. The CBA concludes that "the analysis therefore depicts a "worst case" scenario for vehicle technology costs".

This position is supported by others, A 2004 World Bank report on reducing urban air pollution from transport states:

> "the technology to achieve reductions to 10-15 wt ppm (sulfur), as well as the exhaust-control technology enabled by ultralow sulfur diesel, is undergoing continuous improvement. As a result, significant cost reductions are almost certain in the coming decade."

The NSW Department of Environment and Conservation also noted this trend for reducing technology costs over time in its submission on the draft RIS. The DEC stated (drawing on work of the International Energy Agency):

> "it has been the experience of a wide range of industries that as production increases, production costs decrease. This relationship is often called the experience curve and can be explained by a combination of learning, specialisation, scale, investment and competition".

The CBA also recognises that significant uncertainty surrounds the estimation of the individual component costs and expenses. Within this range of uncertainty it is possible that Options 3 and 4 could be in net total benefit within a much shorter time frame.

There were also a number of major benefits from strengthening of vehicle emissions standards and improving fuel quality that were not quantified in the CBA that need to be considered:

- the maintenance benefits associated with use of low sulfur diesel in heavy vehicles – US EPA assesses benefits in the order of one US cent per gallon (0.4 Australian cents per litre) in reduced maintenance costs;
- the significant greenhouse benefits estimated to be delivered from both light and heavy vehicles (CBA estimated 1769Gg CO_2 in 2020 alone) – these were only reported in a qualitative manner in the RIS because there is significant reluctance to place a dollar value on each mitigated tonne of carbon dioxide equivalent in the absence of a carbon trading regime. The CBA concluded that under Option 3, there is a net annual greenhouse benefit from 2016 (no NAFC) and 2010 (with NAFC);
- the cost to Australian vehicle and component manufacturers from lack of access to export markets if our vehicle and fuel standards were *not* to harmonise with international best practice; and
- potential gains in amenity values from better air quality which can translate to benefits in tourism revenue, investment and other economic benefits.

The CBA assumption that fuel prices remain constant over the course of the study also has the effect of underestimating benefits associated with fuel consumption savings, as it is likely that the real price of crude oil is likely to increase over the time frame covered by the analysis.

The CBA quantitative results can therefore be considered as understating the net benefits of strengthening standards (see additional analyses in section 6.5.3).

6.5.3. Additional Analyses

Extension of CBA Analysis to 2030

While the net present value results for Option 3 are significantly negative, additional analysis beyond 2020 presents a more positive outcome. The trends in Table 13 indicate that benefits relative to costs will continue to grow beyond 2020, with the total benefits expected to begin exceeding total costs some time in the following decade. The study period does not cover the entire period where the costs for the Options will be incurred, which are mainly up front, nor the benefits gained, which will increase as the vehicle fleet turns over, and vehicles meeting the proposed new standards become dominant in the fleet (in both numbers and VKT terms). Noting the average age (10.4 years for cars and 15.7 years for trucks) and turnover period (around 17 years) of Australia's vehicle fleet , it is clear that under Options 3 and 4, new petrol vehicles that come on stream in 2008 will not become completely dominant in the fleet until 2030 or later, and new diesel vehicles even later. Consequently, it is more useful to consider an analysis period that extends to at least 2030. Extrapolating the underlying trends for the period up to 2020, positive internal rate of returns are achieved by 2030 of 4% (Option 3 with NAFC) and 9% (Option 3 without NAFC).

Refinement & Extension of CBA Option 3 – Vehicles Only to 2030

As noted in section 1.3 of this RIS, the fuel standards identified in the CBA have been considered by the Australian Government, and decisions have been made to mandate 50ppm sulfur petrol and 10ppm sulfur diesel from 2008 and 2009 respectively. No decision has yet been made on 10ppm sulfur petrol. In light of this decision, it is useful to consider the CBA estimates of the costs and benefits of the vehicle standards in isolation from the fuel standards. As such it is appropriate to consider the vehicle related costs and benefits associated with Option 3, as this option covers both light and heavy vehicles. Table 14 provides a summary of this analysis, utilising the CBA estimates under options 2 and 3 ("no NAFC" analysis[9]) to enable the costs and benefits from light and heavy vehicles to be separately addressed. Table 14 also adjust the costs and benefits for light vehicles in 2008-2010 to reflect the 2 year introduction period from 01/07/08 recommended by LTEC (see section 8.1).

[9] The "no NAFC" values are preferred as the "with NAFC" figures - when considering Options 2 and 3 - are inaccurate, because in those scenarios all of the costs of meeting NAFC are attributed but only a reduced level of NAFC-related fuel consumption benefits are considered. The CBA modelling only considers fuel consumption benefits under Option 4 ("with NAFC") because this is the only option that assumes the availability of 10ppm sulfur PULP, which is a key assumption underlying the NAFC.

TABLE 14 SUMMARY OF VEHICLE COSTS AND BENEFITS FOR OPTION 3 (NO NAFC) ($M)

Year	Costs ($M)			Benefits ($M)			Net Benefit ($M)		
				Health		Fuel Savings			
	Light Vehicles	Heavy Vehicles	Urea	Light vehicles	Heavy Vehicles	Heavy Vehicles	Light Vehicles	Heavy Vehicles	All Vehicles
CBA Ref	*Table 8.13*	*Tables 8.13, 8.15*	*Table 8.15*	*Table 8.13*	*Table 8.15, Section 9.1*	*Table 8.15*			
2008	41	0	0	2	0	0	-39	0	-39
2009	105	0	0	13	0	0	-92	0	-92
2010	168	31	4	31	1	38	-137	4	-133
2011	211	63	12	54	17	60	-157	2	-155
2012	212	64	20	69	38	83	-143	37	-106
2013	213	65	29	84	60	106	-129	72	-57
2014	214	66	37	99	83	129	-115	109	-6
2015	214	68	46	114	106	152	-100	144	44
2016	215	69	54	128	130	174	-87	181	94
2017	215	71	62	141	155	195	-74	217	143
2018	215	73	70	153	179	216	-62	252	190
2019	215	74	77	165	204	236	-50	289	239
2020	215	75	84	176	227	254	-39	322	283
2021	218	73	85	184	253	257	-33	352	318
2022	219	74	86	193	265	261	-27	365	338
2023	221	75	87	201	277	264	-20	378	358
2024	222	76	88	209	289	267	-13	391	378
2025	224	77	89	218	300	270	-6	403	397
2026	225	79	90	226	310	274	0	415	415
2027	227	80	92	234	320	277	7	426	433
2028	228	81	93	242	330	280	14	437	451
2029	230	82	94	251	339	283	21	447	468
2030	231	83	95	259	348	287	28	457	485
				NPV (5% discount p.a.)			**-$934.88**	**$2,639.71**	**$1,704.83**

In comparison to Table 13, it is clear that the extension of the modelling to 2030 (as illustrated in Table 14) considerably improves the cost benefit outcome for the vehicles component of Option 3 (no NAFC) from significantly negative to slightly positive. While in net present value terms, the light vehicle component is still overall negative the magnitude of the costs has been considerably reduced and from 2027-2030 there is an increasing positive trend in net benefits.

However, as noted in sections 6.5.2 and the DEC analysis below, there is strong evidence that technology costs reduce over time. The NSW DEC submission refers to work by the International Energy Agency which concludes that costs reduce by 10-30% for each doubling of production volumes. In an effort to estimate the impact of this effect, the vehicle cost data in Table 14 was adjusted using a 15% cost reduction value. The impact of this adjustment is shown in Table 15.

TABLE 15 SUMMARY OF VEHICLE COSTS AND BENEFITS FOR OPTION 3 (NO NAFC) WITH TECHNOLOGY COST ADJUSTMENT OF 15% ($M)

Year	Costs ($M)			Benefits ($M)			Net Benefit ($M)		
				Health		Fuel Savings			
	Light Vehicles	Heavy Vehicles	Urea	Light vehicles	Heavy Vehicles	Heavy Vehicles	Light Vehicles	Heavy Vehicles	All Vehicles
CBA Ref	*Table 8.13*	*Tables 8.13, 8.15*	*Table 8.15*	*Table 8.13*	*Table 8.15, Section 9.1*	*Table 8.15*			
2008	41	0	0	2	0	0	-39	0	-39
2009	105	0	0	13	0	0	-92	0	-92
2010	168	31	4	31	1	38	-137	4	-133
2011	200	63	12	54	17	60	-146	3	-143
2012	171	64	20	69	38	83	-102	38	-65
2013	173	55	29	84	60	106	-89	82	-7
2014	148	56	37	99	83	129	-49	119	69
2015	150	48	46	114	106	152	-36	164	128
2016	151	49	54	128	130	174	-23	201	178
2017	152	50	62	141	155	195	-11	238	227
2018	131	51	70	153	179	216	22	275	297
2019	132	44	77	165	204	236	33	320	353
2020	133	44	84	176	227	254	43	353	396
2021	134	45	85	184	253	257	51	380	430
2022	135	46	86	193	265	261	58	394	452
2023	136	46	87	201	277	264	65	407	473
2024	137	47	88	209	289	267	73	420	493
2025	137	48	89	218	300	270	80	433	513
2026	118	48	90	226	310	274	108	445	553
2027	118	42	92	234	320	277	116	464	580
2028	119	42	93	242	330	280	123	475	599
2029	120	43	94	251	339	283	131	486	617
2030	120	43	95	259	348	287	139	497	635
				NPV (5% discount p.a.)			**-$162.55**	**$2,873.52**	**$2,710.97**

Table 15 illustrates that the application of this expected cost reduction factor significantly improves the cost benefit result, with the light vehicle component still negative in net present value terms at 2030, but at a relatively low value. Adoption of a higher value within the IEA range is likely to bring the light vehicle sector into positive terms (for example a 20% value results in an estimated NPV (5% discount rate) for 2030 for light vehicles of $32 million).

Extension & Enhancement of CBA Analysis by NSW DEC

The NSW Department of Environment and Conservation (DEC) submission on the draft RIS acknowledged the significant costs identified in the CBA, but considered that the benefits were likely to be underestimated. In an effort to address this, DEC undertook additional cost benefit analyses, which drew on the CBA, and then extrapolated the analysis period from 2020 to 2030. The DEC analysis also factored in estimates of additional benefits from expected maintenance savings and greenhouse gas reductions.

DEC noted that the 2020 endpoint of the CBA would tend to skew the analysis as the significant upfront refining and vehicle capital costs would not be offset by the benefits which would not be fully realised until virtually all the fleet is replaced by vehicles meeting the proposed new standards.

DEC noted that the RIS does not assign a dollar value to greenhouse gas savings (in the absence of a carbon trading regime), but that the CBA does suggest some shadow prices in Attachment B to the CBA. Utilising these values for greenhouse abatement, DEC considered that the combined vehicle maintenance and greenhouse benefits are in the order of $27-$71 million in 2020. At 2030, these benefits, in present value terms, could be the range of $200-$600 million.

The DEC analysis concluded that adoption of Option 4 assessed over the 2006-2030 period (except that the *Euro 5* is adopted in 2010/11, rather than 2009/10) would result in an estimated positive net present value of $470-$830 million. DEC notes that while this estimate is subject to considerable uncertainty - given the need to extrapolate from 2020-2030 - it nevertheless “gives a good indication of the order of magnitude of the likely benefits” of the package.

6.6. Conclusions of the Cost Benefit Analysis

Notwithstanding the above limitations relating to its quantitative analysis, the CBA study made the following conclusions:

- in terms of light vehicles, adopting *Euro 4* emission standards supported by a 50ppm sulfur limit in petrol establishes conditions that give a positive net benefit to further reduce the sulfur limit in petrol to 10ppm – an annual net improvement in benefits from $66M in 2010 to $244M in 2020 if NAFC is met, as well as major (unquantified) reductions in the level of greenhouse gas emissions; and
- in terms of heavy vehicles, there is significant benefit in adopting *Euro 5* emission standards and a 10ppm sulfur limit in diesel – an annual net improvement in benefits from $17M in 2010 to $318M in 2020, as well as reductions in the level of greenhouse gas emissions.

These findings are consistent with studies in Europe and the US that have supported the introduction of low sulfur fuels and strengthened vehicle emissions standards in those countries.

A net present value analysis of the CBA results indicates that when the analysis is limited to 2020, there are significant negative results under each option. However, when the analysis is extended to a more realistic time frame (2030), positive internal rates of return are achieved (e.g. 4% for Option 3 with NAFC; 9% for Option 3 without NAFC). As noted above, the inclusion of more realistic vehicle cost estimates and other factors also considerably improves the overall outcome in net present value terms.

6.7. Stakeholder concerns about the Findings of the CBA

While stakeholders in the fuel and vehicle industries were consulted by the authors of the CBA during its preparation, a number of concerns about the CBA were raised by stakeholders in their submissions on the draft RIS:

- The Australian Institute of Petroleum is concerned about the non-inclusion of major interface costs arising from the common use of piping and tanks for almost zero sulfur fuels with other grades of fuel; as well as the absence of the use of a net present value discount factor to the stream of costs and benefits;

- Environment Victoria is concerned about the non-inclusion of health benefits of SO_2 reduction;
- The NSW Department of Environment and Conservation considered that:
  - The timeframe for the CBA was too short, leading to an underestimate of the benefits,
  - The absence of monetary values for greenhouse and vehicle maintenance savings will also lead to an underestimate of the benefits, and
  - The vehicle and fuel technology costs are likely to be overestimated, because they do not take into account the reasonable expectation that there will be a fall in unit costs over time;
- The Truck Industry Council considered that:
  - the CBA view that there will be fuel consumption improvements in moving from *Euro 4* to *Euro 5* is incorrect, and a 3-5% penalty is more likely (on the assumption that the improvements will actually be realised in relation to *Euro 4, not Euro 5),* and
  - compliance costs are likely to be around $8000 per vehicle compared to the CBA estimate of $3000.
- PACCAR Australia considers the CBA fails to analyse the risks associated with urea and SCR systems for heavy vehicles; and
- The Australian Trucking Association considers that the CBA is deficient in not costing potential alternative approaches to the Options set out in Section 5.

6.8. Results from Overseas Studies

Europe and the United States of America both undertook major cost benefit analysis processes prior to setting their vehicle emissions standard and fuel sulfur reduction timetables. While their standards starting points and the vehicle mix in their transport fleet and infrastructure differ , the findings of these studies have some relevance to Australia.

6.8.1. Europe

The European Parliament’s 2001 Directive for revised petrol and diesel quality standards announced a move to 50ppm by 2005 and 10ppm by 2009 for both petrol and diesel, which are starting from levels of 150ppm sulfur and 350ppm sulfur, respectively. Table 16 summarises the results of the European Commission’s cost benefit analysis.

TABLE 16 EUROPE - SUMMARY OF COSTS, BENEFITS AND EMISSIONS REDUCTIONS

			2007	2012	2020
CO2 emissions changes					
Change in CO2 emissions in refineries, (kT)			407.0	5,348.3	5,404.3
CO2 change from cars (3% petrol 2% diesel), (kT)			-1,245.9	-6,850.0	-13,574.9
Net change in CO2 emissions (kT)			**-838.9**	**-1,501.7**	**-8,170.6**
Costs and Benefits, € million					
Increase in refining costs (average per year)			-75.4	-995.0	-1,019.0
Savings due to lower fuel consumption (average)			120.5	661.6	1,309.1
Benefits from better air quality			0.0	304.1	18.3
Net benefits (- depicts net costs)			**45.2**	**-29.3**	**308.4**
Net Present Value (4%	**- €million**	**1,061.2**			
	- $m Australian	**1,744.5**			
Changes in air related emissions					
NOx, kilotonnes			0	-39.0	-2.5
VOC, kilotonnes			0	-14.4	-0.9
CO, kilotonnes			0	-176.8	-9.9
PM, tones			0	-366.7	-11.8

Note All costs are without VAT or excise duties. For emissions negative signs indicate reductions, for benefits negatives signs indicate net costs. The above analysis has assumed a phased introduction of zero sulfur fuels in 2007. The earlier introduction in 2005 is expected to increase the benefits slightly.

Source: EC, 2001a.

6.8.2. United States of America

The US has addressed the lowering of sulfur and revised vehicle standards in two separate processes for petrol and diesel. In December 1999, it announced reductions of petrol sulfur levels to 30ppm over the period 2004-07 and strengthened vehicle emissions standards. It measured the cost to industry of this as US$5.3 billion and the health and environmental benefits at US$25.2b. Note that as the US did not follow the European (and Australian) step-wise approach, that is lowering sulfur through 150 or 50ppm steps, this analysis aggregates the majority of benefits arising from the first step with the incremental gains of the second.

Likewise for diesel and heavy duty vehicles, in 2000 the US announced new standard to reduce diesel sulfur content from 500ppm to 15ppm in one step, by 2007 when its new heavy duty vehicle rules are in place. The US EPA's regulatory impact analysis noted that the cost of complying with the new standards will decline over time as manufacturing costs are reduced and capital investments are recovered. The total monetised benefits of these rules in 2030 were expected to be US$70.4billion.

