

Setting the Ethanol Limit in Petrol

An Issues Paper

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INTRODUCTION

This paper provides an opportunity for public comment on the most appropriate ethanol limit in petrol and/or the assessment method to determine the limit. The limit will be regulated under the *Fuel Quality Standards Act 2000*.

The Act provides the framework for the establishment of national fuel standards for automotive use. The main object of the Act is 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 emission control technology; and (c) allow more effective operation of engines.

The first set of standards, for both petrol and diesel, came into effect on 1 January 2002. The Government determination on environmental standards for petrol and diesel is at Appendix A. Work is under way to develop operability standards for these fuels.¹

Background

In May 2000, under the process to set the environmental standards for petrol, a maximum oxygen content of 2.7% in petrol was proposed.² However, this limit would restrict ethanol/petrol blends to a maximum of 7.8% ethanol, which is less than the E10 (10% ethanol) already on the market.

Since most stakeholders accept that E10 can be used without adverse impacts on vehicle performance and durability, the position was revised in September 2000 to provide for a maximum oxygen content of 3.5%, to accommodate ethanol blends up to 10%.³ Ethanol/petrol blends would still be required to meet the Reid Vapour Pressure (RVP) limits set by State and Territory legislation. Most stakeholders supported this position. The fuel ethanol industry did not support this position, and has sought a limit above 10%.

In April 2001, Manildra Park Petroleum stated that ethanol blends up to 20% do not have any adverse impacts on vehicle operability and performance. Manildra Park Petroleum stated that 10% to 20% ethanol/petrol blends have been supplied to some of the NSW vehicle fleet since 1992, with no serious vehicle compatibility, drivability or operability issues arising. The company commissioned a study, conducted by the Department of Chemistry at Macquarie University, on the effects of higher ethanol blends on fuel parameters.⁴ This study was presented to Environment Australia and other Government agencies. Environment Australia (EA) commissioned an independent technical review of the study.

At that time, EA acknowledged that there were no real-world data on the impacts of higher ethanol blends on emissions outcome and engine operability, that take into account Australian conditions (climatic and current/future vehicle technology).

¹ The proposed operability standards are presented in: DISR, 2001, Setting National Fuel Quality Standards: Paper 4: Discussion Paper on Operability Fuel Parameters (Petrol and Diesel), available at <http://www.ea.gov.au/atmosphere/transport/fuel/paper4.html>

² This proposal represented harmonisation with European Standards and was presented in the May 2000 Discussion Paper.

Throughout this paper '%', where it relates to oxygen content is '%m/m' and where it relates to ethanol content it is '%v/v'.

³ This exemption was presented in the September 2000 "Revised Commonwealth Position" available at: <http://www.ea.gov.au/atmosphere/transport/fuel/pubs/fuel0900.pdf>

⁴ Batts, B., 2000, A Report on Direct Determination of the Effect of the Addition of Ethanol on the Physical Properties of Gasoline.

The Federal Chamber of Automotive Industries (FCAI) opposes the use of 20% ethanol blends without modifications to the current Australian automotive fleet, on the basis of engine calibration and materials durability issues.

In May 2001, the Government deferred a decision on setting a standard for the ethanol limit in petrol for 12 months, to allow completion of studies which will provide a scientific basis for setting the appropriate level of the cap. The studies will include an examination of issues including vehicle operability, environmental performance, effects on engines, and any health or safety implications.

Environment Australia has established an Ethanol Task Force to assist in the development of an appropriate process to assess the impacts of higher ethanol blends in petrol (ie. higher than 10% and up to 20%) on other fuel parameters, materials compatibility and engine operability and performance. The Task Force has assisted in the development of this paper.

The membership and Terms of Reference for the Ethanol Task Force are at [Appendix B](#).

Ethanol/petrol blends will be treated as 'petrol' under the national *Fuel Quality Standard Act* 2000. Such blends will need to meet all legislative requirements for petrol (including any State and Territory requirements such as Reid Vapour Pressure limits). The operability and durability of vehicles will also need to be unaffected by fuel blends up to 20% ethanol and by sharp changes between petrol and ethanol/petrol blends.

Consideration is limited to ethanol/petrol blends up to 20% ethanol. Pure ethanol or E85 (85% ethanol) blends are not considered.

Guide to this paper

This paper is presented in two parts:

Part 1 provides background information on the use of ethanol as an automotive fuel.

Part 2 raises issues for comment relating to:

- A: vehicle operability and effects on engines;
- B: environmental performance; and
- C: any health or safety implications.

The purpose of this paper is to provide a basis for discussion and to highlight issues which require further comment or input. In Part 2 of the paper, each issue presented invites specific comment. (For your convenience, the issues for comment are collated at the end of this section.) In responding, please provide supporting documentation wherever possible.

Your comments on higher ethanol blends should be considered in the context of:

- the current and future vehicle fleet, which must be able to operate effectively and efficiently on an ethanol limit higher than 10%, without the need for re-tuning/re-calibration or other modifications; and
- the current storage and distribution system, for all grades of petrol, which must be utilised - or require only minor modifications.

For each issue, please indicate if laboratory or field work is required to assess the impact of higher ethanol blends and suggest how such work should be designed and implemented.

The paper is not intended to provide a technical assessment of the issues involved and readers may wish to refer to the associated references to obtain further technical details.

Call for public submissions

In order to ensure that the most appropriate ethanol limit in petrol is adopted in Australia, comments on the issues raised in this paper are sought from all interested stakeholders and members of the public.

All submissions will be treated as public documents. Written comments are requested by **Friday 15 March 2002** and should be sent in Microsoft Word or Rich Text Format to:

Clean Fuels and Vehicles Section
Environment Australia
PO Box 787
Canberra ACT 2601
Fax: 02 6274 1172
Email: fuel.quality@ea.gov.au

An interim report will be delivered to the Commonwealth Government outlining the current information set and the views contained in stakeholders' submissions. The submissions will also be used to inform an appropriate process to assess the impacts of ethanol blends in the range of 10% to 20%.

ISSUES FOR COMMENT

Collated below are the issues relating to higher ethanol blends (higher than 10% but less than 20%) that are raised in this paper. In each case it would be particularly helpful if you could indicate if laboratory or field work could give some resolution to the particular issue and suggest how this might be designed and implemented.

1. The effect of higher ethanol blends on octane sensitivity.
2. The effects of higher ethanol blends on:
 - a.) enrichment; and
 - b.) existing and future vehicle technologies.
3. The likely effect of higher ethanol blends on:
 - a.) Reid Vapour Pressure (RVP);
 - b.) Flexible Volatility Index; and
 - c.) the distillation curve.
4. The likely effect of higher ethanol blends on:
 - a.) the range of existing and future vehicle technologies; and
 - b.) general engine operability, such as:
 - i.) cold startability;
 - ii.) warm-up performance;
 - iii.) uneven idling and unevenness during cruising; and
 - iv.) driveability index.
5. The cost implications of blending ethanol with a Blendstock for Oxygenated Blends in order to meet RVP requirements.
6. Issues relating to other fuel parameters.
7. The potential impacts of ethanol blends on the following parameters:
 - a.) corrosion;
 - b.) stability; and
 - c.) gum deposits.
8. The effect of higher ethanol blends on:
 - a.) different vehicle technologies (eg: carburetted, fuel injected, closed loop); and
 - b.) components.
9. The significance of the potential increase in fuel consumption from higher ethanol blends, in comparison to other alternative/renewable fuels.
10. The potential impact of higher ethanol blends on vehicle warranties in Australia.
11. The emission effects of higher ethanol blends.
12. The potential impact of higher ethanol blends on materials construction in the petrol distribution and storage system.
13. The contribution of ethanol content to phase separation in:
 - a.) the storage and distribution network; and
 - b.) vehicle tanks.

14. The possible risk of more persistent BTEX (benzene, toluene, ethylbenzene and xylene) plume associated with the use of higher ethanol blends.
15. The health and safety impacts of higher ethanol blends.

PART 1: BACKGROUND

What is ethanol and why is it used as an automotive fuel?

Ethanol (ethyl alcohol) is a clear, colourless liquid with a faint odour. It has a high latent heat of vaporisation⁵ and contains oxygen, characteristics that are relevant to its environmental performance in combustion as a motor fuel, and in its storage and distribution.⁶

Ethanol can be produced in two forms: hydrated and anhydrous. Hydrated ethanol, usually produced by distillation from biomass fermentation, contains 95% ethanol with the balance being water. It is suitable for use as a straight spark ignition fuel in warm climates or for blending as a 15% emulsion in diesel. A further process of dehydration is required to produce anhydrous ethanol (100% ethanol) for blending with petrol. As ethanol is an excisable product, being the active ingredient of alcoholic drinks, it may only be produced by a licensed distillery. Most industrial ethanol is denatured (to prevent oral consumption), by the addition of small amounts (1 - 5 %) of unpleasant or poisonous substances.⁷

Ethanol can be used as an automotive fuel by itself and can be mixed with petrol to form an ethanol/petrol blend. The most common uses are:

- a) 10% ethanol (known as E10);
- b) 85% ethanol (known as E85); This blend is used in some states of the US and requires particular vehicle technology known as 'Flexible Fuel Technology' (FFT).
- c) 20 - 24% ethanol (known as E22); This blend, used in Brazil, requires specific vehicle optimisations (re-calibration and component changes) for 22% ethanol.⁸ and
- d) 100% ethanol (E100); This is also used in Brazil and requires vehicle technology dedicated to the fuel.

Ethanol is a known 'octane enhancer' and 'oxygenate'. An octane enhancer is a component added to petrol to increase, in this case, the research octane number and to reduce engine knock. An oxygenate is a fuel octane component containing hydrogen, carbon and oxygen in its molecular structure.

Oxygenates are often added to petrol to increase octane, to extend petrol supplies and to induce a lean shift ('enleanment')⁹ in the engine's operation. Oxygenates chemically 'enlean' the fuel by providing it with additional oxygen, altering the air/fuel ratio¹⁰ and thereby improving combustion and reducing tailpipe emission of carbon monoxide (CO) for vehicles where no feed-back control of the air/fuel ratio exists (ie. open-loop).

⁵ Latent heat is the amount of heat absorbed or given when a substance changes its state without changing its temperature. Therefore ethanol requires a greater energy input to vaporise than does petrol.

⁶ Renewable Transport Fuels Working Group, 2001, Renewable Energy Action Agenda, Initiative 2 – Promote the Development of the Renewable Transport Fuel Industry

⁷ Ethanol for blending with petrol is denatured according to ATO guidelines. In these circumstances, the ethanol is free of excise duty and no further excise is payable when that denatured ethanol is blended with petrol on which excise duty has been paid. In instances where petrol/ethanol blends are made in a place licensed under the *Excise Act* 1901 such as a refinery or a terminal, a formula in the Act results in the ethanol component of the blend being free of excise duty.

⁸ Apace Research, 1998, Intensive Field Trial of Ethanol/Petrol Blends in Vehicles; Petrobras advise that 26% blends have been used in the past but exhibit a negative emission outcome (see SAE paper 2001-01-1966). Typical blend range is 20% - 24%.

⁹ When there is more oxygen present than is required for stoichiometric combustion (stoichiometric combustion is the complete combustion of fuel to CO₂ and water, with no excess oxygen).

¹⁰ Raising the A/F ratio is a consequence of the different proportions of air needed to react with stoichiometric (chemically correct) proportion of ethanol compared with the hydrocarbons.

Ethanol blends tend to result in reduced emissions of carbon monoxide (CO); hydrocarbons (HCs); particulate matter; and certain known carcinogens. However, ethanol blends are likely to increase emissions of aldehydes, particularly acetaldehyde. Several US studies conclude that the overall ozone forming potential of ethanol blends is the same or lower than that of petrol.¹¹ This outcome is achieved by blending the ethanol into a blendstock to meet volatility requirements.¹² Emissions of oxides of nitrogen (NOx) have been shown to decrease in some circumstances and to increase in others. These concepts and the emissions outcomes of using ethanol blends are discussed further under Environmental Performance in Part 2.

Ethanol can be considered as a renewable fuel when produced sustainably from agricultural sources and has potential for greenhouse gas emissions abatement. Whether this potential is realised depends on the feedstock and the technology used in the production process, especially the nature of energy inputs used in biomass production, transportation, distillation and other phases, as well as on the distribution and blending procedures.¹³

How is ethanol used as an automotive fuel?

Brazil

Brazil is the largest user of fuel ethanol in the world. It is the only country that utilises ethanol blends at concentrations higher than 10%, with the exception of the use of E85 in Flexible Fuelled Vehicles in the US. Currently, 18.9% of the cars in Brazil operate on 100% ethanol. The remaining cars are optimised to run on blends of 22% (to meet the range of 20-24% blends). Brazil consumes nearly 4 billion gallons (15 billion litres) of fuel ethanol per year.¹⁴

Dedicated and optimised engines and fuel system materials are manufactured for the 22% ethanol/petrol blend.¹⁵ Most of Brazil's vehicle production is indigenous (including Volkswagen, Fiat, Ford and General Motors Holden), with both domestic and imported vehicles optimised to meet the unique fuel supply situation.

All petrol fuels sold in Brazil have an ethanol content ranging from 20% to 24%. The only other available fuel is neat (100%) ethanol.

United States

The US EPA regulates the use of 10% ethanol blends via the 'Substantially Similar Rule'¹⁶ to ensure that the use of oxygenates does not contribute to emission control system failure. The regulation prohibits the introduction, or increase in concentration of, a fuel or fuel additive which is not 'substantially similar to any fuel or fuel additive already utilised'. The Substantially Similar Rule recognises that the use of certain types of oxygenates have no adverse effects below a specified oxygen content.