Of interest in the US cost benefit analyses was their approach of measuring costs and benefits of the standards changes over a relatively long period (2000-2030). The rationale for this 30 year time frame was the proper reconciliation of up front capital costs of the early years of implementation (retro-fitting and upgrade of oil refineries and the redesign and upgrade of vehicles, leading to higher fuel and vehicle purchase costs), with the benefits arising from the new standards that only become close to being fully realised when almost all of the fleet is turned over (2030).

The US approach also differed from the CBA used for this Statement, by including monetary values for impact on visibility and household soiling, and recognition (but not monetising) of a number of other effects arising from air pollution, including decreased forestry and agricultural productivity, and damage to ecosystem function.

6.9. Other Implications Of Strengthening Standards

6.9.1. Impact on Australian refineries

Australia has seven refineries that are operated by multinational oil companies, namely:

- Kwinana (WA) and Bulwer Island (Qld) operated by BP;
- Kurnell (NSW) and Lytton (Qld) operated by Caltex;
- Altona (Vic) operated by ExxonMobil; and
- Geelong (Vic) and Clyde (NSW) operated by Shell.

While there has been an upswing in profitability over the last twelve to eighteen months, the refinery industry in Asia, including Australia has suffered from over-capacity and poor returns during the last decade. ExxonMobil recently closed its Port Stanvac (SA) refinery, because it was not economic and further investment to meet new fuel standards could not be justified. Except for Altona, all refineries are now producing 50ppm sulfur diesel, which is the 2006 standard for this parameter.

The CBA made estimates of the likely costs to Australian refineries of meeting the proposed post-2006 petrol and diesel standards based on advice from refineries, as contained in Table 12 above.

Aside from investments to meet new fuel standards, the Australian Department of Industry has estimated that Australian refineries will need to invest around $1 billion by 2012 to maintain their integrity, reliability and competitiveness. There are therefore a number of pressures that Australian refineries face, of which meeting new fuel standards is one.

6.9.2. Asia region fuel supply capacity and effect on fuel price

Currently, Australia has no tariffs or other barriers to imports. Stakeholders have advised that imports come from refineries in Asia, particularly China and Singapore, that are typically more modern, larger and have lower production costs than local refineries.

The recently published *APEC Clean Fuels Study* considered the transport fuel supply impacts of various fuel parameter changes likely over the coming decade, on the individual refining sectors of the various APEC member economies. It confirmed that from 2006 Australia would need to expand its production or increase its imports to meet additional product demand and improved product quality.

The fuel price costs identified in 6.2 above are based on the assumption that petrol of the appropriate quality will be able to be imported at costs comparable to those faced by domestic refineries. A number of stakeholders from the petroleum industry have identified that the share of fuel imported will grow from its current level of approximately 10% to a level of approximately 25% by mid-next decade, as domestic demand for fuel increases.

In setting fuel quality standards that have a high level of parity with US and Europe but are generally ahead of those in Australia's immediate region, the ability to access competitively priced imports will become increasingly important.

Australia's current fuel quality standards that are somewhat more stringent than those in our immediate region do not appear to have led to a discernible price differential. Given the considerable lead time that would be provided, and the advances that other Asian countries are also making with their own fuel standards (see 3.2.3 above), it is not expected that changes to Australian fuel standards along the lines proposed in this Statement will restrict importers ability to access competitively priced fuel.

In relation to diesel, the Coffey CBA identified that the incremental cost of achieving 10ppm diesel from a base of 50ppm ranged from 0.35 to 0.49c/L, based on a study that considered twelve Asian countries and 145 refineries for the Asian Development Bank. This is consistent with a European Commission study that identified production costs of 0.5 to 1.6c/L for diesel. The same study identified the cost of going to 500ppm petrol from a base of 150ppm as being in the range of 0.2 to 0.5c/L. These figures are also comparable with Coffey's findings for Australian refinery costs of 1.0c/L and 0.7c/L, for PULP and diesel, respectively (see Table 12 above). For non-Australian Asian region refineries, given the potential for greater efficiency from larger and more modern refining facilities, costs should be no greater than those identified for Australian refineries.

These costs appear small and are likely to be lost in normal price fluctuations due to currency movements and other geopolitical factors, including Middle East instability and growing demand from China for petroleum products. Any price increase will increase transport expenses of businesses that may have a flow on effect to the prices of other goods and also disproportionately affect regional Australia who are required to travel longer distances, but these impacts are not expected to be significant.

Independent fuel importers and the major Australian producers (who are also importers) have stated that 50ppm sulfur PULP and 10ppm sulfur diesel will be available in the region in the proposed timeframe.

6.9.3. Issues surrounding the use of urea solution in heavy vehicles

Truck manufacturers have a number of options for meeting emission reduction standards of heavy vehicle standards, with USA based manufacturers continuing to use engine-based approaches while Europe has more recently focused on post-combustion tail pipe technologies. Over time, market forces are likely to influence manufacturers' choice of technologies as the relative performance of these varying technologies in the field becomes clearer.

Unlike traditional catalyst technologies made up of self contained metal and ceramic units placed in the exhaust stream, most European manufacturers have indicated that they will choose to meet *Euro 5* using technology that involves Selective Catalytic Reduction (SCR), which requires an on-board supply of a reagent (urea solution) to enable the catalytic process to occur. The solution is fed into the exhaust stream immediately post-combustion and prior to entering the catalyst. This process involves a separate system for storing and distributing urea solution to the exhaust stream, which would require truck operators to separately fill urea solution tanks on top of their normal fuelling requirements (see Appendix E for a description of the chemistry aspects of this process). SCR has the ability to significantly reduce the formation of NOx while maintaining good fuel economy. These benefits have prompted European manufacturers, and some Japanese, to bring forward the adoption of urea based SCR technology to meet *Euro 4* emission standards. Some US manufacturers also expressed interest in the SCR approach, but the US EPA has indicated its unwillingness to accept SCR technology until the industry is able to put forward a proposal to the EPA that adequately demonstrates that SCR equipped vehicles will continue to comply with the standards in-service (as discussed below).

The TIC and ATA have raised concerns about the uncertainties surrounding the adoption of urea based SCR technologies. If the urea solution is not present in the exhaust system, then NOx emissions from these vehicles will be much higher than the limit specified in the standard. .

The EC Commission has recently released draft provisions for inclusion in the *Euro 4* and *Euro 5* standards specifically aimed at addressing concerns about urea based SCR systems, including the use of on board diagnostic (OBD) technology and standards, and the use of equipment to assess vehicles against the in-service conformity requirements that manufacturers have to satisfy. Manufacturers are investigating technology options that would limit the performance of a truck using SCR technology if an aqueous urea solution is not present.

As indicated above, many heavy truck manufacturers are moving to urea based systems for *Euro 4* compliance (rather than wait until *Euro 5*), including for the fuel consumption benefits offered by the urea based technologies. If this occurs, many of the costs (and benefits) being attributed to *Euro 5* will instead apply to *Euro 4*. Individual manufacturers will make these decisions on a commercial basis, and it is difficult to accurately estimate the appropriate attribution to these separate *Euro* implementations at this time.

The Australian Government's decision in August 2004 to delay the application of *Euro 4* standards under ADR80/01 by 12 months (to 2007/8) was in response to industry's request to provide more time for industry to adopt to the challenges presented SCR technology and for regulators to develop appropriate strategies to deal with in-service compliance. It is LTEC's view that this delay should provide sufficient time to resolve the issues surrounding SCR and urea use. TIC advice is that SCR technology for *Euro 5* essentially involves the same hardware as supplied for *Euro 4*, with the lower NOx limits in *Euro 5* being met principally by an increase in the dosage rate of the reagent (urea).

In consideration of the above, LTEC considers that there would be little benefit in delaying a decision on adoption of *Euro 5*, particularly given the long lead times that both fuel and vehicle suppliers prefer to have in order to plan investments.

6.10. Implications Of Not Strengthening Standards (Option 1)

The 'do nothing' approach is inconsistent with the Government's policy to harmonise with international standards and could have significant negative ramifications for Australian industry. The Australian Productivity Commission's 2002 *Review of Automotive Assistance* noted "… lower [laxer] fuel standards might well be a further constraint on the industry's uptake and development of engine technologies necessary to remain competitive in global markets".

Not maintaining international parity is also likely to be increasingly unpopular amongst motorists, as motor vehicles available for sale fall further behind the latest available international technology.

Option 1 attracted very little support from stakeholders in the public consultation process.

7. STAKEHOLDER VIEWS

The key mechanisms used by the LTEC Review to consult with stakeholders were:

- a public discussion paper;
- a public seminar; and
- the public release of a draft RIS.

In May 2003 MVEC published a Discussion Paper on the its internet site (http://www.ephc.gov.au/ltec/), which was emailed directly to key stakeholders. Stakeholders were invited to provide written responses to the paper that included a series of questions on the key issues of interest to the review, including on the Options described earlier. To assist stakeholders prepare their responses and to facilitate information exchange, MVEC also hosted an all day Seminar in Melbourne that drew around 90 participants from all sectors. Key stakeholders were also given the opportunity to make formal presentations to the Seminar. Over 30 submissions were received in response to the Discussion Paper. These included submissions from the vehicle and petroleum industries, automobile associations, Government agencies, research bodies, and individuals. Copies of the submissions are on the LTEC internet site at: http://www.ephc.gov.au/ltec/. A summary of these submissions is at Appendix F.

LTEC published this RIS in draft form in December 2003. Direct consultations were also held with key industry stakeholders in February 2004. Submissions were received from 29 stakeholders in response to the Draft RIS. Copies of these submissions have also been published on the LTEC internet site and a summary of these submissions is at Appendix G. The final RIS for Post-2006 Fuel Standards is also available on the LTEC internet site. LTEC released a Status Report in September 2004, and the FCAI and TIC provided further submissions in response to this Report. The Status Report is also available on the LTEC internet site.

Brief summaries of stakeholder views on each of the key proposals follow.

7.1. *Euro 4* Light Vehicles

There was broad support for the adoption of the *Euro 4* emissions standards for light vehicles, including from the Australian Automobile Association (the peak vehicle and fuel consumer body) and the Federal Chamber of Automotive Industries (FCAI), which represents both local manufacturers and importers of new vehicles. In relation to the timing for the introduction of the standards, the MVEC Discussion Paper had proposed 2008/9, while the FCAI favoured 2009/11 to assist some local manufacturers in complying with *Euro 4* , including enabling them take full opportunity of the Commonwealth's new Automotive Competitiveness and Investment Scheme Research and Development program.

7.2. 50ppm Sulfur 95RON & 98RON Petrol

In relation to complementary petrol standards, there was broad agreement that a 50ppm sulfur limit for petrol is necessary to support the range of technologies likely to be used by vehicle manufacturers in meeting *Euro 4,* and that 95RON petrol will the preferred grade for manufacturers of *Euro 4* compliant vehicles. The Australian Institute of Petroleum (AIP) acknowledged this linkage, and stated that it could supply this grade of fuel in 2008.

A number of fuel producers emphasised the importance of the Government's provision of early production and import incentives, as a factor in their acceptance of the timing being proposed (in relation to both 50ppm PULP and 10ppm diesel).

The AIP is concerned that a 50ppm sulfur PULP standard will require a relaxation in the olefins parameter in the fuel standards to overcome issues associated with maintaining a high octane number. DEH has agreed to address this issue through a separate process in the lead up to the proposed sulfur standard being mandated.

7.3. 10ppm Sulfur 95RON & 98RON Petrol

There was also broad support for the introduction of 10ppm sulfur limits in 95RON and 98RON petrol grades, however the AIP and the Independent Petroleum Group (representing importers) expressed concerns about the cost and availability of 10ppm sulfur petrol, particularly if a standard was imposed before 2010.

7.4. *Euro 5* Heavy Vehicles

While there was broad support for the adoption of the *Euro 5* heavy vehicle emissions standards, there were concerns expressed by representatives of heavy vehicle engine manufacturers and operators.

In response to the draft RIS, the principal industry group affected by the *Euro 5* proposal (the truck engine manufacturers - represented by the TIC) did not oppose the ultimate adoption of the *Euro 5* standards (and equivalents), but argued that it would be premature to make a decision on the timing of such a standard now. The TIC argued that the focus should be on sorting out the impending issues associated with *Euro 4* compliance under ADR80/01. TIC argued that any new standard should, at the earliest, not take effect until 2010. In light of this comment, LTEC agreed to relax the 2009/11 timing proposed in the draft RIS to 2010/11. A later (September 2004) submission from the TIC in response to the LTEC Status Report, stated that the TIC agreed with the revised LTEC timeframe for *Euro 5* of 2010/11, but argued that the ADR should not be gazetted before January 2007, to ensure that all the OBD and associated requirements have been finalised. These issues are discussed in more detail in section 8.3.

The Australian Trucking Association (ATA), representing truck operators, is opposed to the adoption of *Euro 5* on a range of grounds, and believes that much more economic analysis is needed before it could be supported. The ATA questioned the basic approach taken by the review, considered that the appropriate balance between environmental, social and economic objectives had not been met, and proposed that the process be recommenced using an alternative set of evaluation criteria (which was defined in general terms only).

Both the TIC and ATA also argue that little or nothing has been done to deal with emissions from non-road diesel engines, and this should be a higher priority for governments. They also argue that the combined effects of new noise standards (ADR83/00), *Euro 4* emission standards, and potential changes to truck standards for safety reasons (underrun, cabin strength etc) may impact on the efficiency of the industry and its capacity to meet a growing freight task (at least while current mass and dimension controls remain).

7.5. 10ppm Sulfur Diesel

In relation to diesel fuel standards, there was broad support for the adoption of 10ppm sulfur limits in diesel as necessary standard to support *Euro 5* vehicles. Some respondents considered there was merit in adopting a 10ppm sulfur limit in diesel on PM reduction grounds, even if *Euro 5* was not adopted.

7.6. Recognition of Alternative Standards

The truck and bus industry argued for the continued acceptance of the latest US standards (US 2007) as an alternative to *Euro 5,* and also argued that the latest Japanese standards (Japan JE05 Long Term) were equivalent in stringency to *Euro 5* and US2007.

In relation to the US2007 standards, the TIC noted that the complex banking and trading arrangements which apply in the US mean that not all engines in the 2007-2010 period will comply with the very stringent US2007 limits (which are much lower that the equivalent *Euro 5* limits). All engines in the US are required to be compliant by 2010, and the US Engine Manufacturers Association (EMA) considers that it will take until 2010 to meet the very stringent NOx limits. To address this, the TIC suggests that Australia should adopt the US2007 standards, but apply the *Euro 5* emission limits. The US EMA suggests that we simply refer to “engines covered by an EPA certificate”.

8. PROPOSED STANDARDS AND TIMING

LTEC's proposal for new vehicle emissions and fuel quality standards, and the associated timings for their introduction are described below. In making these recommendations, the key sources of information considered by LTEC were:

- the information and options outlined in the MVEC Discussion Paper issued in May 2003;
- the stakeholder views expressed in response to the above discussion paper, at the June 2003 Seminar, and in response to the Draft RIS; and
- the CBA commissioned by the Department of the Environment and Heritage.

8.1. Light Vehicles and 50ppm Sulfur Petrol

Proposal

LTEC recommends the adoption of the *Euro 4* emissions standards for light vehicles from 2008/10, and that 50ppm sulfur limits in 95RON & 98RON petrol be mandated from 1 January 2008 to support the *Euro 4* standards.

Rationale

In making this proposal, LTEC notes the broad support for adoption of *Euro 4* light vehicle standards, and for the mandating of 50ppm sulfur 95 & 98RON petrol to support those standards. LTEC also notes the FCAI's request for a deferral the introduction of the standards until 2009/11.

LTEC also notes that the petrol engined passenger vehicle sector is the major contributor to ozone pollution from the transport sector, and thus improved emissions performance has the capacity to contribute most to improvements in ozone levels in urban areas. There are already *Euro 4* compliant light vehicles available in the European automobile market and these standards will be mandated in Europe from 2005. Some large volume imported vehicle models compliant with *Euro 4* are already being supplied to the Australian market and are cost competitive, even though the current minimum standard in Australia is only *Euro 2.* LTEC notes that the FCAI request for a 1/1/09 – 1/1/11 timeframe for *Euro 4* is based on the preferred timeframe for the local manufacturing industry, and one manufacturer in particular, and is aimed at maximising their capacity to juggle new model releases with the combined challenges of meeting *Euro 4* and stricter fuel consumption targets to apply from 2010.

In relation to fuel standards, LTEC concludes that there is strong evidence to indicate that 50ppm sulfur petrol is necessary to support the range of technologies likely to be used by vehicle manufacturers in meeting *Euro 4* and to ensure the *Euro 4* emission standards are delivered in-service over the effective life of the vehicle. LTEC also notes that 50ppm sulfur petrol will be mandated in 2005 in Europe in conjunction with the *Euro 4* vehicle emissions standards.