The US EPA regulations also create a process by which a waiver can be granted for an oxygenated 'recipe' that is demonstrated not to cause or contribute to the failure of any emission control device or system. Under this regulation, the US EPA has granted

¹¹ American Coalition for Ethanol Web Site

¹² D. Munro, pers. comm.

¹³ Renewable Transport Fuels Working Group, 2001, Renewable Energy Action Agenda, Initiative 2; BP, pers. comm.

¹⁴ Renewable Fuels Association Web Site

¹⁵ Moreira, J.R. and J. Goldenberg, 1999, The Alcohol Program.

¹⁶ US EPA Web Site

waivers for concentrations of ethanol in petrol up to 10%. The finished product must conform to gasoline specified by ASTM D 4814-88 and US original equipment manufacturer (OEM) vehicle warranties specify that petrol must not contain more than 10% ethanol. Therefore, the use of blends higher than 10% in OEM vehicles could result in the void of vehicle warranties.

The US Department of Energy (under its Clean Cities Program) and the National Corn Growers Association are cooperating to promote the development of refuelling infrastructure for E85 and to encourage fleet operators to choose ethanol to meet the alternatively fuelled vehicles requirements of the Energy Policy Act.¹⁷ As previously stated, E85 blends require FFT.

The potential phase-out of MTBE (methyl tertiary butyl ether) and an increasing emphasis on domestic energy supply and energy security are likely to favour increased use of fuel ethanol in the US.¹⁸

Europe

In Europe, the ethanol limit is controlled by the oxygen content limit of 2.7%, which equates to an ethanol limit of 7.8%. No waiver for ethanol blends higher than 7.8% is provided. ETBE (ethyl tertiary butyl ether) is the oxygenate preferred by European refiners and car manufacturers.¹⁹

The use of ethanol as a transport fuel in Europe is limited by a number of factors, such as concerns over the potential use of Genetically Modified crops to meet demand, and the recency of the implementation of an EU-wide renewables policy.²⁰

Australia

Australian ethanol is produced from the fermentation of sugar from either wheat starch or from 'C' grade molasses.²¹ In 2000-01, around 43 million litres of fuel ethanol was produced. The Australian Taxation Office advises that the volume to date this financial year has increased significantly, and on present projections, may total over 60ML in 2001-02.

In 1999-2000 approximately 530ML of E10 was sold in New South Wales and Victoria. Ethanol/petrol blends are being blended, distributed, and sold by over 200 service stations operated by independent oil companies in NSW. Manildra Park Petroleum, the largest independent distributor of ethanol blended fuel in the Sydney/Wollongong basin, has been selling blends up to 20% in NSW since 1992.²²

It should be noted that although it is currently not widely used in Australia, MTBE will be phased out by 1 January 2004, and this may have implications for the use of ethanol as an octane enhancer to meet increasing demand for 95 RON (research octane number) petrol.

¹⁷ Hart/IRI Fuels Information Services, 2001, Overview of Higher Ethanol Blends.

¹⁸ Hart/IRI Fuels Information Services, 2001, Overview of Higher Ethanol Blends.

¹⁹ Hart/IRI Fuels Information Services, 2001, Overview of Higher Ethanol Blends.

²⁰ Hart/IRI Fuels Information Services, 2001, Overview of Higher Ethanol Blends.

²¹ C molasses is a by-product of the sugar milling process. Clarified cane juice is concentrated into a syrup. The syrup is further concentrated by boiling in a vacuum until crystals of a required size are grown. The syrup is separated from the crystals in centrifugals. The centrifuging process is repeated until further extraction of crystals is not economical, usually three times. The syrup remaining after the third centrifuging is known as C molasses.

²² ABA pers. comm.

Field Trials

To date, in Australia there have been two field trials on ethanol/petrol blends in vehicles. Both were commissioned by National Energy Research Development and Demonstration Council (NERDDC)/Energy Research and Development Council (ERDC). One study conducted by CSR and the NRMA in 1980-83, examined the impacts of E15 (15% ethanol). The other study was conducted by Apace (published in 1998), and examined the impacts of E10. These studies are outlined below.

In 1979, the NERDDC commissioned CSR Chemical Ltd to conduct a two-stage project into the use of ethanol blends with petrol. The project included a 100 vehicle fleet trial conducted in 1980-83 by CSR and the NRMA on anhydrous E15 and hydrated alcohol E15 (with 1% butanol as co-solvent). The study utilised 15% ethanol blends as it was concluded that any higher blends would 'lead to problems not only in the supply of sufficient ethanol but in the performance of unmodified engines.' The study also stated that serious attention would have to be given to economic issues.

The NERDDC report highlighted many issues relating to impact of E15 on fuel parameters, engines and engine fuel systems. For example, the ethanol blends were more volatile in the low to mid-range of their respective distillation curves, and laboratory testing of plastics and elastomers indicated that some materials were not suitable for use with the ethanol blends.²³ Although this study utilised older vehicle technology, and engines and fuel systems have substantially changed (as have refineries and refinery processes), it provides the only field trial data on E15 available in the Australian context. It is worth noting that such blends had an impact on fuel parameters and older vehicle technology.

In 1994, ERDC commissioned a study by Hassall and Associates (Project No. 227 - Extended Field Trials of Ethanol Blends in Vehicles) to develop a costed and prioritised work program to resolve identified field trial needs in Australia for ethanol-based fuel. The program design was required to take into account environment and economic cost/benefit issues.

ERDC Project No. 227 formed the basis of Project No. 339, an intensive field trial of ethanol/petrol blends (10%) in vehicles. Project No. 339 was published by Apace Research in 1998 and established the effect of E10 blends on:

- noxious and greenhouse gas emissions;
- fuel consumption;
- vehicle drivability under various climatic conditions;
- fuel system component and materials compatibility;
- engine wear; and
- water tolerance issues arising from blending, storage and distribution.

The emissions outcomes of the study are detailed later in this paper. In terms of vehicle operability, the study found that there were no significant differences in performance; and there was a reduced tendency for 'knock' under both hot and cold conditions. There were no discernible effects on any plastic or elastomer materials, no discernible corrosion in fuel wetted metal parts such as fuel tanks and fuel lines, and no additional or unusual wear to that normally expected.²⁴

²³ Hassall and Associates, 1994, Extended Field Trials of Ethanol Blends in Vehicles.

²⁴ Apace Research, 1998, Intensive Field Trial of Ethanol/Petrol Blends in Vehicles.

PART 2: ISSUES

A: Vehicle Operability and Effects on Engines

i: Effects of ethanol on fuel parameters

Octane

The octane number is a measure of the resistance to the abnormal combustion phenomenon known as ‘knock’. As previously stated, ethanol in petrol is known to enhance the octane number or rating of fuel, and is recognised worldwide as a proven octane enhancer.

The octane performance of a fuel is measured under two different operating conditions that provide the ‘research’ and ‘motor’ octane numbers (RON and MON) of the fuel. RON relates to low speed (lugging) operation, and MON relates to high engine speed operation.

The octane requirement of a particular engine type results from a number of design factors such as compression ratio and the design of the combustion chamber. Engines and petrol octane numbers are complementary; engines are designed to operate effectively on commercial fuel of specified octane numbers and fuel suppliers must ensure petrol octane meets these market needs.²⁵

The difference between the RON and MON is called the ‘sensitivity’. Petrol manufacturers try to maintain this at about 8 to 10 units to prevent high speed knock and possible engine damage. The sensitivity of E10 is about 14 units, although this may vary somewhat depending on the composition of the base petrol.

Issues for comment:

1. The effect of higher ethanol blends on octane sensitivity.

Oxygen content

The oxygen content required for combustion in a motor vehicle running on non-oxygenated fuel is sourced from the air. The oxygen content of a fuel has an effect on the Air-to-Fuel (A/F) ratio. The A/F ratio required for complete combustion (the stoichiometric balance) is 14.6:1, that is 14.6 kilograms of air to one kilogram of non-oxygenated fuel.

Ethanol blended fuels have an increased oxygen content (ethanol at 10% equates to an oxygen content of 3.5%), which will alter the A/F ratio at which the engine is operating. The A/F ratio of the Brazilian-made Volkswagen, which is optimised to run on 22% ethanol, is set at 12.7:1.²⁶

Changes in the oxygen content will have different impacts on various vehicle technologies. The Australian car fleet has a mix of vehicle technologies, including:

- pre-1986 vehicles designed to run on leaded petrol and not fitted with catalysts;
- open-loop carburetted vehicles - with oxidation only catalyst;

²⁵ D. Munro, pers. comm.

²⁶ ABA, pers. comm.

- open-loop fuel injected vehicles - with oxidation only catalyst;
- closed loop (computer controlled) carburetted vehicles with three-way catalysts for HC, CO and NO_x control, (this technology is also referred to as Electronic Control Module (ECM));
- closed-loop fuel-injected vehicles - either central point injection, banked port injection or sequential port injection with three-way catalyst; and
- (in the future) direct injection engines.

The electronic management system in a modern car has the ability to change the air/fuel ratio to maintain stoichiometric balance in order to minimise exhaust emissions. The extent to which the electronic management system can control the ratio and maintain pollution control of the vehicle may vary from manufacturer to manufacturer but must meet emissions standards.

Carburetted vehicles with open loop systems are unable to make adjustments to changes in the oxygen content of the fuel. Computer controlled carburetted vehicles may compensate, at least in part, to the changed circumstances. Closed loop fuel injected vehicles may be able to substantially compensate, so that a higher fuel oxygen content has little influence on emissions up to a point when it moves outside the range of the control system. For some current vehicles the maximum level of oxygen that can be compensated for is 3.5%.²⁷

Issues for comment:

2. The effects of higher ethanol blends on:
 - a.) enleanment;
 - b.) existing and future vehicle technologies.

Volatility

Volatility refers to a fuel's ability to change from liquid to vapour. It is characterised by three measurements - vapour pressure, flexible volatility index and distillation curve.

Volatility is commonly measured by RVP (Reid Vapour Pressure), which is the fuel's vapour pressure at 37.8 degrees Celsius. This is a measure of the fuel's more volatile components which vaporise first, known as 'front end volatility'. RVP is largely governed by the fuel's butane content, which has an RVP of around 350 kPa.²⁸

Flexible Volatility Index (FVI) is a parameter used to ensure good hot weather operability of the fuel by limiting the fuel volatility so that vapour lock will not occur. It is the sum of the RVP and the percentage of fuel evaporated in a simple distillation test at 70C. The proposed operability standards provide for a FVI limit.²⁹

The distillation test is used to determine the fuel's volatility across the entire boiling range of petrol and the plot of the evaporation temperature versus volume distilled is referred to as the distillation curve.³⁰

Petrol that is too volatile may vaporise easily and boil in fuel pumps, lines or in carburettors at high operating temperatures. If too much vapour is formed, this could

²⁷ D. Munro, pers. comm.; H. Watson, pers. comm.

²⁸ Coffey Geosciences, 2000, Review of Fuel Quality Requirements for Australian Transport.

²⁹ DISR, 2001, Paper 4: Discussion Paper on Operability Fuel Parameters (Petrol and Diesel).

³⁰ Changes in Gasoline III, 2000.

cause a decrease in fuel flow to the engine, resulting in symptoms of vapour lock, including loss of power, rough engine operation, or complete stoppage.³¹ Fuel economy could also deteriorate and evaporative emissions could increase, particularly if the carbon canister overloads, resulting in venting of fuel vapour to the atmosphere.³² Fuel vaporisation may have a greater impact in carburetted or mechanical fuel injection engines than later model electronic fuel injection engines.

Volatility is directly affected by regional temperatures. The more volatile a fuel, the greater the evaporative losses of hydrocarbons which contribute to photochemical smog. Since this is an urban airshed problem, the States and Territories manage RVP and ethanol blends will be required to meet the RVP limits set by the relevant States and Territories.

Although ethanol itself has an RVP less than that of petrol, its addition to petrol markedly increases the RVP of the blend, which can lead to increased evaporative emissions. It is generally accepted that the peak RVP of ethanol blends occurs at around 5-10% ethanol concentration, and is about 6.5% above the RVP of neat petrol. At 20% ethanol concentration, the RVP is approximately 5% above that of neat petrol.³³ The increase in RVP can be overcome if ethanol is blended with a blendstock which has reduced RVP (usually lower butane), this is known as a Blendstock for Oxygenated Blends (BOB). This ensures that the final product (blendstock with ethanol) does not exceed volatility requirements. This practice is utilised in the US and Brazil.

Driveability Index

The Driveability Index (DI) of petrol is a specification used to manage engine performance during cold weather and whilst the engine is warming up. Driveability problems usually show as hesitation and stumbling when accelerating, uneven idling and surging when cruising. The problems usually disappear as the car warms up. Petrol is a mixture of many hydrocarbons with differing boiling points. If petrol does not have sufficient front-end or lighter components and in particular, sufficient mid-range components, then a vehicle will not drive or run smoothly, particularly when the engine is cold.

DI is a mathematical expression of distillation properties that have been developed by the European automotive industry to describe the influence of fuel volatility on driveability:

$$DI = 1.5 T10 + 3 T50 + T90 + 11 \text{ Oxygenates}$$

where T10, T50, T90 are the temperatures at which 10%, 50 % and 90% respectively, of the petrol has evaporated and oxygenates is the concentration of oxygenates in wt-%. (Note: oxygenate correction does not apply to ethers.)³⁴

Ethanol has a higher heat of vaporisation than other octane enhancers (such as ethers) resulting in poorer cold start performance for ethanol/BOB blends compared to petrol. Furthermore, if base petrol stock is not adjusted to maintain RVP there is an apparent improvement in DI for moderate ethanol addition (approximately 15%). However, when blended with a BOB, ethanol may cause inferior driveability.³⁵ Adding alcohols to petrol also depresses the boiling temperature of individual hydrocarbons.³⁶

³¹ D. Munro, pers. comm.