LTEC considers that in complying with *Euro 4* (and concurrently meeting tighter fuel consumption targets) manufacturers are likely to adopt 95RON petrol as the preferred fuel, so logically the 50ppm sulfur limit should only apply to this grade of petrol, and 91RON petrol should remain at the *Euro 3* 150ppm limit (which applies from 1 January 2005). This approach has been supported by the AIP.

While the CBA concluded that in isolation, there would be net costs associated with *Euro 4* and 50ppm sulfur petrol, LTEC notes that the CBA did not factor in a number of elements likely to significantly reduce the compliance costs over the assessed period. In particular, the assumption in the CBA that technology costs for emissions control technology do not diminish over time is likely to lead to an overestimate of costs, particularly towards the latter half of the assessment period. Additional analysis undertaken on the CBA data confirmed that costs are significantly reduced when these factors are taken into account, and may shift to a net positive position depending on the assumptions. As noted above, the existence of *Euro 4* vehicles on the Australian market today, also points to the minimal impact of *Euro 4* compliance on cost competitiveness. In any event, while there is consensus about the merits of moving towards 10ppm sulfur petrol, it is clear that the Australian fuel industry (producers and importers) strongly prefers a stepped approach.

LTEC recognises AIP’s concerns regarding a relaxation of the olefins standard, but considers that this can be addressed through the normal review processes under the *Fuel Quality Standards Act 2000* in the lead up to the implementation of the sulfur standard.

In considering:

- the findings of the CBA and supplementary analysis;
- the current representation of *Euro 4* vehicles in the Australian market;
- the decision to mandate 50ppm sulfur limits in 95RON and 98RON petrol from 1 January 2008; and
- the request from the FCAI to delay the start and end dates proposed by LTEC for *Euro 4* by 12 months;

LTEC concludes that a 1 July 2008 start date and 1 July 2010 end date for the adoption of *Euro 4* emission standards for light vehicles represents an appropriate balance between the environmental objectives and the longer lead time proposed by the FCAI. Available information suggests this timeframe should be achievable for all manufacturers, and the 6 month delay will not have a significant impact on the overall benefits of the new standard, but will assist in minimising compliance costs for manufacturers.

8.2. 10ppm Sulfur 95RON & 98RON Petrol

Proposal

LTEC recommends the introduction of a 10ppm sulfur limit in 95RON and 98RON petrol, with an indicative introduction date of 1 January 2010, but with a deferral of a final decision on the timing pending an LTEC review of likely demand and availability of this fuel in 2010. The review would involve all stakeholders and be completed by end 2005.

Rationale

LTEC notes that the evidence does not suggest that 10ppm sulfur limits in petrol are necessary for achieving compliance with the Euro 4 light vehicle emissions standards. LTEC nevertheless considers that there is a strong case on greenhouse gas reduction grounds and on a monetary cost benefits basis, to move to 10ppm sulfur limits in 95RON and 98RON petrol in 2010. Work undertaken by the European Commission has indicated that a move to 10ppm sulfur limits in petrol is cost effective (principally on the basis of greenhouse and fuel consumption benefits) and will be critical in facilitating the adoption of technology designed to deliver significant improvements in fuel consumption. This is now reflected in petrol sulfur limits of 10-15ppm in Europe, US and Japan by the end of the decade.

In Australia the vehicle industry has committed to deliver a significant reduction in the National Average Fuel Consumption (NAFC) of new vehicles by 2010, and the FCAI has indicated that availability of 10ppm sulfur petrol is a key factor in achieving that target. LTEC also notes that the CBA indicates that net greenhouse benefits and monetary benefits arising from fuel consumption savings are substantially improved if the 2010 NAFC target is met. The crucial role that the achievement of the NAFC target plays in the case for 10ppm petrol is illustrated clearly in a comparison of Option 3 and Option 4 (where the only difference is the adoption of 10ppm sulfur petrol in Option 4). Table 13 indicates that in absence of the NAFC, Option 3 provides greater net benefits than Option 4. This situation is reversed when the NAFC is included.

From the vehicle industry perspective, there is clearly a strong interdependence between and availability of 10ppm and the achievement of the NAFC target. Equally, the CBA indicates that the case for moving to 10ppm sulfur petrol is heavily reliant on the NAFC policy remaining in place and being achieved..

LTEC also notes the strong concern raised by fuel suppliers regarding supply and cost issues associated with a move to 10ppm sulfur petrol.

On balance, LTEC considers that there is merit in seeking more information on the issues around 10ppm sulfur petrol and recommends that a decision on the implementation timing for this standard be deferred until the completion of a more detailed review.

8.3. Heavy Vehicles and 10ppm Sulfur Diesel

Proposal

LTEC:

- recommends the adoption of the *Euro 5* emissions standards for heavy vehicles from 2010/11, and that 10ppm sulfur limits in diesel be mandated from 1 January 2009 to support the *Euro 5* standards:
- recommends a delay the introduction of *Euro 4* emissions standards for heavy vehicles under ADR80/01 until 2007/8, consistent with the announcement of 12 August 2004 by the Minister for Transport and Regional Services;
- recommends that the durability, OBD and other components of *Euro 4* and *Euro 5* for heavy vehicles currently being finalised by the European Commission be incorporated into the relevant ADRs when they become available; and
- recommends that the start date for the heavy vehicle component of ADR83/00 (vehicle noise) be amended to align with the revised start date for ADR80/01.

Rationale

In making these proposals, LTEC notes that the heavy vehicle diesel fleet is a significant source of NOx emissions, and the major transport source of PM emissions. Adoption of the *Euro 5* standards will lead to significant reductions in NOx emissions from heavy vehicles, but will not directly reduce PM emissions. LTEC notes the significant concerns raised by the truck and bus industries regarding costs and uncertainty over the urea issue, but does not support these industries' request for a deferral of a decision on these grounds, as it considered that it was important for both the vehicle and fuels industry to know the "goalposts" as early as possible.

The TIC and Paccar submissions clearly reflect the current uncertainty in the heavy duty truck/engine industry over the urea/SCR/*Euro 4* compliance issue, and its preference would be that the focus stay on *Euro 4* compliance at this stage, and not be contemplating *Euro 5*. LTEC notes that the Australian Government has moved to address those concerns by agreeing to delay the implementation of *Euro 4* standards by 12 months until 2007/8. LTEC supports this decision as it provides time for both industry and regulators to address these issues. While no detailed analysis of the impact of the Government's decision has been undertaken, LTEC's view is that in the medium-long term a 12 month delay will have little impact on overall air quality benefits. The delay will defer compliance costs for industry, but more importantly provide the capacity to develop measures to provide greater assurance that the *Euro 4* standards will be delivered in practice.

LTEC has also received a recent (August 2004) submission from the TIC seeking a commensurate delay in the application of the new noise standards for heavy vehicles under ADR83/00 *External Noise* (ADR83/00 was deliberately timed to coincide with the introduction of *Euro 4* under ADR80/01). The TIC argues that the design of emission control systems in both SCR and EGR engines is integrated with the noise muffler systems, and thus additional, and ultimately redundant, noise control measures would have to be undertaken if the start dates for these two ADRs were not realigned. LTEC notes that the 2003 RIS prepared for the introduction of ADR83/00 argued for the alignment of the new noise standards and the *Euro 4* emission standards, in order to optimise engine and vehicle design, and minimise costs. On this basis, LTEC supports the continued alignment of the timing of the heavy vehicle components of ADR83/00 and ADR80/01, as it will significantly reduce design costs for truck manufacturers, with little long term impact on vehicle noise from the truck fleet.

While LTEC agrees that there is merit in the TIC proposal that *Euro 5* not be implemented before 2010, LTEC is not convinced that there is any benefit in delaying the <u>decision</u> on the implementation date until 2007. Recent advice from the European Commission indicates that *Euro 5* implementation dates will not change. The EC has also advised that it expects on-board diagnostic (OBD), durability and related requirements for *Euro 4* and *Euro 5* to be in place by early 2005 (neither the *Euro 4* or *Euro 5* emission standards currently have any OBD requirements).

There are undoubtedly significant issues for jurisdictions to consider regarding assurance of in-service compliance with trucks and buses using urea based SCR systems. It is anticipated that these technical issues will be resolved given the work underway in Europe and the US, and in any event these are problems which will have to be faced for *Euro 4* [or before, as it is possible that these vehicles will become available and may be imported earlier], and thus these issues would not be exacerbated by the introduction of *Euro 5*.

Nevertheless, the truck industry considers that it is premature to adopt *Euro 5* while key aspects such as OBD have not been finalised. This could be addressed by adopting *Euro 5* in the ADRs as it currently stands (i.e. minus any OBD requirements), and requesting the Australian Transport Council to make an in-principle commitment to updating the ADR as related matters are resolved at the international level. This is consistent with the current European situation, whereby the *Euro 5* emission limits and test procedures are legislated and in place, while the OBD requirements are yet to be finalised and approved.

LTEC also notes the concerns raised by the ATA and TIC regarding the intersection of emission requirements with new safety requirements, dimensions and the freight task. However, as for the urea issue, there is no evidence that these challenges will be exacerbated by *Euro 5*, as the technical and design issues will need to be addressed in achieving compliance with ADR80/01 (*Euro 4*) and ADR83/00 (vehicle noise). As stated earlier, the 12 month delay in the application of these standards will facilitate the resolution of these issues.

The ATA submission presents a more fundamental set of objections to the *Euro 5* proposal, and questions the validity of the review process. In essence, ATA is arguing that LTEC should take no action on *Euro 5* until standards for non-road engines were introduced, until it could be demonstrated that the emission reduction expected from *Euro 5* was proportional to the heavy duty vehicle sector's contribution to air pollution, and until it could be conclusively demonstrated that *Euro 5* represented least cost emissions abatement. LTEC does not have the capacity to comprehensively analyse the costs and benefits of all emission abatement opportunities across the economy, which the ATA approach would entail. In addition, the capacity to impose least cost emissions abatement on other sectors is limited by legislation.

LTEC considers that the alternative ATA approach would be costly, complex and unwieldy, and fails to recognise that adoption of internationally recognised emission standards has been demonstrated to be the most efficient and effective means of reducing the impact of vehicle emissions on the environment.

LTEC also considers that this RIS, and the associated independent CBA, constitute a comprehensive and detailed analysis of the costs and benefits of the proposed standards, while acknowledging that such analyses are limited by the available data, and that there are often differing views about cost estimates. The Review process has also involved extensive consultation with regulators, key industry stakeholders and the wider community over a 2 year period. LTEC also notes that in light of industry concerns about a lack of standards for off-road engines, the Chair of LTEC has written to the Chair of the Environment Protection and Heritage Council's Air Quality Working Group, advising of these concerns and seeking their examination of the issue (the issue is outside the scope of LTEC's terms of reference).

LTEC does not consider it appropriate for Governments to make any undertakings in relation to urea supply or distribution, which is essentially a matter for the private sector. However, given the likely significant use of urea based technologies, Governments will need to consider how to ensure in-service compliance with the standards. To this end, LTEC has commenced a consultation process with key stakeholders to develop a national action plan for SCR and urea infrastructure. LTEC also notes that the European Commission is soon to finalise the final components of the *Euro 4* and *Euro 5* standards to incorporate requirements for OBD, which will assist in-service compliance measures for vehicles utilising SCR technology.

In relation to diesel fuel standards, LTEC notes the work undertaken in Europe and the US, which concludes that 10ppm sulfur diesel (15ppm in the US) is necessary to enable the adoption of technologies required to comply with *Euro 5.* LTEC notes that such technologies also enable heavy vehicles to deliver fuel consumption improvements while still achieving compliance with the tighter emissions standards. As with petrol, sulfur limits of 10-15ppm will be adopted in diesel fuel standards in the EU, US, and Japan by the end of the decade.

The CBA concluded that the combination of *Euro 5* and 10ppm sulfur diesel would deliver significant fuel consumption reductions from heavy vehicles, resulting in savings in operating costs for operators, and reductions in greenhouse gas emissions. The CBA also noted that the introduction of 10ppm sulfur diesel would deliver an immediate 5% reduction in PM emissions from the pre-*Euro 4* diesel fleet. The availability of such fuel would also facilitate early introduction of *Euro 5* and equivalent vehicle technology. For these reasons and in anticipation that the proposed implementation date for *Euro 5* will be 2010 at the latest, LTEC recommends an implementation timing of 1 January 2009 for 10ppm sulfur diesel.

In considering:

- the findings of the CBA and supplementary analysis;
- the broad support for the adoption of *Euro 5* for heavy duty vehicles, including from the key engine manufacturing body (Truck Industry Council);
- the decision to delay the application of the *Euro 4* standards, and subsequent actions in train to address SCR and urea issues; and
- the decision to mandate 10ppm sulfur limits in diesel from 1 January 2008;

LTEC concludes, while acknowledging the ATA proposals, that it would be appropriate to apply the *Euro 5* emission standards for heavy vehicles from 1 January 2010 (with a 1 year phase in).

8.4. Recognition of Alternative Standards

Proposal

LTEC recommends the acceptance of the US EPA 2007 and Japan JE05 Long Term emissions standards as alternative standards to *Euro 5*.

Rationale

LTEC notes that all diesel engines and vehicles are imported into Australia, and the majority of these are from Japan, with the balance from US and European suppliers. LTEC also supports the Australian Government's policy to harmonise its emissions and other vehicle standards with the UN ECE Regulations, wherever possible. Nevertheless, there is a growing convergence of the UN ECE, US and Japanese standards in terms of their stringency, and on technical grounds LTEC considers the US 2007 standards and the Japanese 05 Long Term standards offer an equivalent level of performance to the *Euro 5* standards.

In relation to the US2007 standards, Australia is not able to adopt the US banking and trading approach. LTEC is also reluctant to adopt "hybrid" standards as proposed by the TIC (Euro emission limits on a US test). Nevertheless, it would be unreasonable and impractical for Australia to impose the full US2007 requirements ahead of their full implementation in the US. LTEC considers the preferable option is to adopt an approach along the lines suggested by the US EMA, which is based on the engine concerned being covered by a US EPA certificate of compliance (a similar approach was taken in ADR80/00 to deal with the complexities of the "consent decree" agreement in the US). Assuming a 1/1/10 start date for ADR80/02 (*Euro 5),* and to enable early compliance with ADR80/02, this would mean the ADR would accept an engine covered by a certificate of conformity for any of the model years 2007, 2008, 2009, 2010 or 2011 up until 1/1/12, after which it would formally apply the full US2007 standards (this also approximately mirrors the lag for *Euro 5* under a 1/1/10 start date).

LTEC also notes that there is work well under way under the auspices of the UN ECE to develop an internationally harmonised emissions test cycle for heavy vehicles, so accommodating the complexities of alternative standards may not an issue in the longer term. In the interim, LTEC considers that requiring engines sourced from Japan and the US to be re-certified to the UN ECE requirements, when they offer equivalent levels of environmental performance, would impose unnecessary costs and deliver no net environmental benefit.

Vehicles complying with the US 2007 standards will also deliver significant reductions in PM emissions (unlike the *Euro 5* vehicles that only have to meet a lower NOx emissions limit).

8.5. Summary of Proposed Standards

8.5.1. New Standards

In summary, LTEC recommends the following new standards for the post-2006 period:

- *Euro 4* emissions standards for light petrol, LPG and NG vehicles from 1 July 2008 for new models and 1 July 2010 for all models;
- 50ppm sulfur fuel standards for 95RON & 98RON petrol from 1 January 2008;
- 10ppm sulfur fuel standards for 95RON & 98RON petrol with an indicative introduction date of 2010, but a final decision on the timing deferred, pending a review by LTEC to be completed by December 2005;
- *Euro 5* emissions standards for heavy diesel, LPG and NG vehicles and US EPA 2008 for petrol engines from 1 January 2010 for new models and 1 January 2011 for all models ,with US 2007 (implemented in accordance with section 8.4) and Japan JE05 LT being accepted as alternatives for diesel, LPG and NG vehicles ,; and
- 10ppm sulfur fuel standards for diesel from 1 January 2009.

Due to the importance of the linkages between the vehicle standards and the associated fuel standards, and the necessity for engine technologies to enable a vehicle to concurrently meet tighter emissions standards and improve fuel consumption, the proposals can be considered as two distinct packages:

Light Vehicles Package

- ➢ *Euro 4* emissions standards for light vehicles in July 2008/2010 supported by 50ppm sulfur 95 & 98RON petrol standards in January 2008; and
- ➢ A 10ppm sulfur petrol (95 & 98RON) standard with an indicative introduction date of 2010, but a final decision on timing deferred pending a review by LTEC to be completed by December 2005.

Heavy Vehicles Package

- ➢ *Euro 5** emissions standards for heavy vehicles in January 2010/11 supported by 10ppm sulfur diesel standards in January 2009.

* with US EPA 2007 and Japan 05 Long Term emission standards accepted as alternatives, and US 2008 applying to heavy duty petrol engines.

8.5.2. Amendments to Existing Standards

LTEC also recommends the following complementary changes to existing and new ADRs:

- *ADR80/01* – amend Clause 2 Applicability and Implementation to set an implementation date for diesel, LPG and NG vehicles to 1 January 2007 for new models and 1 January 2008 for all models (using format adopted in current text in ADR80/00);

- *ADR80/01* and *ADR80/02* – incorporate durability, OBD and related requirements for *Euro 4* and *Euro 5* when finalised by the European Commission;

- *ADR80/02* – incorporate any further changes to US 2007 and Japanese LT 05 standards when finalised by US and Japanese authorities (subject to satisfactory assessment by LTEC); and

- *ADR83/00* - amend Clause 2 Applicability and Implementation to set an implementation date for diesel, LPG and NG vehicles with a GVM greater than 3.5 tonnes to 1 January 2007 for new models and 1 January 2008 for all models.

9. IMPLEMENTATION AND REVIEW

The ADRs are national standards under the *Motor Vehicle Standards Act 1989* and are subject to regular review in light of international developments.

A Memorandum of Understanding (MOU) between the National Transport Commission (NTC) and the National Environment Protection Council (NEPC) sets out the consultative arrangements governing the development of ADRs for vehicle emissions and noise. LTEC is responsible for managing the work program developed under the MOU, and the review of emissions standards is the highest priority item on the current work plan.

Under the legislation establishing the NEPC, any new emissions ADRs are to be jointly developed and agreed by the NTC and NEPC, with formal endorsement being the responsibility of the Ministers of the Australian Transport Council (ATC).

Given that certain provisions relating to OBD and other matters relevant to the *Euro 4* and *Euro 5* emission standards for heavy duty vehicles are not yet finalised by the European Commission, it is proposed that the LTEC emissions package be presented to ATC and NEPC Ministers in two steps as follows:

Step 1

Step 1 would be presented to Ministers by end 2004, and would seek Ministers' agreement to following new/revised ADRs:

- New ADR79/02 adopting current Euro 4 emission standards for light duty petrol, LPG and NG vehicles;
- New ADR80/02 adopting current Euro 5 emission standards for heavy duty diesel, LPG and NG vehicles and US EPA 2008 emission standards for heavy duty petrol vehicles (with acceptance of US2007 standards [in the manner proposed above] and Japanese 05 LT term standards as alternatives for diesel, LPG and NG vehicles);
- Revised ADR80/01 for diesel, LPG and NG vehicles to reflect 12 month delay in start and end dates; and
- Revised ADR83/00 for diesel, LPG and NG vehicles with a GVM greater than 3.5 tonnes to reflect 12 month delay in start and end dates

Step 1 would also seek Ministers' in-principle commitment to:

- update ADR80/01 and ADR80/02 when OBD, durability, useful life and in-service conformity provisions are finalised and published by the European Commission; and
- update ADR80/02 in light to changes to US2007 and Japan LT05 requirements regarding emission limits and comparable requirements on OBD, durability and like issues.

Step 2

Step 2 would be presented to Ministers after OBD, durability, useful life and in-service conformity provisions are finalised and published by the European Commission, and following any comparable changes to US and Japanese standards. Step 2 would seek Ministers' agreement to revise ADR80/01 and ADR80/02 to adopt these provisions.

Any new ADRs endorsed by the ATC will, subject to consideration by the Australian Minister for Transport and Regional Services, be given force in law in Australia by making them National Standards (ADRs) under section 7 of the *Motor Vehicle Standards Act 1989*. . Drafts of the new ADRs and the amendments for the revised ADRs identified in Step 1 above are at Appendix H. These ADRs would be implemented under the type approval arrangements for new vehicles administered by DOTARS. Under these arrangements, manufacturers are required to ensure that vehicles supplied to the market comply with the vehicle emissions requirements of the relevant ADRs. Penalties are incurred for non-compliance with the Act.

The recommended standards for the sulfur limits in petrol and diesel would be set by Ministerial determination under the *Fuel Quality Standards Act 2000*. The Minister for the Environment is required to consult with the Fuel Standards Consultative Committee before the making of such a determination. The Committee includes representation from each State and Territory Government, and representatives of the petroleum industry, the vehicle industry, a non-government environment protection body, and consumers.

The Secretary of the Department of the Environment and Heritage (DEH) is required to prepare, and the Minister must table in Parliament, an annual report on the operation of the Act. The report includes advice on compliance with the standards and any prosecutions made under the legislation. There are significant penalties for non-compliance with this Act. The main offences under the Act relate to the supply of non-compliant fuel and the alteration of fuel that is the subject to a fuel standard and carry penalties of 500 penalty units, currently $55,000 for an individual or $275,000 for a corporation. The Clean Fuels and Vehicles Section of the DEH enforce the Act.

The standards proposed in this Statement would be reviewed at a number of levels. DOTARS monitors vehicle technology developments, and works in close association with DEH, which has fuel and air quality programs that closely consider trends in these areas. Individual state jurisdictions, which are responsible for monitoring and managing air quality at the air catchment level have a strong and direct interest in evaluating vehicle and fuel standards and in ensuring that LTEC continues to conduct appropriate reviews of such standards.

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Appendix A Vehicle Emission Standards in Place as of 2004

ADR Categories			Applicability Dates for New ADRs				
			Applicable New ADR [1], [2], [3], [4]	**2002/3 (Diesel Vehicles)** [5] **/00 version of applicable ADR**	**2003/4 (Petrol Vehicles) /00 version of applicable ADR**	**2005/6 (Petrol Vehicles) /01 version of applicable ADR**	**2006/7 (Diesel Vehicles) /01 version of applicable ADR**
Description	**GVM (t)**	**Category**					
Passenger Vehicles							
	≤ 3.5	MA, MB, MC	ADR 79/..	*Euro 2*	*Euro 2* [6]	*Euro 3* [6]	*Euro 4*
	> 3.5	MA, MB, MC	ADR 80/.	*Euro 3 or US MY2000* [6]	*US 96* [7]	*US MY2000* [7]	*Euro 4* or *US 2004* [6]
Buses							
Light	≤ 3.5	MD	ADR 79/.	*Euro 2*	*Euro 2* [6]	*Euro 3* [6]	*Euro 4*
	> 3.5 ≤ 5	MD	ADR 80/.	*Euro 3 or US MY2000* [6]	*US 96* [7]	*US MY2000* [7]	*Euro 4* or *US 2004* [6]
Heavy	> 5	ME	ADR 80/.	*Euro 3 or US MY2000* [6]	*US 96* [7]	*US MY2000* [7]	*Euro 4* or *US 2004* [6]
Goods Vehicles (Trucks)							
Light	≤ 3.5	NA	ADR 79/.	*Euro 2*	*Euro 2* [6]	*Euro 3* [6]	*Euro 4*
Medium	> 3.5 ≤ 12	NB	ADR 80/.	*Euro 3 or US MY2000* [6]	*US 96* [7]	*US MY2000* [7]	*Euro 4 or US 2004* [6]
Heavy	> 12	NC	ADR 80/.	*Euro 3 or US MY2000* [6]	*US 96* [7]	*US MY2000* [7]	*Euro 4* or *US 2004* [6]

Notes (1) – (7) to the Table are on the next page.

Notes to Table

(1) The introduction of *Euro 2* standards for light petrol and light diesel vehicles is via ADR 79/00 *Emission Control for Light Vehicles,* which adopts the technical requirements of UN ECE Regulation 83/04.

(2) The introduction of *Euro 3* standards for light petrol vehicles, and *Euro 4* standards for light diesel vehicles, is via ADR 79/01 *Emission Control for* UN ECE Regulation 83/05. ECE R83/05 embodies the *Euro 3* and *Euro 4* requirements for light duty petrol and diesel vehicles, however the ADR will only mandate the *Euro 3* (pre 2005) provisions of R83/05 for petrol vehicles, but will allow petrol vehicles optional compliance with *Euro 4* standards.

(3) The introduction of *Euro 3* and *Euro 4* standards for medium-heavy diesel vehicles (all buses and trucks above 3.5tonnes GVM) will be via a new ADR 80/00 *Emission Control for Heavy Vehicles,* and ADR 80/01 *Emission Control for Heavy Vehicles,* respectively. These ADRs adopt the technical requirements of the European Council Directive 99/96/EC amending European Council Directive 88/77/EEC.

(4) These new ADRs (ADRs79/00, 79/01, 80/00, 80/01) will replace the existing ADR37/01 and ADR70/00. The "/00" & "/01" versions represent the 2002-4 and 2005-7 groupings of the new requirements, respectively.

(5) A new smoke ADR (ADR30/01) will also apply to all categories of diesel vehicles. The smoke standard will apply from 2002/3 and will adopt UN ECE R24/03 and allow the US 94 smoke standards as an alternative. This new ADR will replace ADR30/00.

(6) Nominated standards also apply to vehicles fuelled with LPG or NG.

(7) UN ECE & EU do not have standards for medium-heavy petrol engines, hence US EPA is adopted in lieu.

Appendix B Current Standards for Petrol & Diesel in Australia

Petrol Standards

Parameter	Standard	Grade	Date of effect
Sulfur	500ppm (max) 150ppm (max) 150ppm (max) 50ppm (max)	ULP/LRP PULP All grades PULP	1 Jan 2002 1 Jan 2005 1 Jan 2008
Research octane number (RON)	91.0RON (min) 95.0RON (min) 96.0RON (min)	ULP PULP LRP	1 Jan 2002
Distillation	FBP 210°C (max)	All grades	1 Jan 2005
Olefins	18% pool average over 6 months with a cap of 20% 18% max by vol	All grades	1 Jan 2004 1 Jan 2005
Aromatics	45% pool average over 6 months with a cap of 48% 42% pool average over 6 months with a cap of 45%	All grades	1 Jan 2002 1 Jan 2005
Benzene	1% max by vol	All grades	1 Jan 2006
Lead	0.005g/L (max)	All grades	1 Jan 2002
Oxygen content	2.7% m/m (max) 3.5% m/m (max)	All grades (no ethanol) All grades (with ethanol)	1 Jan 2002 1 Jan 2003
Phosphorus	0.0013g/L (max)	ULP, PULP	1 Jan 2002
MTBE (Methyl tertiary-butyl ether)	1% by volume (max)	All grades	1 Jan 2004
Ethanol	10% by volume (max)	All grades	1 July 2003
DIPE (Di-isoproprypyl ether)	1% by volume (max)	All grades	1 Jan 2002
TBA (Tertiary butyl alcohol)	0.5% by volume (max)	All grades	1 Jan 2002
MON	85.0 (min) 81.0 (min) 82.0 (min)	PULP ULP LRP	16 Oct 2002 16 Oct 2002 16 Oct 2002
Copper Corrosion (3 hrs @ 50^0C)	Class 1 (max)	All	16 Oct 2002
Existent Gum (washed)	50 mg/L (max)	All	16 Oct 2002
Induction Period	360 minutes (min)	All	16 Oct 2002

Diesel Standards

Parameter	Standard	Date of effect
Sulfur	500ppm (max) 50ppm (max) 10ppm (max)	31 Dec 2002 1 Jan 2006 1 Jan 2009
Cetane Index	46 (min) index	1 Jan 2002
Density	820 to 860 kg/m^3 820 to 850 kg/m^3	1 Jan 2002 1 Jan 2006
Distillation T95	370°C (max) 360°C (max)	1 Jan 2002 1 Jan 2006
Polyaromatic hydrocarbons (PAHs)	11% m/m (max)	1 Jan 2006:
Ash and suspended solids	100ppm (max)	1 Jan 2002
Viscosity	2.0 to 4.5 cSt @ 40°C	1 Jan 2002
Carbon Residue (10% distillation residue)	0.2 mass % max	16 Oct 2002
Water and sediment	0.05 vol % max	16 Oct 2002
Conductivity @ambient temp	50 pS/m (Min) @ambient temp (only applies at terminals, refineries, major distribution centres)	16 Oct 2002
Oxidation Stability	25 mg/L max	16 Oct 2002
Colour	2 max	16 Oct 2002
Copper Corrosion (3 hrs @50^0C)	Class 1 max	16 Oct 2002
Flash point	61.5^0C min	16 Oct 2002
Filter blocking tendency	2.0 max	16 Oct 2002
Lubricity	0.460 mm (max) (only for diesel containing less than 500ppm sulfur)	16 Oct 2002

Appendix C Ozone Modelling Results – Future Sydney Air Quality

1. Introduction

The purpose of this document is to provide information on forecast air quality in Sydney to assist the MVEC in its review of motor vehicle emissions and fuel standards. The paper provides results from recent modelling undertaken by NSW EPA to assess the impacts on ozone concentrations in Sydney of implementation of firstly the current mandated standards and secondly the standards being considered for the review, *Euro 4* and *Euro 5*.

2. Air Quality in Sydney - A Snapshot

The MVEC Vehicle Emissions and Fuel Standards Review Discussion Paper identifies that the Ambient Air Quality NEPM criteria pollutants relevant to the review are carbon monoxide, nitrogen dioxide and ozone as the vehicle standards being considered do not change the particle standards for any vehicle. In NSW carbon monoxide levels are below the NEPM standard which has not been exceeded in Sydney since 1998. Likewise for nitrogen dioxide, there have been no exceedences of the NEPM standard in the last four years, although the long term maintenance of this trend will depend on control of total oxides of nitrogen. The forecast emission reductions from the motor vehicle fleet associated with current mandated standards position for the continuation of the trends for these two pollutants.

Ozone levels on the other hand are problematic and, based on current and forecast levels, further tightening of vehicle emission limits and improvements to fuel quality will be needed to reduce the potential for ozone in the Sydney GMR.

3. Ozone in the Sydney GMR

Although there has been no deterioration in ozone over the past decade, even with population and economic growth, trends do not indicate any improvement. The variability in ozone levels from year to year is mainly due to weather conditions – in wet years the ozone days are down because of insufficient hot, calm days required to allow ozone to form.

However, the underlying emission mix in the air shed to form ozone remains high as evidenced in 2000 and 2001, in each year of which a high number of ozone exceedences were recorded. In 2001 there was 19 exceedences of the one hour standard and 21 of the four hour standard. These levels were masked by bushfires which added to the emission load. Nevertheless even without the fires ozone would still have exceeded the national standards. A review to consider a lower one hour NEPM ozone standard is scheduled for commencement in 2003. Should a tighter one-hour standard be adopted - .08ppm is the level to be considered, exceedences would likely increase as ozone levels in the Sydney GMR are between this level and the current standard on an additional 10-15% days in summer.

Ozone is a secondary pollutant formed when oxides of nitrogen and volatile organic compounds react in sunlight. Significant reductions in both these emissions are expected from the motor vehicle emission changes being implemented between 2002 and 2007. Over the period 2002 to 2020 and assuming full implementation of the vehicle emission and fuel standards mandated for introduction up to 2007, emissions of CO, VOCs and NOx from the Sydney GMR motor vehicle fleet are projected to fall by 62%, 40% and 55% respectively. The impact of these changes on ozone concentrations in Sydney are considered in 2.1.3 below.

4. Background to Ozone Formation

The generation of ozone and other photochemical pollutants from the two precursors NOx and VOCs is complex and highly non-linear. Figure 1 (Dawson 2002) demonstrates the impact of either NOx or hydrocarbon (HC or VOC) control on ozone formation.

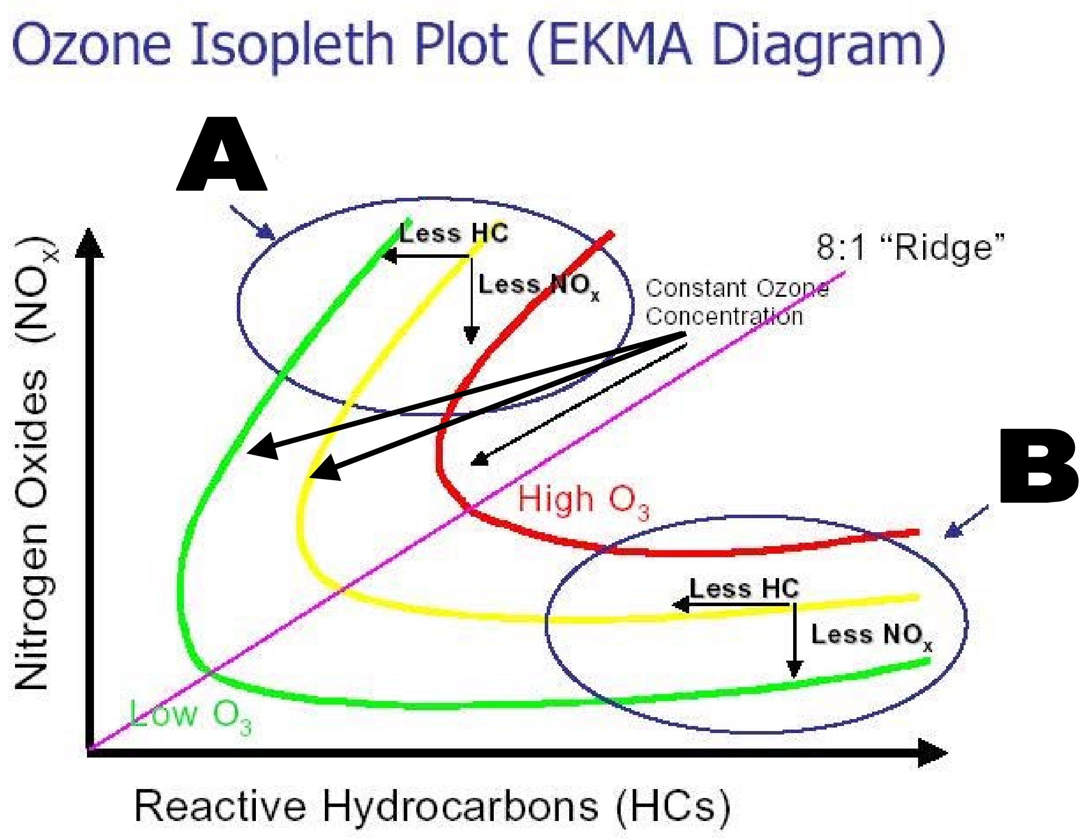

Figure 1: Ozone isopleth plot, transcribed from Dawson (2002)

The significance of Figure 1 is that the effectiveness of emissions reductions depends on the ratio of the two precursor pollutants. For a VOC to NOx ratio of about 8, reduction of the precursors is equally effective. Generally, at lower VOC:NOx (top left), VOC reduction is more effective and at higher VOC:NOx, NOx reduction is more effective. These states can be termed "NOx-rich" and "VOC-rich" respectively.