³² Changes in Gasoline III, 2000.

³³ Apace Research, 1998, Intensive Field Trial of Ethanol/Petrol Blends in Vehicles.

³⁴ DISR, 2001, Paper 4: Discussion Paper on Operability Fuel Parameters (Petrol and Diesel).

³⁵ H. Watson, pers. comm.; American Petroleum Institute, 2001, Alcohols and Ethers.

³⁶ American Petroleum Institute, 2001, Alcohols and Ethers.

Control of the DI and oxygen content are used to assure good cold start and warm up performance.³⁷

Issues for comment:

3. The likely effect of higher ethanol blends on:
 - a.) RVP;
 - b.) FVI; and
 - c.) the distillation curve.
4. The likely effect of higher ethanol blends on:
 - a.) the range of existing and future vehicle technologies; and
 - b.) general engine operability, such as:
 - i.) cold startability;
 - ii.) warm-up performance;
 - iii.) uneven idling and unevenness during cruising; and
 - iv.) driveability index.
5. The cost implications of blending ethanol with a BOB in order to meet RVP requirements.

Other fuel parameters

Higher ethanol blends must meet all the legislated requirements for petrol quality. These include the environmental parameters that have been determined (see Appendix A) and the operability standards (see Paper 4), once they come into effect.

Issues for comment:

6. Issues relating to other fuel parameters.

ii: Effects of ethanol on vehicle operability and components

General operability and materials compatibility

Ethanol blends may have varying effects on different technologies within the existing and future Australian car fleet (the technologies are outlined above under Oxygen content).

During the 1970s and 1980s, when blends ranging between 14% and 24% were used, numerous modifications were made to automobiles manufactured and sold in Brazil.³⁸ Changes to the cylinder walls, cylinder heads, valve, valve seats, pistons, piston rings, intake manifolds, carburettors and electrical systems were among the modifications

³⁷ World-Wide Fuel Charter, 2000.

³⁸ Hart/IRI Fuels Information Services, 2001, Overview of Higher Ethanol Blends.

made.³⁹ Nickel plating of steel fuel lines and fuel tanks is common in Brazil to provide adequate corrosion protection against E20-type fuel.⁴⁰

Most metal components in automobile fuel systems will corrode or rust in the presence of water, air or acidic compounds, and the addition of ethanol increases petrol's ability to hold water. Several studies which have examined the effect of E10 on vehicle tanks and fuel system components have concluded that ethanol up to 10% does not increase corrosion in normal, everyday operation. Auto manufacturers in the US have indicated that they do not have major concerns about metal corrosion, provided that all fuels contain corrosion inhibitors at the proper treated levels and that ethanol is limited to 10%. There are ASTM specifications to ensure that fuel grade ethanol is suitable for addition to gasoline.

Elastomer (rubber-like compounds used in fuel lines, evaporative canister lines etc) compatibility with ethanol blends is more difficult to generalise. A number of petrol constituents can have an effect on elastomer swelling and deterioration. For instance, aromatics, such as benzene have been shown to have detrimental effects on some fuel system elastomers. Some studies have shown that E10 blends contribute less elastomer swelling than would the amount of additional aromatics needed to obtain the same increase in octane number.⁴¹ However, the combination of ethanol with higher aromatic levels may cause greater swelling than either product by itself.⁴²

Pre-1986 vehicles may have fuel components that are sensitive to ethanol blends, but specific documentation on the effect of fuel components on older fuel systems is often lacking. In response to this, auto technicians in the US are advised to replace parts on pre-1980 vehicles with components which are resistant to 10% ethanol blends such as EGR valves, fuel inlet needle tips and fluoro elastomers (for fuel lines, evaporative control lines etc.).⁴³

Occasionally, in older model vehicles, deposits in fuel tanks and fuel lines are loosened by E10. When this occurs, the vehicle's fuel filter may become plugged, but this is easily remedied by a fuel filter change.⁴⁴

Concerns have been raised that fuel containing blends of ethanol higher than 10% may cause paint damage to a vehicle during refuelling, and such damage may not be covered by a vehicle's warranty. Holden laboratory tests have shown that blends of 20% pure ethanol in petrol can damage some conventional paint systems.⁴⁵

Manildra Park Petroleum has stated that it has received no reports of component problems associated with the use of higher ethanol blends in pre-1980 vehicles in NSW.⁴⁶ Conversely, anecdotal reports from car dealers in NSW indicate that vehicle operability problems are associated with the use of high alcohol blend fuels.⁴⁷

It is also worth noting that Holden is currently exporting an Australian built vehicle (Holden Commodore) to the Brazilian market. Modifications have been made to fuel system materials to prevent corrosion, and engine calibration changes have been necessary to allow proper engine operation. In the case of the latter modification, the changes are such that an engine calibrated for successful operation on E22 may not

³⁹ Hart/IRI Fuels Information Services, 2001, Overview of Higher Ethanol Blends.

⁴⁰ FCAI, pers. comm.

⁴¹ Changes in Gasoline III, 2000.

⁴² Changes in Gasoline III, 2000.

⁴³ Changes to Gasoline III, 2000.

⁴⁴ Changes in Gasoline III, 2000.

⁴⁵ FCAI, pers. comm.

⁴⁶ ABA, pers. comm.

⁴⁷ FCAI, pers. comm.

perform satisfactorily on neat petrol.⁴⁸ The exported vehicle has a revised engine calibration which ensures that stoichiometric air/fuel ratio is achieved using E22. Higher flow-rate injectors are also necessary to allow higher fuel flow to compensate for 'enleanment' of the A/F ratio due to the increased oxygen content of the E22 blend.

Issues for comment:

7. The potential impacts of ethanol blends on the following parameters:

- a.) corrosion;
- b.) stability; and
- c.) gum deposits.

8. The effect of higher ethanol blends on:

- a.) different vehicle technologies (eg: carburetted, fuel injected, closed loop); and
- b.) components.

Fuel consumption

Ethanol, like other alternative/renewable fuels, has a lower calorific value than petrol. This results in ethanol/petrol blends having a lower calorific value than that of neat petrol.

Fuel consumption is influenced by a range of factors including: energy content of the fuel; vehicle technology; engine maintenance and calibration; driving conditions; and individual driving patterns and behaviour.

The 1998 Australian field trial observed a fuel consumption increase of up to 2.8% with E10.⁴⁹ This finding is consistent with theoretical energy losses of approximately 2-3%.