However, a further complication occurs where significant ozone concentrations are generated at low VOC:NOx – label A – a reduction in the concentration of NOx leads initially to an increase in ozone concentration. At high VOC:NOx ratio – label B – a reduction in NOx is required to reduce ozone concentration.

In the real world, the VOC:NOx ratio varies in time and space due to temporal variations in emissions, temporal variations in mixing in the atmosphere, and as photochemical reactions consume the available NOx. These variations can be very large: observations in Sydney have this ratio can vary from 2 to 14 in a single day.

Current analysis and simulation of days recording elevated ozone concentrations in Sydney shows that both NOx-rich and VOC-rich conditions occur. Further, ozone concentrations in excess of the NEPM standards can occur under both NOx-rich and VOC-rich conditions. Therefore managing the air environment to meet the AAQ NEPM goals requires strategies that consider both cases.

A critical implication of this observation is that a reduction in NOx is necessary to reduce ozone concentrations for some conditions, but, depending on the size of the reduction, may exacerbate ozone concentrations at other times.

5. Impacts of changes to vehicle emission and fuel standards on ozone in Sydney

The following section considers results from recent air quality modelling undertaken by the NSW EPA for the MVEC Review. The modelling assessed the impact of changes to vehicle emissions and fuel quality on ozone concentrations in Sydney out to 2020.

The ozone event selected for the modelling was the episode of 21-23 January 2001. This event contained two days, the 21st and 23rd January, on which national ozone standards were exceeded. The 21st and 23rd represent days with different characteristics and hence allow the emissions scenarios which incorporate the reductions expected from the current mandated standards as well as those from progression to *Euro 4* (2008/09) and *Euro 5* (2009/10) to be tested under different sets of conditions. Because of the nature of these days it was expected that they would respond differently to changes in emissions in different ways.

The results supported this expectation. For the 21 January 2001, the reductions in NOx emission associated with current mandated standards lead to an increase in ozone production in the plume. This resulted in higher concentrations of peak ozone and in a larger area affected by elevated concentrations of ozone.

On this day the maximum ozone concentration increases by nearly 30 per cent and the area experiencing exceedences of the NEPM standards increases by more than a factor of 10. Subsequent implementation of *Euro 4* and *Euro 5* indicates a lessening of this effect. While there is effectively no change in the maximum ozone, the area of exceedence is about ten per cent smaller.

TABLE 1 : MODEL RESULTS FOR 21 JANUARY 2001 - ONE-HOUR OZONE CONCENTRATIONS

	Maximum ozone ppb	Number grid cells* > 100 ppb (area km^2)	Number of grid cells* > 80 ppb (area km^2)
Observed	**109**	-	-
2002 – model base case	105	7 (252)	28 (1008)
Scenario 1 – 2020 (mandated vehicle emission standards)	134	82 (2952)	153 (5508)
Scenario 2 – 2020 (*Euro 4* petrol & *Euro 5* diesel)	132	74 (2664)	147 (5292)

* grid cell = 6x6 kilometres; total of 3600 grid cells in domain; Sydney region has 212 grid cells or 7632 km^2.

TABLE 2: MODEL RESULTS FOR 21 JANUARY 2001 - FOUR-HOUR OZONE CONCENTRATIONS

	Maximum ozone ppb	Number grid cells* > 80 ppb (area km^2)	Number of grid cells* > 60 ppb (area km^2)
Observed	**86**	-	-
2002 – model base case	79	0	144 (5184)
Scenario 1 – 2020 (mandated vehicle emission standards)	88	26 (936)	151 (5436)
Scenario 2 – 2020 (*Euro 4* petrol & *Euro 5* diesel)	87	26 (936)	152 (5472)

* grid cell = 6x6 kilometres; total of 3600 grid cells in domain; Sydney region has 212 grid cells or 7632 km^2.

For the 23 January 2001, the urban plume is more reacted and closer to NOx-limited conditions. As a result, the reductions in NOx emission associated with the changes in motor vehicle emission standards lead to a decrease in ozone production in the plume, characterised by both a reduction in peak ozone and the area affected by elevated concentrations of ozone. However, peak ozone concentrations remain above both the one-hour and four-hour NEPM standards.

On this day the currently mandated emission controls resulted in an 11% reduction in maximum ozone and a 35% reduction in the area reporting an ozone concentration greater than the NEPM one-hour standard. This is a substantial reduction, but not sufficient to obtain compliance with NEPM. Implementation of *Euro 4* and *Euro 5* results in a reduction in maximum ozone of 14% and a reduction in the area greater than the NEPM one-hour standard of 44%.

TABLE 3: Model results for 23 January 2001 - one-hour ozone concentrations

	Maximum ozone ppb	1.1.1 Number grid cells* > 100 ppb (area km^2)	Number of grid cells* > 80 ppb (area km^2)
Observed	**175**	-	-
2002 – model base case	137	133 (4788)	472 (16992)
Scenario 1 – 2020 (mandated vehicle emission standards)	122	86 (3096)	414 (14904)
Scenario 2 – 2020 (*Euro 4* petrol & *Euro 5* diesel)	118	75 (2700)	400 (14400)

* grid cell = 6x6 kilometres; total of 3600 grid cells in domain; Sydney region has 212 grid cells or 7632 km^2.

TABLE 4: MODEL RESULTS FOR 23 JANUARY 2001 - FOUR-HOUR OZONE CONCENTRATIONS

	Maximum ozone ppb	Number grid cells* > 80 ppb (area km^2)	Number of grid cells* > 60 ppb (area km^2)
Observed	**137**		
2002 – model base case	115	148 (5328)	815 (29340)
Scenario 1 – 2020 (mandated vehicle emission standards)	104	126 (4536)	765 (27540)
Scenario 3 – 2020 (*Euro 4* petrol & *Euro 5* diesel)	101	116 (4176)	747 (26892)

- grid cell = 6x6 kilometres; total of 3600 grid cells in domain; Sydney region has 212 grid cells or 7632 km^2.

It is important to note that the emissions estimates used in the modelling assume vehicles meet the emission limits at 80,000 kilometres and 100,000 kilometres for *Euro 4*. Sensitivity analysis undertaken indicated standards would have a less favourable impact on ozone if these durability provisions were not met.

As the modelling for the MVEC review was limited to one ozone event of two days, it is not possible to draw definitive conclusions from the results. However, the modelling does indicate that even with implementation of current vehicle emission and fuel standards the likelihood is that there will continue to be exceedences of the ozone standards in Sydney. This same pattern of ozone impact was also seen in recent EPA modelling undertaken to assess the impact of urban growth scenarios in Western

Sydney. Of significance it would seem that at least for the two days modelled for the MVEC review the further emission reductions expected from the adoption of *Euro 4* and *Euro 5* would reduce the potential for ozone formation, more so than that from the current mandated changes.

Appendix D European Fuel Quality Standards

Directive 98/70/EEC	Petrol		Test	
Year	**2000**	**2005****	**Method**	**Date**
Sulfur (mg/kg)	150max	50 (10)	pr.EN-ISO/DIS 14596	1996
Aromatics (%v/v)	42max	35	ASTM D1319	1995
Benzene (%v/v)	1.0max	***	Pr. EN 12177	1995
Olefins (%v/v)	18max	***	ASTM D1319	1995
Lead (g/l)	0,005max	***	EN 237	1996
Oxygen content (%m/m)	2.7max	***	EN1601	1996
Oxygenates (%v/v)		***		
Methanol (with stabilising agents) (%v/v)	3max	***	EN1601	1996
Ethanol (with stabilising agents) (%v/v)	5max	***	EN1601	1996
Ethers containing 5 or more carbon atoms per molecule (%v/v)	15max	***	EN1601	1996
Other oxygenates * (%v/v)	10max	***	EN1601	1996
Research Octane Number	95min	***	EN 25164	1993
Motor Octane Number	85min	***	EN 25163	1993
Reid Vapour Pressure (summer period) (kPA)	60max	***	EN 12	1993
Distillation - Evaporated at 100°c (%v/v) - Evaporated at 150°c (%v/v)	46,0min 75,0min	***	EN-ISO 3405	1988

Directive 98/70/EEC	Diesel		Test	
Year	**2000**	**2005****	**Method**	**Date**
Sulfur (mg/kg)	350max	50 (10)	pr.EN-ISO/DIS 14596	1996
Cetane number	51,0min	***	EN-ISO 5165	1992
Density 15°C (kg/m3)	845max	***	EN-ISO 3675	1995
Polyaromatics (wt%)	11max	***	IP 391	1995
Distillation 95% point (°C)	360max	***	EN-ISO 3405	1988

** Other mono-alcohols and ethers with a final distillation point no higher that the final distillation point laid down in the national specifications or, where these do not exist, in industrial specifications for motor fuels.*

*** New Sulfur levels in Diesel and Gasoline were set under amendments to Directive 98/70/EC. The amendments set a mandatory requirement for the "geographically balanced" availability of 10ppm-sulfur diesel and gasoline in 2005. From 1 January 2009, all gasoline and diesel fuel offered for sale must not exceed 10ppm sulfur.*

Appendix E Technical Rationale for Reducing the Sulfur Content of Fuels

As there are some differences between the technologies required for petrol vehicles and for diesel vehicles, it is worth considering these vehicle technologies and fuel interactions separately.

Petrol Vehicles

The current availability of *Euro 4* compliant vehicles in the European market, including some high volume models, demonstrates that conventional petrol engine technologies are capable of compliance with the *Euro 4* emissions standards, and in-service will operate satisfactorily on *Euro 3* petrol (150ppm sulfur), although component durability is likely to be affected.

It is unlikely that the emissions limits for petrol vehicles will be further reduced in European standards below those in the *Euro 4* standards, as they reflect close to the technological limits of the conventional petrol engine. However, it is possible that in the future, petrol vehicles will be required to meet particulate standards, as some new petrol engine technologies lead to significant increases in particle emissions. The key reason manufacturers are interested in petrol with levels of sulfur below 50ppm is to access more fuel efficient engine technologies. These fuels allow for adoption of technologies that can concurrently reduce NOx emissions and improve fuel consumption.

- *Reduction in NOx Emissions*

Conventional technology vehicles operating on 50ppm-sulfur fuel can meet the *Euro 4* emissions standards, but there is some evidence that even lower NOx emissions may be achieved from levels of sulfur below 50ppm. The magnitude of these benefits is strongly debated, but AEA report concluded that benefits of 30ppm relative to 50ppm were marginal, and most benefit would be gained from a reduction to 10ppm.

Conventional petrol engine vehicles rely largely on the three-way catalytic converter, in combination with the engine management system, to control emissions. While these catalysts will operate effectively at current sulfur levels, it is widely recognised that catalyst durability in service is affected by fuel sulfur. While a *Euro 4* vehicle may initially comply with the emissions standards when operating on 150ppm sulfur petrol, it is far less certain that it would still be compliant up to 100,000km as required by the standard. This is because the catalyst is likely to have suffered a higher than expected deterioration rate from exposure to sulfur at levels considerably higher than that for which it was designed.

- *Improved Fuel Consumption*

Pressure to reduce greenhouse gas emissions is a key driver for the development of new engine technologies, such as contained in the agreement between the European Commission and the vehicle manufacturers (the “ACEA Agreement”) that requires manufacturers to meet challenging greenhouse gas targets by 2008. At the making of the agreement in 1998, the European vehicle industry (and subsequently the Japanese and Korean manufacturers) indicated that in order to meet the 2008 target (and concurrently meet the NOx limits imposed by the *Euro 4* standards) 50ppm sulfur petrol needed to be readily available by 2000, and 30ppm by 2005. Since then, the focus of discussion has shifted from 30ppm to 10ppm. This shift is also now reflected in a revision of the international vehicle industry’s World Wide Fuel Charter

(WWFC) which has added a new fuel category (Category 4) for markets where "sophisticated NOx and particulate matter after-treatment technologies" are required. The WWFC recommends "zero" (5-10ppm) sulfur limits for Category 4 petrol and also recommends 5-10ppm sulfur for Category 4 diesel.

While there are a range of potential technological and market changes which will be used to achieve the 2008 greenhouse targets in the ACEA Agreement, manufacturers have indicated that the principal strategies will be an increased use of diesel vehicles and, in relation to petrol engined vehicles, a shift to lean burn gasoline direct injection (GDI) technology.

GDI offers fuel consumption improvements of up to 15-20% over equivalent conventional petrol engines. However, in achieving this improvement, higher NOx emissions are produced, which the normal three-way catalyst cannot reduce because of the increased concentration of air in the exhaust stream. This means that in addition to the standard catalyst, new technologies are required to deal with the NOx emissions. The comprehensive AEA "call for evidence" report to the European Commission concludes that the lean NOx trap (also known as a NOx storage trap) is the technology considered "most promising" for GDI lean burn engines in Europe.

There is considerable variability in the sulfur tolerance of advanced technologies, and their performance at various sulfur levels. The AEA report concludes that *Euro 4* compliant vehicles will function on 50ppm sulfur petrol, but that these vehicles would suffer a fuel consumption penalty of 1-5% relative to their operation on 10ppm sulfur petrol. Thus the expected fuel consumption reduction of 15-20% from GDI vehicles, relative to an equivalent conventional vehicle, would potentially be reduced to a 10-15% improvement if the vehicles were required to operate on 50ppm instead of 10ppm.

Diesel Vehicles

Given that 50ppm sulfur diesel is mandated in Australia from 1 January 2006, the question for diesel fuels and vehicles revolves around the benefits, if any, of setting a sulfur limit below 50ppm some time beyond 2006. As in Europe, 50ppm-sulfur diesel will be available in Australia to support the *Euro 4* emissions standards for both light and heavy duty diesel vehicles.

The are a range of different technologies that may need to be adopted to improve the emissions and fuel consumption performance of diesel vehicles, including:

- NOx Storage Traps (NST);
- enhanced exhaust gas recirculation (EGR);
- diesel particle filter systems (DPF);
- continuously regenerative traps (CRT);
- selective catalyst reduction (SCR); and
- more reactive oxidation catalysts (OC).

As the size of the vehicle engine increases, the technology demands also increase, such that larger engined vehicles are likely to require a combination of two or more of the above technologies to comply with *Euro 4* standards. There is a range of views in relation to the impact of sulfur on these technologies, as summarised in Table 1.

Table 1 Impact of Fuel Sulfur on Selected Emission Control Technologies

Vehicle Technology	**IMPACT OF FUEL SULFUR**
Oxidation Catalysts	The AEA concludes that lowering the sulfur level to 10ppm may enable more active oxidation catalysts to be used, but that the magnitude of benefits of this is uncertain.
NOx Storage Traps	The EC concludes that "there is doubt about the viability of NSTs in the absence of 10ppm sulfur diesel…" and higher levels of sulfur will require increased regeneration frequency, which will incur a fuel consumption penalty.
Diesel Particle Filters & Continuously Regenerative Traps	ECMT notes test results which suggest that the 95% particulate removal efficiency at 3ppm sulfur diesel, falls to around 73% at 30ppm, and zero at 150ppm, for both DPFs and CRTs. The European vehicle manufacturers association (ACEA), in its submission to the AEA Report (AEA 2000), provides data indicating that vehicles with CRTs will not meet *Euro 4* emissions standards with sulfur levels >30ppm. In contrast, Concawe concludes that reductions in the diesel sulfur level below 50ppm are not required for most diesel after treatment systems, including CRTs.
Selective Catalyst Reduction (SCR) *(see a further description of SCR technology below)*	In relation to SCR technology, the AEA concludes, "it is not clear how sensitive SCR technology is to fuel sulfur", but the available data suggests that the SCR *per se* should operate satisfactorily on 50ppm sulfur' . However, SCRs are likely to be used in conjunction with reactive OCs and DPFs, and as noted above, their performance (in both emissions and fuel consumption terms) is enhanced in a 10ppm environment compared to 50ppm.

Given Australia will already adopt *Euro 4* for all diesel vehicles 2006-07 and there is currently no "*Euro 5"* for light vehicles, the need for lower sulfur levels to support *Euro 5* heavy duty emissions standards is the key issue. A sulfur limit lower than 50ppm may also provide benefits to light diesel vehicles and *Euro 4* heavy vehicles and these benefits are also discussed. Since, technology options differ between light and heavy diesel vehicles, light and heavy duty diesels will be considered separately.

- *Heavy Duty Diesel Vehicles*

For heavy duty diesel vehicles, the expectation is that to comply with the *Euro 4* emissions standards most manufacturers will use DPF (combined with EGR technology), or they will opt for SCR technology. However, in order to comply with the *Euro 5* NOx standards it is anticipated that the use of both SCR and DPF technology will be required.

Overall, the AEA indicated that while it was difficult to quantify the benefits of 10ppm sulfur diesel on heavy vehicles, it was clear that the expected technologies required for *Euro 4/5* "give better performance and durability at lower sulfur levels, and that it would be very difficult, and perhaps not possible, to meet *Euro 4*/5 standards without 10ppm fuel". The independent reviewers of the AEA report also concluded that meeting the *Euro 5* standards is much more likely with the introduction of near zero sulfur fuels than it is with the use of 50ppm fuel.

In relation to fuel consumption, the EC's assessment was that 10ppm would deliver a fuel consumption improvement in the order of 1-3% relative to 50ppm. In the US, the EPA has determined that 15ppm-sulfur diesel is necessary to support the stringent PM and NOx limits imposed under the 2007 heavy duty diesel vehicle emissions standards, and this limit is principally considered to be a technology enabling measure.

- *Light Duty Diesels*

There is some uncertainty regarding the technology required to meet the *Euro 4* light duty standards, but it is clear that current conventional technology for *Euro 2/3* will be insufficient. Direct injection (DI) is already widely used in diesel engines (principally for fuel consumption reasons), and as emissions standards become more stringent it is likely that DI diesel engines will become standard. The European Commission concluded that one or more of the technologies outlined above will also need to be employed to enable compliance with *Euro 4* emissions standards for light duty diesels regardless of fuel consumption pressures.

In weighing up the evidence, the EC concluded that lowering the sulfur level in diesel from 50ppm to 10ppm would improve the performance of most, if not all, of these technologies, in both emissions and fuel consumption terms. Their conservative assessment, based on the data supplied, was that the fuel consumption benefit of 10ppm sulfur (relative to 50ppm) was in the order of 1-5%.

As the benefits of these lower sulfur levels are essentially related to new vehicle technology, and given that it is likely that vehicle manufacturers will increasingly utilise engines optimised for operation on high octane (95 & 98RON) petrol (principally for fuel consumption reasons), it is logical to target any sulfur reductions in petrol on 95 & 98RON fuel only. It should also be noted that 95RON petrol is the standard upon which the European Commission work is based.

Description of SCR Process *(as described in Coffey Geosciences, 2003)*

Also known as De-NO_X Selective Catalysts or NH3-SCR systems, SCR technology is designed to permit the NO_X reduction reaction to take place in an oxidising atmosphere. It is called ‘selective’ because the catalytic reduction of the NO_X with ammonia (NH_3) as a reductant occurs preferentially to the oxidation of NH_3 with oxygen. The reducing agent reacts with NO_X to form N_2, H_2O and CO_2. The reductant source is usually a urea ($CO(NH_2)_2$) solution, which can be rapidly hydrolysed to produce ammonia in the exhaust stream. SCR technology can achieve NO_X reductions in excess of 90%, the injection rate must be carefully controlled to avoid low NO_X conversion or ammonia slip. Normally, the SCR system is coupled with an oxidation catalyst to avoid ammonia slip.

The drawback to the technology is the necessity of having a storage/supply tank and injection system for the reductant source. For this reason the technology is considered to be only really practically applicable to heavy vehicles by many in the EU automotive industry.

Appendix F Summary of Submissions to the MVEC Review Discussion Paper

Submissions were received from the following organisations & individuals:

- Asian Clean Fuels Association (ACFA)
- Association for Emission Control by Catalyst (AECC)
- Association of Australian Diesel Specialists (AADS)
- Association of Motoring Clubs (AOMC)
- Audi
- Australian Automobile Association (AAA)
- Australian Institute of Petroleum (AIP)
- Australian Liquefied Petroleum Gas Association (ALPGA)
- Bus Industry Confederation (BIC)
- Caltex
- Col Potts Engineering
- CSIRO
- Diesel Test Australia
- Doug Munro (Private Consultant)
- Duncan Seddon & Associates
- Environment Victoria
- EPA Victoria
- Ethyl Asia Pacific
- European Fuel Oxygenates Association (EOFA)
- Federal Chamber of Automotive Industries (FCAI)
- Greenfleet
- Hino Motors
- IMPCO Technologies
- Independent Petroleum Group (IPG)
- IS Edit Transport & Technical Communications (ISETTC)
- Mobil
- Motor Trades Association of Australia (MTAA)
- NSW EPA
- Queensland Government (submitted by Qld EPA)
- SAE/Uni of Melbourne
- Truck Industry Council (TIC)
- US Engine Manufacturers Association (EMA US)
- Victorian Automobile Chamber of Commerce (VACC)
- WA Department of Environment (WA DOE)
- Warren Godson (Private Individual)

Summary of Responses to Discussion Paper Questions

1. The Case for Strengthening Standards

Overall Assessment:

Most parties support further action, provided timing is appropriate. Some reservations regarding lack of cost benefit information. Mixed views on greenhouse gas (GHG) benefits.

Specific Comments:

AAA	Further action warranted. Industry competitiveness should be considered. Harmonising with international standards will improve Aust automotive industry competitiveness. Tighter vehicle emissions and fuel standards will assist greenhouse goals. Need to be accompanied by incentives for early uptake. Need more challenging fuel consumption targets.
AADS	Further action is warranted.
ACFA	Further action is warranted provided it does not increase the cost of fuel or adversely affect the fuel supply market.
AECC	Tighter fuel standards will allow newer technologies and thus assist greenhouse goals
AIP	No urgency for action. A holistic approach to achieving air quality objectives, considering all policy options needs to be taken. Impacts on the fuel and vehicle industries need to be carefully considered. Standards for fuels and vehicles must be closely linked.
ALPGA	Broadly supportive of further action, but need more analysis of costs and benefits of particular measures.
AOMC	Supports further action.
Audi	Further action is warranted provided it is implemented in a cost efficient manner in conjunction with better fuel. Greenhouse benefits will also result.
BIC	See TIC (identical submission).
Caltex	Supports further action, but timing is critical, some delay in timing would not adversely affect air quality outcomes, but may make significant difference to costs and viability.
CSIRO	Further action is warranted in relation to Ozone and PM. It is difficult to assess the impact of the proposed reforms on greenhouse goals.
Diesel Test	Non-committal – should be greater focus on in-service emissions control.

Environment Victoria	Further action warranted. Benefits in both air pollution and greenhouse emissions reductions. Also needs to be focus on other measures such as fleet purchasing policies, vehicle industry preference for large vehicles, FBT arrangements, accelerating NAFC targets.
EPA Vic	Further action warranted. Economic social and environmental considerations should be taken into account. The impact of new vehicle and fuel standards, including life cycle analysis needs to be considered.
Ethyl	Supports further action, also need action on in-service.
FCAI	95RON/10ppm sulfur is required to permit technology required for fuel conservation targets
Godson	Supports further action
Greenfleet	Supports further action – and move to 10ppm sulfur fuels as soon as possible. Consider industry issues, but on a “best case” scenario. Will assist GHG emissions.
IMPCO	Supports further action, but need to be sensitive in choosing time frame. GHG benefits will only accrue if standards are set for CO_2 or fuel consumption.
IPG	No enough evidence to justify adoption of E4 or E5.
ISETTC	Further action is warranted but should be undertaken in a considered and timely manner taking account of unique Australian heavy vehicle issues (heavier loads, longer runs, higher speeds higher operating temperatures) and the issues associated with urea dependent technologies. Should seek to have highest quality fuels to enable latest technologies etc. Do not accept that there necessarily is a greenhouse problem.
Mobil	Qualified support for further action provided it is scientifically sound and cost effective when considered along with complementary measures and the broader economic impact. Availability of Asian fuels needs to be considered. Careful consideration of timing is needed to optimise greenhouse outcomes.
MTAA	Supports the introduction of measures to reduce air toxicity, as long as they don’t become a barrier to entry, and have concerns related to the timing of the introduction of tighter fuel quality standards in Australia taking into account regional fuel supply and the impact on competition and the market.
Munro	The information on air quality impacts is insufficient and there is an absence of a proper analysis of costs and benefits. Until these matters are addressed it is not possible to comment on the specific proposals as no clear case for action has been made.
NSW EPA	Lack of CBA prevents formal position. However, there is need for further action to address ozone exceedences
Potts	Need for further action.
Qld Government	Further action may be warranted, but CBA needed to make an informed decision.

SAE/Uni Melb	Need to see CBA before any decision.
Seddon	Further action is warranted in so far as it maintains Australia's competitive position in the vehicle manufacturing and components industry. Implications on the refining industry such as the generation of unsuitable blend stock need to be considered. The more complex production processes involved in low sulfur fuels will detract from greenhouse goals, greater use of diesel fuels would have a better impact for greenhouse goals.
TIC	Qualified support for action, provided timing is sensible and cost benefit is clear. Technology and urea questions are significant for heavy vehicles. GHG benefits depend on technology choices (will be GHG negative if urea based SCR technology is rejected).
VACC	VACC believes that whilst new emission and fuel standards will improve environmental conditions, the problem of in-service vehicles remains, and greater attention should be paid to the maintenance schedule of vehicles during service life.
WA DoE	Further action warranted. Support FCAI argument re 95RON/50 or 10ppm sulfur fuel.

2. New Motor Vehicle Standards

Overall Assessment:

Most parties support *Euro 4* for light vehicles from 2008 or 2009. FCAI and AIP in agreement on 2009 as appropriate date. Less agreement on *Euro 5* for heavy vehicles. TIC/BIC and others have concerns about technology uncertainties, costs and urea issue, and recommend deferring decision for 2 years. Truck/bus industry wants both US2007 and Japan 05 LT accepted as alternative to *Euro 5*.

Specific Comments:

AAA	Support *Euro 4* provided no additional costs to motorists. European standards preferred. Support proposed timeframe provided fuel is available. In principle support improvements in diesel fuel and emissions.
AADS	Support *Euro 4*, designated time frame is ok, but not support putting it off to a later date. Support *Euro 5*, present time frame ok, no late though. Accept US 07 as an alternative to *Euro 5*.
AIP	Support Euro4 along proposed timeframe, provided appropriate fuels available.
AOMC	Support *Euro 4* and *Euro 5* after application dates in Europe. Accept US2007.
BIC	See TIC (identical submission).
CSIRO	Qualified support for *Euro 4* and *Euro 5*.
Diesel Test	*Euro 5* is questionable, focus should be on in-service fleet.

EMA (US)	Support US EPA 2007 as an alternative
Env Vic	Support alignment with Euro standards as early as possible.
EPA Vic	Support *Euro 4* along proposed timeframe. Support *Euro 5* in 2009/10 with 10ppm sulfur fuels and appropriate urea measures. Support US EPA 2007 as alternative.
Ethyl	Support *Euro 4* in 2008/9 and *Euro 5* in 2010. Allow US2007
FCAI	Support *Euro 4*, 2009 new models, 2010 all new vehicles
Godson	Supports new standards.
Greenfleet	*Euro 4* asap. *Euro 5* in 2007, no to US2007. Make urea free.
Hino	Support *Euro 5* in 2010/11. Accept Japan 05 standards as alternative.
IMPCO	Support *Euro 4* in 2007. Qualified support for *Euro 5*, from October 2010.
IPG	New standards not justified.
ISETTC	Support *Euro 4*. Support *Euro 5*. 2008/09 given issues related to urea. Support US EPA 2007 and other suitable alternatives eg JP 2005.
Mobil	Support *Euro 4* for fuels except for aromatics. Need sufficient lead times. Do not support US EPA 2007.
MTAA	MTAA believes that before any decision is made about the adoption of *Euro 5*-emission standard further research needs to be conducted in relation to the use of SCR Technology and the use of urea for heavy vehicles.
NSW EPA	Lack of CBA prevents formal position. Notes that current package of standards up to 2007 will not be sufficient to prevent ozone exceedences.
Qld Government	Support for *Euro 4* and *Euro 5* standards, with timing to be determined on consideration of the CBA.
SAE/Uni Melb	Support *Euro 4* in 2008/9 (lag is beneficial). Diesel is problematic, technology issues unresolved, *Euro 5* only offers modest NOx benefits, defer decision until 2006.
TIC	Support harmonisation with *Euro 4*, suitability of LPG/NG test fuels an issue. In principle support for *Euro 5* – Japanese 05 LT and US 2007 standards must be accepted as alternatives, timing is critical. Too early to decide – delay decision until 2005. 2010/11 is earliest feasible time frame for *Euro 5*. LPG and NG test fuels for *Euro 5* need to be considered in Australian context, may require amendment.
VACC	VACC believes that to improve urban air quality, we must continue to move forward with the introduction of new emissions standards. Introduction of *Euro 4* (petrol) would have to be adopted late this decade (2008) if environmental benefits are to be achieved, and further research is required to assess the impact of low sulphur fuels on engines and the condition of the current fleet. Such research also needs to address the impact of *Euro 5* (Diesel) and the effect of new low sulphur fuels on vehicle engines compared with environmental gains, given the potential for premature component wear and associated increase in emissions.

WA DoE	Support *Euro 4*, 2008/09 timeframe. Support *Euro 5* in principle, concerns re urea infrastructure and enforcement may require reconsideration of timeline. Support US EPA 2007 and other comparable alternatives.

3. New Fuel Quality Standards

Overall Assessment:

Timing of fuel standards should align with vehicle standards.

Petrol:

Most parties support 50ppm sulfur 95RON fuel to support *Euro 4* light vehicle standards. Fuel industry does not support 10ppm sulfur petrol at this stage, but FCAI consider it necessary to meet NAFC targets. Fuel industry oppose 35% aromatics and want concessions on olefins.

Diesel:

Most parties agree 10ppm diesel necessary to support *Euro 5* heavy vehicle standards, and some consider worth doing even if *Euro 5* not adopted.

Specific Comments:

AAA	Support 10ppm sulfur in 95RON petrol. Aromatics to 35%. 10ppm sulfur in diesel with or without *Euro 5*
AADS	Supports move to 50 and 10ppm sulfur in 95RON, and 10ppm in diesel.
ACFA	Support Euro fuel regime: 35% aromatics, 18% olefins, 15% MTBE. Target of 10ppm sulfur for all petrol, 50ppm in 2008. Aromatics are a concern and MTBE regulations in line with EU should be considered.
AECC	50ppm sulfur essential for *Euro 4*, 10ppm preferred. 10ppm sulfur to support *Euro 5* and also allows retrofit of advanced emissions control technology.
AIP	Petrol: 95RON petrol will be required for new vehicles beyond 2005. Petrol will need to be 50ppm sulfur for *Euro 4*. 35% aromatics is technically expensive in Australia and would need 15% MTBE (*Euro 4* allows). 10ppm sulfur petrol will not be available from Asian refineries for at least 10 years. 10ppm sulfur for petrol will be costly. No changes to 91RON petrol, with the exception of olefins from 2009. Support 50ppm 95RON petrol, but not before 2009. No change to the aromatics standards from the 2005 standards, ie remain at a maximum 42% pool average. The olefins standard for all petrol should be changed in 2009 to allow pool averaging – a 18% pool average across all petrol grades, with a maximum cap of 20%. This would allow greater flexibility for refiners in blending petrol grades to meet octane demand, without

	adversely affecting air quality. The production subsidy already announced to encourage the early introduction of 50ppm sulfur petrol be extended consistent with the above timing. Diesel: There will be limited availability of 10ppm sulfur diesel from Asian refineries for the next 10 years. 10ppm sulfur diesel should not be mandated before 2009, and timing should reflect a clearer understanding of future diesel engine technologies and regional availability. A cautious approach should be taken over any reliance on urea based engine technologies.
ALPGA	A sulfur limit of less than 50ppm in LPG is not feasible without developing new odourant technologies.
Audi	Support 10ppm sulfur for 91and 95RON petrol. 35% aromatics achievable without ethers. Refer ACEA study on merits of 10ppm sulfur.
BIC	See TIC (identical submission).
Caltex	Support 50ppm PULP from 2009 (in line with FCAI timing for *Euro 4*). No change to ULP. Do not support 10ppm prior to 2010. Support 10ppm diesel from 2009 (in line with *Euro 5*). Do not support 35% aromatics (high cost, little benefit). Relaxation of olefins limit (18% pool av, 20% cap)
Diesel Test	Support low sulfur fuels, but in-service quality also needs to be addressed.
EFOA	MTBE is a low health and environmental risk and should not be regulated out of fuel
EMA (US)	*Euro 5*/USEPA 2007 must be accompanied by 10ppm sulfur
EPA Vic	Support harmonised introduction of vehicle standards and 50ppm fuels. Support 10ppm for 95RON. Support action to limit MTBE. Support 10ppm sulfur for diesel
Ethyl	Support 50ppm PULP only. Question merits of 35% aromatics. Support 10ppm diesel only if *Euro 5* adopted.
FCAI	10ppm sulfur required for *Euro 4* & NAFC target
Godson	Support 10ppm in petrol and diesel, and lower aromatics.
Greenfleet	Need 50ppm for *Euro 4*, support move to 10ppm petrol and diesel to maximise benefits of new technology.
Hino	Support 10ppm diesel.
IMPCO	Support 50ppm for *Euro 4*. No comment on 10ppm petrol. 10ppm diesel if *Euro 5* adopted.
IPG	Australia should not move ahead of Asian market. MVEC timetable for low sulfur fuels should be delayed by “several years”. No need to reduce aromatics.
ISETTC	50ppm sulfur should accompany *Euro 4*. 10ppm sulfur should accompany *Euro 5*. 10ppm sulfur should be mandated regardless.