US government agencies, industry and the scientific community have conducted numerous studies examining the effects of oxygenates on motor vehicles. This research indicates that a fuel consumption increase experienced as a result of oxygenate use agrees with the theoretical prediction for fuel energy loss.⁵⁰ It is reasonable to conclude that any fuel consumption increase experienced with oxygenate use is solely a function of the change in fuel composition and the resulting decrease in energy content of the fuel.⁵¹

Recent life-cycle analysis work has revealed that about 4% more fuel is required in an E10 blend to achieve the same MJ/L.⁵² On an energy content basis, it is estimated that for E20 fuel consumption will increase by about 7%.⁵³

The ABA advises that Volkswagen work on engines optimised to 22% blends has shown that power, torque and maximum speed increase by 3.3%, 2.1% and 3.2%, respectively

⁴⁸ Confirmed by GM Brazil

⁴⁹ Apace Research, 1998, Intensive Field Trial of Ethanol/Petrol Blends in Vehicles.

⁵⁰ National Science and Technology Council, Committee on Environment and Natural Resources, 1997, Interagency Assessment of Oxygenated Fuels.

⁵¹ National Science and Technology Council, Committee on Environment and Natural Resources, 1997, Interagency Assessment of Oxygenated Fuels.

⁵² Beer, T., et al, 2001, Comparison Transport Fuels: Life-Cycle Analysis of Alternative Fuels for Heavy Vehicles.

⁵³ Watson, H., 2001, Technical Assessment of "A Report on Direct Determination of the Effect of the Addition of Ethanol on the Physical Properties of Gasoline".

and fuel consumption in litres/100km decreases between 2 and 4.5%, compared with neat petrol.⁵⁴

A US EPA study also showed that vehicle fuel consumption increases steadily with increasing ethanol content. At 10% ethanol, fuel consumption increased about 5%. At 25% it increased by about 8%. At 40%, fuel consumption was about 13% above that of the base fuel.⁵⁵

Issues for comment:

9. The significance of the potential increase in fuel consumption from higher ethanol blends, in comparison to other alternative/renewable fuels.

iii: Vehicle warranty

As previously stated, US OEM vehicle warranties only permit the use of up to 10% ethanol, and it is considered that the situation would be much the same in Australia. The 2000 Auto Manufacturer Fuel Recommendations detail the potential void of vehicle warranties by the use of ethanol blends higher than 10%. For example, Mazda states that vehicles can only use oxygenated fuels containing no more than 10% ethanol by volume. The owner manual states that vehicle damage and driveability problems resulting from the use of ethanol blends that exceed 10% may not be covered by the manufacturer's warranty.⁵⁶ Each manufacturer's recommendation regarding oxygenates and fuel additives is similar, if not identical, across its product line.⁵⁷

In August 2001, the Japan Automobile Manufacturers Association (JAMA) issued the following statement regarding the use of high alcohol blends: 'In the event a user chooses to use a non-specified fuel and any failure is caused by such fuel, the warranty on the vehicle is fundamentally null and void and not applicable.'⁵⁸

Issues for comment:

10. The potential impact of higher ethanol blends on vehicle warranties in Australia.

B: Environmental Performance

There is little information on emissions outcomes for ethanol blends higher than 10%, except for E85. In recent years, Brazil has adopted US Federal Test Procedure emission standards, but data on in-service vehicle performance, emissions standards compliance and air quality information is scant in the open literature.

⁵⁴ ABA pers. comm.

⁵⁵ Guerrieri, D., et al, 1995, Investigation into Higher Percentage Ethanol Blends.

⁵⁶ 2000 Auto Manufacturer Fuel Recommendation (Vehicle Owner's Manual Statements).

⁵⁷ 2000 Auto Manufacturer Fuel Recommendation (Vehicle Owner's Manual Statements).

⁵⁸ JAMA Announcement, 2001, Use of Fuel Containing a High Percentage of Alcohol

In any event, it is difficult to extrapolate the emissions outcomes of optimised Brazilian vehicles with standard (non-optimised) Australian vehicles. The Brazilian context also differs from the Australian one in climatic conditions.⁵⁹

It is difficult to generalise on emissions outcomes and performance of ethanol blends because the results from various studies conducted around the world are often contradictory.⁶⁰ Furthermore, the emissions (tail pipe and evaporative) outcomes from ethanol blended fuels varies markedly between different ethanol blends and different vehicle technologies.

Emissions outcomes for E10

In general, E10 can be expected to yield reductions in the following emissions:

- carbon monoxide (CO);
- exhaust hydrocarbons (HCs);
- particulates;
- oxides of nitrogen (NO_x), (in some circumstances);
- greenhouse gases, depending on the ethanol production process; and
- known carcinogens, such as benzene.

However, some increase in other known carcinogens, such as formaldehyde, can be expected.⁶¹

As previously stated, higher ethanol blends may result in engine management systems being unable to maintain stoichiometric balance, and as a result such systems may revert to open loop control and fail to meet the required emissions outcomes (ie. the new vehicle emission standards established as Australian Design Rules under the *Motor Vehicle Standards Act 1989*).⁶² It should also be noted that if the volatility of ethanol/petrol blends is not contained then such blends may contribute to an increase in evaporative emissions.⁶³

Mixture enrichment resulting from ethanol blends can lead to reductions in CO emissions. This is most marked in carburetted vehicles because, in modern electronic feedback controlled vehicles, CO emission benefits will only be realised during cold operation or during rapid acceleration.⁶⁴

As a result of the reduction in hydrocarbon (strictly volatile organic compounds) emissions, and possible decreased photochemical re-activity of those emissions, ethanol blends have a reduced potential to form photochemical smog as compared to petrol. It should be noted that this benefit is diminished if ethanol blends are permitted to have a higher RVP than petrol.⁶⁵

Further, studies carried out by the California Air Resources Board (CARB) assessing emissions from fourteen 1990-1995 vehicles running on high-RVP 10% blends showed an increase in emissions of NO_x (14%), HCs (10%) and ozone forming emissions (9%).⁶⁶

⁵⁹ Watson, H., 2001, Technical Assessment of "A Report on Direct Determination of the Effect of the Addition of Ethanol on the Physical Properties of Gasoline".

⁶⁰ Duncan Seddon and Associates, 2000, Setting National Fuel Quality Standards, Paper 2A: Management of Petrol Octane Enhancing Additives/Products.

⁶¹ Apace Research, 1998, Intensive Field Trial of Ethanol/Petrol Blends in Vehicles.

⁶² FCAI pers comm.; Watson, H., 2001, Technical Assessment of "A Report on Direct Determination of the Effect of the Addition of Ethanol on the Physical Properties of Gasoline".

⁶³ Apace Research, 1998, Intensive Field Trial of Ethanol/Petrol Blends in Vehicles.

⁶⁴ World-Wide Fuel Charter.

⁶⁵ Greenfuels Web Site

⁶⁶ CARB, 1999, Health and Environmental Assessment of Ethanol as a Fuel Oxygenate: Volume 3.

Within the Australian context, the use of E10 has been found to result in:

- decreased emissions of CO (32%) and HC (12%);
- increases in non-regulated toxics: acetaldehyde (180%) and formaldehyde (25%);
- a slight (1%) increase in NOx; and
- decreases in non-regulated toxics: 1-3 butadiene (19%), benzene (27%), toluene (30%) and xylene (27%).⁶⁷

Recent Australian life-cycle analysis work has revealed that E10 blends are considered greenhouse neutral. The same study revealed that E10 decreased tail pipe emission of hydrocarbons and NOx (25% and 15%, respectively), but particulates (PM 10) remained unchanged.⁶⁸

Emissions outcomes for higher ethanol blends

In 1995, the US EPA assessed various ethanol/petrol blends and their effects on exhaust emissions. The tests, performed at the US EPA's National Vehicle and Fuel Emissions Laboratories, looked at emissions resulting from nine ethanol blends from 10% to 40% ethanol. Six 1990 or later model, in-use vehicles were tested on a baseline petrol. No modifications were made to the vehicles used in the study to adapt them to higher than normal fuel oxygen levels.

The study indicates that, for the majority of the vehicles, total hydrocarbons and carbon monoxide emissions, as well as fuel economy, decreased, while NOx and acetaldehyde emissions increased as the ethanol content in the test fuel increased. Formaldehyde and vehicle exhaust CO₂ were largely unaffected. Most of the emission responses to increasing ethanol concentrations were approximately linear - as the ethanol content increased, the emission reduction or increase became larger.

Hydrocarbon emissions decreased as higher percentages of ethanol were added to the fuel:

- at 10% ethanol, HC emissions decreased by about 18%;
- at 20%, HC emissions decreased by about 22%; and
- at 40%, HC emissions decreased by 45%.

CO emissions were consistently lowered as higher levels of ethanol were added to the fuel:

- at 10%, CO was reduced by about 18%;
- at 25%, CO was reduced by over 30%; and
- at 40%, CO was reduced by over 40%.

NOx emissions increased substantially with ethanol volume:

- at 10%, the NOx emission increase was about 10%;
- at 20%, the NOx emission increase was about 14%; and
- at 40%, the NOx emission increase was about 20%.

CO₂ emissions initially increased at ethanol volumes from 10% to 20%. At about 25%, CO₂ emissions decreased by about 2%.

Formaldehyde emissions increased slightly with ethanol content, especially at volumes of greater than 30%. Acetaldehyde emissions increased significantly with the addition of ethanol. At 35% the increase was about 400%.⁶⁹

The ABA has no plans to consider the use of ethanol blends exceeding 20%.

⁶⁷ Apace Research, 1998, Intensive Field Trial of Ethanol/Petrol Blends in Vehicles.

⁶⁸ Beer, T., et al, 2001, Comparison of Transport Fuels.

⁶⁹ Guerrieri, D., et al, 1995, Investigation into Higher Percentage Ethanol Blends.

Issues for comment:

11. The emission effects of higher ethanol blends.

C: Health and Safety Implications

Storage and stability

There is a range of safety issues directly relating to the storage and stability of ethanol blends. However, there is a range of vehicle operability issues that may also have broader safety implications. As a result, this section covers issues that relate to storage and stability of ethanol blends as well as the potential impacts of such blends on general vehicle operability.

Storage and handling

In the US, there are specific storage and handling procedures for ethanol blends at distribution and service stations, these include requirements for: tanks and tank linings, piping and fittings, and pumps and dispensers.⁷⁰ The Australian Institute of Petroleum is currently developing a code of practice for the storage of ethanol blends.

Although some materials used to fabricate storage systems may have evolved over time to accommodate the storage of ethanol and ethanol blends, a recent US study has revealed that some single-walled fibreglass reinforced plastic tanks as well as some gaskets, sealants, adhesives and other component materials, may not be compatible with ethanol.⁷¹

Issues for comment:

12. The potential impact of higher ethanol blends on materials construction in the petrol distribution and storage system.

Phase separation in storage tanks

Ethanol blends are particularly sensitive to poor handling and storage practices because of the possibility of phase separation. Phase separation can occur when too much water is introduced into a storage tank. Water has a higher density than petrol, so if water separates, it will form a layer below the petrol. As ethanol has an affinity for water, ethanol blends are more likely to suspend moisture and carry it into the fuel system than non-oxygenated fuels. The higher the ethanol content of a fuel, the greater the amount of water that can be absorbed by the fuel without phase separation occurring. However, if too much water is introduced into an ethanol blend, the water and most of the ethanol (around 60% - 70%) will separate from the petrol and the remaining ethanol. The amount

⁷⁰ American Petroleum Institute, 1985, Storing and Handling Ethanol and Gasoline-Ethanol Blends at Distribution Terminals and Service Stations.

⁷¹ NESCAUM, 2001, Health, Environmental and Economic Impacts of Adding Ethanol to Gasoline in the Northeast States.

of water that can be absorbed by ethanol blended petrol without phase separation, varies from 0.3 to 0.5%, depending on temperature, aromatics and ethanol content.⁷²

Because ethanol is hygroscopic and can absorb water from the atmosphere (and any vessel containing water that it enters), it is prudent to ensure that water contamination does not occur in the distribution and storage of ethanol blends.⁷³

In terms of storage and stability, the NERDDC E15 trial suggested that phase separation stability tests would require a six-month trial on an open vessel to allow the ingress of moisture to assimilate the conditions consistent with ambient air entering underground storage tanks.⁷⁴

Phase separation in the vehicle's tank

Water in petrol can have dramatically different effects on an engine, depending on whether it is in solution or a separate phase. A small amount of water solution in a homogeneous ethanol/petrol blend has no adverse effect.⁷⁵ If phase separation occurs and ethanol rich water is drawn into the engine then the engine will stall. Phase separation can occur in a vehicle's tank as a result of first fuelling with an ethanol blend then going out of the ethanol blend system. This situation arises if, for example, a quarter of a tank of ethanol blend is supplemented by three-quarters of a tank of petrol at refill, causing the concentration of ethanol in the blend to fall. It is therefore possible that in this situation, the presence of water normally contained within the ethanol blend may be sufficient to precipitate phase separation.⁷⁶

Issues for comment:

13. The contribution of ethanol content to phase separation in:
 - a.) the storage and distribution network; and
 - b.) vehicle tanks.

BTEX plume

Spills of ethanol blends may result in more persistent BTEX (benzene, toluene, ethylbenzene and xylene) plumes in groundwater. There are three properties of ethanol blends of potential concern: a co-solvency effect that makes other petroleum constituents more soluble in groundwater; depletion of oxygen and other nutrients in groundwater due to rapid biodegradation of ethanol that inhibits the degradation of other more toxic components in petrol; and a surface tension effect that takes place when ethanol, in contact with a layer of gasoline on top of the water table, causes greater lateral spreading of the petrol.⁷⁷ Studies suggest that ethanol blends can cause the toxic BTEX compounds of petrol to travel up to 2.5 times farther than in the absence of ethanol.⁷⁸

⁷² National Science and Technology Council, Committee on Environment and Natural Resources, 1997, Interagency Assessment of Oxygenated Fuels.