Mobil	Do not support below 50ppm sulfur petrol. 91RON should be 150ppm. Do not support 35% limit for aromatics or general use of ethers. Do not support 10ppm sulfur for diesel.
NSW EPA	Lack of CBA prevents formal position. Notes that current package of standards up to 2007 will not be sufficient to prevent ozone exceedences.
Qld Government	Need more information from fuel industry to make informed choice on proposals, however technical case for 50ppm and 10ppm 95RON petrol and 10ppm appears sound, while noting more limited evidence on the diesel question because of uncertainties over vehicle technology.
Seddon	MTBE is a low risk compound and should not be banned. Should be a separate standard for ethanol. Australia's distribution and tankage system preclude offering fuels with different sulfur levels side by side due to the risk of cross contamination. Care should be taken in mandating below 50ppm sulfur as these fuels are not available from Asian refineries. Low sulfur will come at significant cost and risk of cross contamination. 35% aromatics are achievable without ethers. It may not be possible to technically guarantee 10ppm sulfur diesel.
TIC	No comment on petrol. Support 10ppm diesel before application of *Euro 5*, and consider there are benefits from 10ppm even if *Euro 5* not mandated.
VACC	50ppm sulphur fuel should not be introduced until the impact of the current fleet is known. If 50ppm sulphur fuel is going to damage older engines, considering that that fleet is aging and kilometres travelled is increasing, new standards may have a negative result, causing vehicles in service to become more of a pollution problem. 35% for aromatics may be possibly be achieved with ethanol, however, availability of a constant supply could be a problem.
WA DoE	Support 10ppm sulfur in 95RON petrol. Support 10ppm sulfur diesel.

4. Economic Impact of Tighter Standards

Overall Assessment:

Vehicles

Submissions provided very little cost information. Audi estimates additional cost of *Euro 4* around 1% (relative to *Euro 3*). FCAI provided no information. TIC considers US EPA estimates are very conservative, and notes cost for urea supply not addressed.

Fuels

AIP appears to generally accept EU cost estimates quoted in paper, but caution that no detailed costing done for Australian refineries. Main AIP concern regarding cost for

10ppm petrol. Industry also argues that sensible timing (2009 for 50ppm petrol and 10ppm diesel) will minimise costs – avoid getting too far ahead of Asia.

Specific Comments:

AAA	Do not agree that fuel and vehicle costs will automatically rise due to new standards. Fuel price increases may be offset by fuel consumption savings. Not all costs are attributable to the MVEC proposals ie some *Euro 4* are here and are already creating demand for high quality fuels. Technology and manufacturing improvements will also offset costs.
AADS	Considers MVEC cost estimates reasonable. Production costs for fuel must be met. We cannot put off the introduction of low sulphur fuels because of costs, the user pays.
AIP	Petrol: 50ppm sulfur would impose major costs on Australian refineries. Costs will vary widely between refineries. The experience of overseas refineries in unlikely to be a reliable guide. Reduction in sulfur content to 50ppm could cost each refinery $50-$150 million, plus operating costs in the order of 1 cpl. A further reduction to 10ppm could incur capital costs $100 to over $200 million with additional operating costs of 1-2 cpl. Costs are indicative only, as no detailed costs estimates have been carried out. Diesel: Cost of 10ppm sulfur diesel will vary widely across refineries. A purely indicative estimate at this time is a capital cost of around $50 million, and operating costs over 0.5 cpl.
ALPGA	MVEC costs appear reasonable. Cost to consumers will depend on timing, need more detailed evaluation.
Audi	*Euro 4* requires secondary air pump and advanced catalysts adding approx 1% to retail price. *Euro 4* petrol 10ppm instead of 50ppm: 1-3% improvement in fuel consumption *Euro 5* Diesel 10ppm instead of 50ppm: 2-4% improvement in fuel consumption
BIC	See TIC (identical submission).
Caltex	Potentially severe cost impacts if standards for low sulfur petrol and diesel mandated too early. Sensible timing combined with incentives for early compliance are best way to avoid excessive cost risks.
Env Vic	Increase in fuel and vehicle costs outweighed by air pollution and greenhouse benefits.
Ethyl	Costs of increased octane demand not covered.
IPG	If Australia's fuel standards move ahead of Asia will affect capacity to source competitively priced imports.

Mobil	Production cost impacts of tighter fuel specifications cited in the discussion paper are not unreasonable, however, the more relevant question to be addressed is what the cost impact is for consumers and this will very much depend on the timing of introducing these tighter standards. Mandating tighter specification fuels significantly ahead of them being generally available in the Asian market can be expected to have substantial cost impacts for refiners and this may impact consumers, at least in the medium term. European fuel economy/greenhouse gas emission benefits cited for 10ppm sulfur petrol (versus 50ppm) are significantly overstated. These are largely related to the use of lean burn GDI vehicles and, projected fleet penetration of these vehicles is now much lower in both Europe and Japan as they have proven to be less cost effective in improving fuel economy than alternative technologies. None of these alternative engine/emission technologies require 10ppm sulfur petrol. Most current/developing technology in Europe for achieving *Euro 4*/5 standards in light or heavy diesel vehicles does not require use of 10ppm sulfur fuel and providing such fuel is not likely to affect fuel consumption in those vehicles
Seddon	Low sulfur petrol: EU costs too low, e.g. see Concawe (1999) report and Oil & Gas Journal (2000). Latter suggests US cost will be in the region of 2-3c/L Aus to achieve 30ppm sulphur. 10ppm sulfur diesel costs are too low. Article in Oil & Gas Journal (2000) suggests US cost of 3-5 c/L Aus to achieve 30ppm sulphur, and 15ppm could cost 9-20 c/L Aus Oil & Gas Journal (2001). Costs quoted too low for Australia as the assumptions are not applicable.
TIC	Agree data on heavy vehicle compliance costs is limited. Consider MVEC estimates (based on US EPA) are very conservative. Cost of urea use may offset savings from better fuel consumption in an SCR technology vehicle by up to 50%. Cost of urea infrastructure and supply not addressed. Lack of costing information generally warrants delay in decision.
VACC	Initial cost estimates for new vehicles seem to be reasonable, but Australian conditions once the vehicle is in service need to be considered.

5. Role of Complementary Measures

Overall Assessment:

Most parties support the use of incentives for early compliance, particularly with fuels.

Specific Comments:

AAA	Incentives for early production of tighter fuels are warranted.
AADS	Supports incentives for both vehicles and fuels

ACFA	Supports incentives for both vehicles and fuels if properly integrated.
AECC	Promotion of *Euro 4* petrol emission standards and 10ppm sulfur with tax incentives.
Audi	Tax incentives for low sulfur fuel are warranted
BIC	Yes, incentives for vehicles and fuels can help
Caltex	Yes, but for fuels only (similar to ULSD excise differential).
CSIRO	Incentives to advance supply of cleaner fuels preferable to bringing forward standards.
Diesel Test	Does not support incentives.
EMA (US)	Additional measures should include incentives, education, enforcement and R&D eg tax incentives, fuel consumption information, traffic management, behaviour education.
EPA Vic	There is a need for measures to enforce existing standards. Incentives for refineries to meet new fuel standards are required.
Ethyl	See TIC (identical submission).
FCAI	Support incentives for fuels only eg excise advantage
IPG	Supports a suite of incentives for new heavy vehicles.
Mobil	Incentives are key to ensure availability of fuels ahead of mandatory dates…assists import of advanced technology vehicles, mitigate costs of early compliance. Support production subsidies from 1/1/06-31/12/08 for 50ppm petrol and 10ppm diesel (1 year extension on both budget proposals), and for 10ppm petrol, from 1/1/09 to the post 2010 date that 10ppm sulfur petrol is presumably mandated.
Munro	Supports incentives for 10ppm diesel (and notes urea is an issue).
Potts	Support incentives for clean vehicles
Qld Transport	Incentives warranted for short time frame measures, if longer timeframe no need.
SAE/Uni Melb	Support incentives for vehicles and fuels, favour incentives for heavy duty LPG and NG vehicles meeting *Euro 4* or 5 ahead of mandatory date.
Seddon	Tax incentives for fuels and vehicles are warranted.
VACC	For end users to comply in the early stages to new emissions standards, incentives will be needed to encourage purchase of new vehicles. The best way to achieve this is for a reduction in registration costs for green vehicles, providing the vehicle is correctly maintained.
WA DoE	Incentives are warranted, particularly for fuel industry

6. The Discussion Paper Options

Overall Assessment (all options):

Not all submissions addressed the 4 options. Very little support for option 1, but opinion divided on the remaining options. Most support for Option 4, but key stakeholders (AAA, AIP, FCAI, TIC/BIC) divided.

Option 1:

- **Status Quo ("Do nothing")**

Overall Assessment:

Very little support for option 1

AAA	No to option 1.
AADS	No to option 1
AOMC	No to option 1.
Audi	No to option 1
BIC	See TIC (identical submission).
Env Vic	Effectively does not support Option 1.
EPA Vic	No to Option 1
Ethyl	Option 1 might be viable if IM programs introduced to address high emitters.
Godson	No to Option 1.
Greenfleet	No to Option 1.
ISETTC	No to Option 1.
Mobil	Yes to Option 1. Allow time for further consideration of environmental outcomes required.
Qld Government	Need BCA before providing an informed view on any option.
Seddon	No to Option 1
TIC	Not a strong case for Option 1. While BCA may support do nothing option, expectation of Australian community that Australian fleet should keep pace with overseas standards.

Option 2:

- **Mandate *Euro 4* emissions standards for petrol, LPG and NG light vehicles**
- **Mandate 50ppm sulfur limit for petrol**
- **Status quo for diesel vehicle emissions standards and diesel fuel standards (*Euro 4* and 50ppm sulfur)**

***Timeframe*: 2008/09**

Overall Assessment:

Limited support, except from TIC/BIC who want deferral of decision on *Euro 5* (therefore favour status quo at this stage).

Specific Comments:

AADS	Minimum option
BIC	See TIC (identical submission).
Mobil	If action is deemed necessary, support for Option 2 pending resolution of appropriate standards for heavy diesel vehicles. 50ppm sulfur for 95RON petrol only.
Qld Government	Need b-c analysis before providing an informed view on any option.
SAE/Uni Melb	Appears to be preferred option at this stage.
Seddon	Preferred Option. Continues the move to harmonisation in a timely manner with achievable milestones.
TIC	Support Option 2, except delay decision on *Euro 5* and require 10ppm diesel by 2010.
VACC	VACC believes that Option 2 would be the best option to follow with compulsory maintenance and policing of compliance to gain maximum benefits for the condition of the environment. 50-ppm sulphur fuel may be an issue until the impact on the current fleet can be assessed.

Option 3:

- **Mandate *Euro 4* for petrol, LPG and NG light vehicles**
- **Mandate 50ppm sulfur limit for petrol**
- **Mandate *Euro 5* for diesel, LPG and NG heavy vehicles**
- **Mandate 10ppm sulfur limit for diesel**

***Timeframe*: 2008/09 (*Euro 4*) & 2009/10 (*Euro 5*)**

Overall Assessment:

Limited support. AIP did not specifically respond to the options, but AIP proposals largely consistent with Option 3.

Specific Comments:

AADS	Preferable option.
AIP	AIP proposals largely consistent with Option 3, except 2009 for 50ppm sulfur petrol
ALPGA	Preferred option for LPG vehicles, given odourant problems with going below 50ppm sulfur limit in LPG.
BIC	See TIC (identical submission).
Caltex	Essentially preferred option, except delay 50ppm standard for petrol until 2009 (in line with FCAI).
Ethyl	Support Option 3 (but not aromatics)
Qld Government	Need b-c analysis before providing an informed view on any option.
TIC	Could not support at this time, because of concerns about timing, alternative standards, LPG/NG test fuels, lack of CBA, technological and infrastructure issues with *Euro 5*.

Option 4:

- **Mandate *Euro 4* for petrol, LPG and NG light vehicles**
- **Mandate 50ppm sulfur limit for petrol in 2008**
- **Mandate 10ppm sulfur limit for petrol in 2010**
- **Mandate *Euro 5* for diesel, LPG and NG heavy vehicles**
- **Mandate 10ppm sulfur limit for diesel**

***Timeframe*: 2008/09 (*Euro 4*) & 2009/10 (*Euro 5*)**

Overall Assessment:

Favoured by AAA, FCAI and most State agencies.

Specific Comments:

AAA	Qualified support for Option 4. Should be accompanied by removal of impediments, incentives, education programs, enforcement, continued R&D of new technologies and traffic management
AADS	Best option, but incentives may be required. Introduce incentives for regular servicing of vehicles to maintain low exhaust emissions. We must endeavour to achieve the best outcome in the shortest possible time to protect air quality in Australia.
AECC	Support Option 4
Audi	Support Option 4 with 10ppm sulfur for petrol and diesel
EPA Vic	Support Option 4
FCAI	Support Option 4. 10ppm sulfur petrol in 2008
Godson	Support Option 4, but go direct to 10ppm petrol and diesel.
Greenfleet	Support Option 4.
ISETTC	Support Option 4 with alternative of JP2005.
Qld Government	Need b-c analysis before providing an informed view on any option.
WA DoE	Support Option 4 for petrol. *Euro 5* must be accompanied by appropriate measures for urea.

Appendix G Summary of Submissions on the Draft RIS

Stakeholder	Position on Proposed New Standards*					Summary of Main Comments
	2008		2009		2010	
	Euro 4	50ppm Petrol	*Euro 5*	10ppm Diesel	10ppm Petrol	
ACT Department of Urban Services	✓	✓	✓	✓	✓	
Australian Automobile Association	✓	✓	✓	✓	✓	Supports RIS recommendations. Need to ensure that fuel incentive passed on to consumers – eg ACCC monitoring. Support incentive, but not one funded from an increase in all fuel prices. Want diesel passenger/light commercial vehicle standards strengthened. Want to see more incentives for uptake of vehicles & fuels.
Australian Government Treasury						No comments.
Australian Institute of Petroleum – Initial Submission	✓	✓	✓	✓	✗	Strongly agrees that improvements in fuel quality should be closely integrated with improvements in vehicle engine technology. 10ppm Diesel: Support 2009 date as consistent with Euro 5. 50ppm Petrol: "AIP companies should be able to supply 50ppm 95RON petrol from 1/1/08, if that is the date selected by Government". "There should be reasonable availability of 50ppm sulfur petrol by the end of the decade; however availability in 2008 may be somewhat restricted". Supports production incentives announced by Australian Government, "which should encourage the availability of the fuel ahead of the standard while reducing the price risk". 10ppm Petrol: Not convinced case has yet been made for 10ppm petrol. "Conclusions in the RIS supporting the introduction of a 10ppm sulfur petrol standard in 2010, drawn from the Coffey Cost-benefit Analysis, are seriously flawed". Issues identified in the CBA include: - No recognition of major interface costs;

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✓ = support;
✗ = do not support (either opposed to all aspects, or on key elements such as timing)

Stakeholder	Position on Proposed New Standards*					Summary of Main Comments
	2008		2009		2010	
	Euro 4	50ppm Petrol	*Euro 5*	10ppm Diesel	10ppm Petrol	
AIP (continued)						- alternative options to achieve emission reductions not considered; - lack of fuel availability from Asian market; - no justification for the claim that net benefits are conservative; - study did not apply a Net Present Value discount factor to the stream of costs and benefits (eg 2-3%) that AIP claim would have led to negative returns over the first 19 or 20 years of the project. "A 10ppm sulfur petrol standard in Australia in 2010 runs a serious risk of import supply constraints and upward price pressures". "AIP therefore strongly advocates that a consultation process [to be completed be end 2005] be put in place [with AIP and FCAI, and their members] with the aim of assessing the need from 10ppm sulfur 95RON petrol 95RON petrol and to consider mechanisms for providing the necessary assurance of availability in early years without a mandate." Olefins: AIP is concerned that its recommendation, to relax the olefins specification by replacing the 18 % maximum with a pool average maximum of 18 % and cap of 20 % in 2008, was not considered.
Australian Institute of Petroleum (Supplementary Submission)						This submission provides further information in support of AIP's position in support of a relaxation of the Olefins standard from an 18% maximum (from 1 Jan 2005) to a pool average approach of an 18% average maximum over 6 months and a 20% cap over all petrol. The paper provides technical detail and recommends that the olefins proposal be implemented as a package together with the introduction of 50 ppm sulfur Premium Unleaded Petrol.
Australian Liquefied Petroleum Gas Association Ltd						ALPGA states that the RIS has not considered LPG, and rather than commenting on the specific proposals contained in the report, has provided a copy of a report that presents the case for the adoption and use of LPG as a mainstream automotive fuel for the future.

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Stakeholder	Position on Proposed New Standards*					Summary of Main Comments
	2008		2009		2010	
	Euro 4	50ppm Petrol	*Euro 5*	10ppm Diesel	10ppm Petrol	
Australian Trucking Association			×	✓		ATA does not support introduction of Euro 5 and does not consider that the proposed *Euro 5* introduction timing represents fair balance between environmental policy objectives, and social and economic objectives. ATA supports financial incentives for production of 10ppm sulfur diesel. ATA recommends an alternative approach based on: Air Quality NEPM targets; reductions in pollutants needed to meet the targets; share of the reductions that are the responsibility of the trucking sector; and the most equitable and least cost approach for the trucking sector to meet such a responsibility. The ATA considers introduction of *Euro 5* as poor public policy because: its inequitable; it lacks scientific rigour; the broader regulatory and policy environment for the trucking industry has not been taken into account (eg less productive B-Doubles, shorter B-Doubles, limits on truck mass and length, higher on-costs); technical issues associated with urea infrastructure etc remain unresolved. ATA considers that it is unfair to force international harmonisation with *Euro 5* when other diesel engine sectors are not addressed in Australia.
BP Australia	✓	✓	✓	✓	×	Supports 50ppm petrol and 10ppm diesel in line with MVEC timings. Supports AIP approach seeking further consideration of the timing for the 10ppm sulfur petrol standard. The 2 year incentives are a major factor for the availability of fuel for the proposed mandated dates.
Caltex	✓	✓	✓	✓	×	Supports 50ppm petrol and 10ppm diesel in line with MVEC timings. Does not support 10ppm petrol in 2010, supports AIP proposal for a separate process to re-consider by the end of 2005. Supports a relaxation of the Olefins standard to apply from 1/1/08, due to the greater blending difficulties associated with meeting a 50ppm sulfur 95RON petrol standard. Incentives for clean fuels seen as an integral part of the fuel/vehicles package. Caltex would like to see the various measures, including subsidies for early production, put into legislation as soon as possible so sovereign risk is minimised. Request for Government to consider extending the diesel incentive forward one year, so it can produce 10ppm sulfur diesel from January 2006 rather than January 2007. Other than post 2006 fuel standard requirements, refiners face additional investments and costs this decade, relating to: increasing proportion of 95RON petrol (95RON petrol) in the petrol pool growing beyond 50% in the next decade; hydrotreating to reduce sulfur in petrol also reduces octane, which will increase the cost of producing lower sulfur petrol; state governments regulating lower levels of vapour pressure, requiring the more volatile components of petrol (eg butane) to be removed from petrol; and taxation of LPG from 2008 will reduce LPG sales, exacerbating the need to 'dispose' of excessive butane.

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× = do not support (either opposed to all aspects, or on key elements such as timing)

Stakeholder	Position on Proposed New Standards*					Summary of Main Comments
	2008		2009		2010	
	Euro 4	50ppm Petrol	*Euro 5*	10ppm Diesel	10ppm Petrol	
Col Potts Engineering						Submission provides a range of statistics and seems generally supportive of recommendations in Draft RIS.
CSIRO				✓		The Draft RIS does not give sufficient prominence to the issue of fine particles. Australia should review PM emission standards for light diesel engines sourced from Japan. While not wanting to disturb proposals to reduce sulfur and enable latest technology, wants to alert to the potential problems relating to up to a six fold increase in fine particles relating to gasoline direct injection (being introduced to reduce fuel consumption).
Environment Victoria (NGO)	✓	✓	✓	✓	✓	Climate change benefits of proposed standards need greater emphasis. A range of other incentives suggested: Review Fed Gov fleet purchasing policy; Influence Australian OEMs focus on large engines; Change fringe benefits approach to vehicles; Accelerate NAFC; and Encourage fleet turnover. Question the non-inclusion of health benefits of SO_2 reduction in the Cost Benefit Analysis (CBA). Criticises non-quantification of some benefits of strengthening of standards in CBA.
EPA Victoria	✓	✓	✓	✓	✓	Suggest that health benefits of proposed standards could be emphasised more.
Ethyl Asia Pacific Company			✓	✓		Support restriction of lower sulfur to 95RON petrol given its new technology enabling intention. The impact of reducing sulfur to 10ppm in petrol on octane is potentially a significant negative, and also will be overkill for the existing vehicle fleet. While recognising it is out of scope of the current review, reiterates importance of inspection and maintenance programs to reducing in-service emissions.
ExxonMobil					×	Broadly endorses the AIP submission, but considers MVEC recommendations premature, and considers 10ppm 95RON petrol is particularly high risk strategy. Consider that proposed standards will not deliver net environmental benefit, at least in near term. Recommend addressing off road diesel engine standards instead, as more efficient means of getting air quality gains. Further tightening of fuel standards will increase fuel costs and increase refinery emissions. Consider that high penetration of hybrid vehicles (19% by 2020) will achieve comparable fuel consumption savings without needing 10ppm 95RON petrol.

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✓ = support;
× = do not support (either opposed to all aspects, or on key elements such as timing)

Stakeholder	Position on Proposed New Standards*					Summary of Main Comments
	2008		2009		2010	
	Euro 4	50ppm Petrol	*Euro 5*	10ppm Diesel	10ppm Petrol	
Federal Chamber of Automotive Industries	×	✓			✓	Accepts *Euro 4* but proposes introduction timing of 2009/11, in part to enable vehicle manufacturers to best utilise the Federal Government's new Automotive Competitiveness and Investment Scheme "own use" Research and Development program in support of enhanced vehicle environmental performance. FCAI submits that a considerable additional reduction of CO_2 could be achieved in Australia if the price of diesel was kept significantly below that of unleaded petrol, encouraging the sale of a greater number of diesel engined light vehicles. FCAI supplied technical material to support case for 10ppm petrol to deliver the fuel consumption benefits expected under the NAFC agreement.
Federal Chamber of Automotive Industries (supplementary submission of 30/09/04, responding to LTEC Status Report)						Re-iterated earlier submission favouring adoption of *Euro 4* on the 2009/11 timeframe.
Warren Godson						Generally seeks earlier introduction dates for vehicle emissions and fuel quality standards than those being proposed. Recommends that sulfur be reduced to 10ppm in all grades of fuel not just 95RON petrol. Concerned that draft RIS understates problems associated with the use of MTBE (& ETBE), and they should never be used as an octane enhancer. Considers that the reduction of aromatics to 35% (consistent with *Euro)* is still important and can be achieved through the use of ethanol; and that LPG or Autogas be harmonised with current *Euro* standards.
Independent Petroleum Group		✓		✓	×	Do not anticipate problems in sourcing 50ppm petrol and 10ppm diesel as timing consistent with major world markets. Too early for decision on 10ppm petrol (delay 2 years). Support 50ppm S for <u>all</u> grades of petrol not just 95RON petrol, due to likely mis-fuelling at the forecourt if there is not differentiated nozzle sizes. Do not support AIP proposal to relax olefins specification
IOR Energy Pty Ltd				×		"IOR considers that any decision to adopt *Euro 5* diesel emission standards should be deferred until a more informed cost-benefit analysis in the Australian context has been made out." "Regulatory flexibility should continue to allow the supply of 50ppm diesel, particularly in non urban areas, if it does not have any deleterious effect on the consumer's engine".

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Stakeholder	Position on Proposed New Standards*					Summary of Main Comments
	2008		2009		2010	
	Euro 4	50ppm Petrol	*Euro 5*	10ppm Diesel	10ppm Petrol	
Motor Trades Association of Australia	✓	✓	✓	✓	✓	Concerned that costs associated with new standards be fully passed on to motorists. More consideration needed of ramifications of urea-based Selective Catalyst Reduction (SCR).
Northern Territory Government						Generally supportive of approach in RIS, but consider the following issues need further examination: the cargo penalty associated with *Euro 5* technology using urea, as well as its supply in rural area; changes required to service stations for the distribution of 95RON petrol petrol; and the lead times required by Australian refineries.
PACCAR Australia			✗	✗		"The adoption of Euro-centric emissions rules threatens the efficiency gains that have been achieved in the heavy road-transport industry." Concerned that the RIS doesn't recognise that there are Australian designed and manufactured trucks (PACCAR produces Kenworth trucks). Concerned that the RIS and CBA doesn't adequately analyse the risks associated with Urea/SCR compliance.
Qld Department of Fair Trading	✓	✓	✓	✓	✓	
Qld Environmental Protection Agency						The Qld Government raised the following concerns: **Costs of producing 10ppm sulfur fuel:** Representatives of the oil refining industry in Queensland have advised that the capital and operating costs of producing 10ppm sulfur petrol and diesel are expected to be significantly higher than estimated in the cost-benefit analysis presented in the RIS. **Presentation of cost benefit analysis:** The Cost-Benefit Analysis in Section 6 – "Comparative Analysis of Options" would benefit from a clearer presentation. **Differential impact in urban and rural areas:** The paper should include a discussion of the differential impact that the proposal will have in urban and regional and rural areas. Additionally, IOR Energy, which operates two mini-refineries in far-western Queensland, has advised that with currently available technologies, the capital cost of producing 10ppm sulfur diesel would render its mini-refineries non-viable. **Modelling of ozone concentrations:** A more accurate assessment of the benefits of the proposed changes would have been obtained if modelling studies had been conducted for other capital cities. It would be helpful if the discussion paper addressed any changes in relative concentrations of different types of ROCs from the different emission control technologies, and how this might influence overall ozone generation potential.

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Stakeholder	**Position on Proposed New Standards***					Summary of Main Comments
	2008		2009		2010	
	Euro 4	50ppm Petrol	*Euro 5*	10ppm Diesel	10ppm Petrol	
Qld Environmental Protection Agency (continued)						**Fate of sulfur removed from fuel:** The sulphur limits under consideration in the RIS are 50ppm and 10ppm for petrol and 10ppm for diesel. The removal of the sulphur from the fuel will produce extra sulphur at the refineries and the fate of this sulphur and its impact on the environment is not clear from the draft document. **Price Monitoring:** The RIS indicates that increased production costs will translate to a relatively small increase in fuel prices at the bowser. It is important that the Australian Competition and Consumer Commission has a monitoring role at key implementation stages so that prices are not artificially raised.
SA Department of Transport and Urban Planning	✓	✓	✓	✓	✓	While supporting the recommendations contained in the Draft RIS, SA makes recommends further work in these areas: **Air Toxics**: as transport is the greatest contributor of toxics into the environment and these will be specifically dealt with through the introduction of the Air Toxics NEPM, fuel and vehicle standards should address this problem more directly; **Particle emissions**: Particle emissions pose a significant risk to health and should be further addressed in the vehicle emissions standards, noting that while introduction of low sulfur fuels is likely to reduce these emissions from the entire vehicle fleet, there is no direct reduction in particulate matter from Euro 4 to Euro 5 standards for heavy vehicles. Recent concerns of ultra fine particles (PM2.5 and below) from petrol vehicles should be further addressed in the light vehicle standards. **MTBE**: The concentration of MTBE in fuel and its potential impact on water quality in Australia is of significant concern. Further reduction of allowable levels of MTBE in fuel should be considered.
Truck Industry Council			✗	✓		Considers implementation of *Euro 5* a low priority. Notes uncertainty about infrastructure requirements relating to Selective Catalyst Reduction (SCR) technology which need to be resolved before *Euro 5* is legislated, as well as issues relating to *Euro 4* implementation. Aspects of RIS relating to heavy vehicle contribution to air pollution incorrect/misleading. Recommends delaying legislation of *Euro 5* until January 2007; delaying introduction of Euro 5 until 2010; and that the referencing to the US EPA standard be revised to properly recognise the approach taken in the US. Also concerned that 'off road' diesel engines are ignored.
Truck Industry Council (supplementary submission of 20/08/04 responding to media release of 12/08/04)						TIC requests that the timing of noise standards for heavy vehicles in ADR83/00 be delayed by 12 months to align with the new start date for ADR80/01.

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✓ = support;
✗ = do not support (either opposed to all aspects, or on key elements such as timing)

Stakeholder	**Position on Proposed New Standards***					Summary of Main Comments
	2008		2009		2010	
	Euro 4	50ppm Petrol	*Euro 5*	10ppm Diesel	10ppm Petrol	
Truck Industry Council (supplementary submission of 27/09/04, responding to LTEC Status Report)			✓#	✓		TIC supports 12 month delay for ADR80/01; supports adoption of OBD and related requirements into ADR80/01; supports industry/government consultation process on urea/SCR issue, while raising concerns about proposed potential options for addressing the issue; supports adoption of *Euro 5* in 2010/11 # as per revised timing proposed by LTEC. TIC Proposes that ADR80/02 not be gazetted before January 2007.
US Engine Manufacturers Association						US EMA supports the adoption of US standards functionally equivalent to *Euro 5* (US EPA 2007) as an alternative to *Euro 5* for heavy-duty vehicles. Due to the complexity of US EPA 2007 standards, EMA recommends that reference to "engines covered by an EPA certificate" should be used to demonstrate compliance, rather than reference to a specific numeric standard. *Euro 5* should be adopted only in conjunction with 10ppm sulfur limit standard. The Draft RIS incorrectly attributes comments by EMA on complementary measures.
Harry Watson, University of Melbourne						The RIS should include a simple description of the effect of the proposed new standards on the business as usual emissions scenario and a simple description of benefits. "The report should draw attention to the fact that work on evaporative emissions is overdue."
WA Department of Environment	✓	✓	✓	✓	✓	WA would prefer to see a reduction in limit of aromatics but also strongly supports limitations for oxygenates such as MTBE. WA notes that use of urea injection and selective catalytic reduction will require on-road enforcement in a nationally coordinated manner prior to 2009 to ensure that emissions from such vehicles are not significantly higher. WA supports the use of incentives for clean fuels.
NSW Department of Environment and Conservation	✓	✓	✓ in 2010	✓	defer decision	NSW notes that their air quality modelling indicates that while some motor vehicle pollutants will decrease, photochemical smog (ozone) is not reducing to levels that would ensure long-term compliance with national air quality goals. NSW considers that a deferral of *Euro 5* introduction by one year, due to industry concerns, is acceptable. While its preferred start date for the standard of 10ppm sulfur PULP remains 2010, given industry concerns about availability, NSW considers deferral of a decision on a mandated start date to be prudent. NSW's preferred position is for: . Euro 4 for light vehicles in 2008/09 and 50ppm sulfur PULP in 2008; . Defer decision on 10ppm PULP until 2006 but target date remain at 2010; and . Euro 5 for heavy vehicles in 2010/11 and 10ppm sulfur diesel in 2009. NSW has estimated the Net Present Value of the NSW preferred position of $470m to $830m

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Appendix H Proposed New & Revised ADRs (*Step 1 Only*)

1. **Draft ADR79/02** ***Emission Control for Light Vehicles***

   This new ADR would embody the *Euro 4* emission standards for light petrol, LPG and NG vehicles.

2. **Draft ADR80/02** ***Emission Control for Heavy Vehicles***

   This new ADR would embody the current *Euro 5* emission standards for heavy diesel, LPG and NG vehicles. It would also adopt the US2008 emission standards for heavy petrol vehicles. It would also accept the US 2007 and Japanese Long Term 2005 standards for diesel, LPG and NG vehicles as an alternative to the *Euro 5* standards.

3. **Draft ADR80/01** ***Emission Control for Heavy Vehicles***

   This revised ADR would relax the current applicability dates for diesel, LPG and NG vehicles in ADR80/01 by 12 months.

4. **Draft ADR83/00** ***External Noise***

   This revised ADR would relax the current applicability dates for heavy duty diesel, LPG and NG vehicles (GVM > 3.5 tonnes) in ADR83/00 by 12 months.

{NOTE: due to formatting issues, the propsed ADRs are supplied as separate documents}