⁷³ Watson, H., 2001, Technical Assessment of "A Report on Direct Determination of the Effect of the Addition of Ethanol on the Physical Properties of Gasoline".

⁷⁴ Hassall and Associates, 1994, Extended Field Trials of Ethanol Blends in Vehicles.

⁷⁵ D. Munro, pers. comm.

⁷⁶ National Science and Technology Council, Committee on Environment and Natural Resources, 1997, Interagency Assessment of Oxygenated Fuels.

⁷⁷ NESCAUM, 2001, Health, Environmental, and Economic Impact of adding Ethanol to Gasoline in the Northeast States, July.

⁷⁸ NESCAUM, 2001, Health, Environmental, and Economic Impact of adding Ethanol to Gasoline.

It is recognised that the BTEX issue is contentious, and is the subject of ongoing research.

Issues for comment:

14. The possible risk of more persistent BTEX plume associated with the use of higher ethanol blends.
15. The health and safety impacts of higher ethanol blends.

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Web Sites

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- Canadian Renewable Fuels Association: www.greenfuels.org
- Environment Australia www.ea.gov.au
- Renewable Fuels Association (US) www.ethanolrfa.org
- US EPA: www.epa.gov

APPENDIX A: TABLE OF ENVIRONMENTAL STANDARDS FOR PETROL AND DIESEL

Fuel Quality Standards - Petrol

Parameter	Proposed standard	Grade	Date of effect
Sulfur	500 ppm (max) 150 ppm (max)	ULP/LRP PULP	1 Jan 2002
	150 ppm (max)	All grades	1 Jan 2005
Research octane number (RON)	91 RON (min)	ULP	1 Jan 2002
	95 RON (min)	PULP	
	96 RON (min)	LRP	
Distillation	FBP 210°C (max)	All grades	1 Jan 2005
Olefins	18% pool average over 6 months with a cap of 20%	All grades	1 Jan 2004
	18% max by vol	All grades	1 Jan 2005
Aromatics	45% pool average over 6 months with a cap of 48%	All grades	1 Jan 2002
	42% pool average over 6 months with a cap of 45%		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)	All grades (no ethanol)	1 Jan 2002
Phosphorus	0.0013g/L (max)	ULP, PULP	1 Jan 2002
Ethanol	Standard (limit) to be set within 12 months.		
MTBE (Methyl tertiary-butyl ether)	1% by volume (max)	All grades	1 Jan 2004
DIPE (Di-isopropyl ether)	1% by volume (max)	All grades	1 Jan 2002
TBA (Tertiary butyl alcohol)	0.5% by volume (max)	All grades	1 Jan 2002

Fuel Quality Standards - Diesel

Parameter	Proposed standard	Date of effect
Sulfur	500 ppm	31 Dec 2002
	50 ppm	1 Jan 2006
Cetane Index	46 (min) index	1 Jan 2002
Density	820 to 860 kg/m ³	1 Jan 2002
	820 to 850 kg/m ³	1 Jan 2006
Distillation T95	370°C (max)	1 Jan 2002
	360°C (max)	1 Jan 2006
Polyaromatic hydrocarbons (PAHs)	11% m/m (max)	1 Jan 2006:
Ash and suspended solids	100 ppm (max)	1 Jan 2002
Viscosity	2.0 to 4.5 cSt @ 40°C	1 Jan 2002

APPENDIX B: THE ETHANOL TASK FORCE

Terms of Reference for the Ethanol Task Force

Under the Fuel Quality Standards Act, Environment Australia has carriage of developing fuel quality standards. This includes setting an appropriate ethanol limit in petrol. An Ethanol Task Force is to be established in July 2001, drawing its members from relevant Government (Commonwealth and State) and industry bodies.

The role of the Task Force is to assist Environment Australia in recommending an appropriate ethanol limit in petrol, by providing advice on the necessary studies that will form the scientific basis for setting the appropriate limit. The studies will need to include an examination of issues such as: vehicle operability, environmental performance, effects on engines and any health or safety implications.

The parameters of this issue are:

1. the current and future vehicle fleet must effectively and efficiently operate on an ethanol limit higher than 10%, without the need for re-tuning/re-calibration or other modifications;
2. the current storage and distribution system must be utilised - or require only minor modifications;
3. the limit must not impact on other fuel parameters, so that the fuel quality standards for petrol will be met.

The Task Force will:

1. contribute to achieving a shared understanding of the issues relating to higher ethanol blends;
2. assist Environment Australia by providing a conduit for stakeholder information on the impacts of ethanol blends higher than 10% but not higher than 20%.
3. provide advice on the appropriate cost-effective methodology and process to assess the impacts of higher ethanol blends
4. assist in identifying the steps of the assessment process, and;
5. give specific attention to identifying significant environmental (eg. emissions) / vehicle operability impacts relating to higher ethanol blends and highlight any associated benefits and costs of higher ethanol blends.

Environment Australia will invite submissions on the implications of ethanol blends up to but no higher than 20%. The Task Force will consider, and advise Environment Australia, on the full set of submissions.

The Task Force will not duplicate any recent substantive work undertaken elsewhere, but may utilise such work to assist in the provision of advice. The Task Force will give consideration to implications for vehicle warranties of ethanol levels up to 20%. The Task Force will limit its consideration to ethanol/petrol blends up to 20% ethanol and will not consider pure ethanol or E85 blends. The Task Force may give some consideration to the issue of petrol/ethanol blends of 11%-20% as an alternative fuel (ie not petrol as defined under the Fuel Quality Standards Act). The Task Force will not address broader ethanol industry development issues or initiatives.

The Task Force will abide by any confidentiality status of Task Force papers.

The advice of the Task Force is to be specifically consistent with the objects of the Fuel Quality Standards Act 2000 as defined under Section 3 of that Act.

The Task Force will meet regularly to assist Environment Australia in developing informed advice on the appropriate ethanol limit for petrol drawing upon the information and advice of the Task Force. Environment Australia will report to Government by May 2002.

Ethanol Task Force Membership

Environment Australia

Department of Prime Minister and Cabinet

Department of Industry Tourism and Resources

Department of Transport and Regional Services

Australian Greenhouse Office

Department of Agriculture, Fisheries and Forestry

The Treasury

Australian Taxation Office

Australian Competition and Consumer Commission

Australian Bureau of Agricultural and Resource Economics

Australian Automobile Association

Queensland Environment Protection Agency

NSW Environment Protection Authority

BP Australia Ltd

Australian Institute of Petroleum

Federal Chamber of Automotive Industries

Service Station Association of Australia

Australian Biofuels Association