SETTING NATIONAL FUEL QUALITY STANDARDS

Proposed Fuel Quality Standard for Fuel Grade Ethanol

AUSTRALIAN GOVERNMENT POSITION

July 2005

1 INTRODUCTION

In April 2003 the Australian Government set a 10% limit on fuel grade ethanol in petrol through the Fuel Standard (Petrol) Determination 2001. The Fuel Quality Information Standard (Ethanol) Determination 2003 took effect on 1 March 2004 requiring labelling of all ethanol blended petrol up to and including the 10% limit. Whilst these policies aimed to increase consumer confidence in ethanol blended petrol, neither established a regulatory requirement for the quality characteristics of fuel grade ethanol. Both the Government and the ethanol industry in Australia acknowledge that a quality standard is critical in market development and consumer acceptance.

In December 2004, the Minister for the Environment and Heritage, Senator the Hon Ian Campbell MP released a technical paper to assist in public discussion on setting an Australian quality standard for fuel grade ethanol. The technical paper, commissioned by the International Fuel Quality Centre (IFQC), did not set out a policy position and was intended to inform stakeholders about fuel grade ethanol and its use in fuel blends. It provided information on the quality and characteristics of fuel grade ethanol internationally and of ethanol's use in particular blends. Stakeholder comment was requested on a series of technical issues relevant to the development of parameters and characteristics of the standard as a whole.

A quality standard for fuel grade ethanol will ensure quality in the market place and develop certainty for the ethanol industry and consumer confidence in the product.

The formal public consultation period on the technical paper closed in February 2005. The submissions received have been taken into consideration by the Government in developing this proposed Australian fuel grade ethanol quality standard. The technical paper and submissions received are available at :
http://www.deh.gov.au/atmosphere/ethanol/publications/standard.html

This paper draws on comments made in this preliminary process and technical information provided in the IFQC paper. It sets out the Government's proposed position on an Australian fuel grade ethanol quality standard for use as blendstock with petrol up to the 10% level. The objective of this paper is to seek stakeholder comment on the position prior to setting the standard in legislation.

Written comments are requested on the position paper by no later than **noon Friday 19 August 2005** and should be sent to:

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GPO Box 787
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or submitted electronically to: fuel.quality@deh.gov.au

Unless marked as confidential, all submissions will be treated as public documents and posted on the Department of the Environment and Heritage's website. The Department of the Environment and Heritage will not post any personal details on the website. Electronic submissions are preferred. Please ensure that your submission is attached as a separate document when replying by email.

2 AUSTRALIAN GOVERNMENT POSITION

Setting the standard

This paper sets out a position on an Australian quality standard for fuel grade ethanol. This position has been established after consideration and assessment of technical information from the IFQC *Setting a Quality Standard for Fuel Ethanol* paper and public comments received in response to this technical paper. The proposed standard is summarised in Table 1. It is proposed that the standard will apply to neat ethanol (E100) for use as blend stock with petrol up to 10% volume.

The rationale for the proposed standard is based on the objective of setting a fuel ethanol quality standard that allows for optimum vehicle and environmental performance.

In general terms, the parameters in the proposed fuel grade ethanol standard harmonise with the established US quality standard *ASTM D4806-04a Standard Specification for Denatured Fuel Ethanol for Blending with Gasolines for Use as Automotive Spark-Ignition Engine Fuel*. Current Australian producers of fuel grade ethanol meet this standard to a large extent on most parameters. Where the proposed standard varies from the US ASTM D4806-04a standard, local production has been considered along with alternative approaches to fuel grade ethanol standards internationally (e.g. South America) and future developments in fuel grade ethanol quality standards (e.g. Europe).

The proposed fuel quality standard is not intended to restrict the type of feedstock used, as long as the ethanol produced meets the standard. It is envisaged that the standard will not disadvantage ethanol produced from alternative feedstock such as cellulosic biomass.

The quality requirements for fuel grade ethanol varies depending on the application it is used in. The market for fuel grade ethanol in Australia is currently aimed predominantly at use as a blendstock/extender to petrol up to the 10% level. Therefore the proposed standard will apply to ethanol used as blendstock for blending with petrol up to the 10% level. As other applications arise, such as higher blends for flexible fuel vehicles, it may be necessary to review the standard or establish new stand alone standards to cover these applications.

Implementation

The suite of parameters proposed for implementation in this standard will ensure a quality fuel grade ethanol product is used in the Australian fuel market.

Table 1 - Proposed Australian Ethanol Standard

Parameter	Standard	Test Method
Ethanol content	99.0 vol % min (prior to denaturing) 94.0 vol % min (after denaturing)	ASTM D5501
Methanol content	0.1 vol % max	ASTM D1152
Non-volatile matter	2.5mg/100ml max	ASTM D1353 BP2002
Water content	1 vol % max	ASTM E203 ASTM E1064
Denaturant Content	1 vol % min 5 vol % max	
Copper	0.1 mg/kg max	ASTM D1688A (modified)
Acidity	0.007 mass % max	ASTM D1613
pHe	6.5-9.0	ASTM D6423
Appearance	Clear without particles	ASTM D2090
Sulphur	50mg/kg max	ASTM D5453-93
Phosphorus	0.5 mg/L	ASTM D3231 (modified) EN 14107 (modified)

* ASTM – American Society for Testing and Materials

** BP – British Pharmacopoeia Standards

All parameters are intended to commence concurrently. The date of implementation is subject to timing of the consultation process.

The rationale supporting the choice of parameters and related limits and test methods is provided in Table 2.

Table.2 – Standard setting rationale

Parameter	Standard	Test Method	Comments
Ethanol content	99.0 vol % min (prior to denaturing) 94.0 vol % min (after denaturing)	ASTM D5501	A minimum ethanol content is required to ensure that other components that may have detrimental effects on vehicles or fuel performance are minimised. Ethanol content is associated with lubricating properties of the fuel, water tolerance and volatility. Limits based on current excise arrangements and current Australian production capabilities.
Methanol content	0.1 vol % max	ASTM D1152	MeOH is corrosive and can cause engine wear. This is a lower limit, based on Australian production capability, than that set in ASTM D 4806 (0.5 vol %).
Non-volatile matter	2.5mg/100ml max	ASTM D1353 BP2002	This measure is used to detect components that are associated with the blocking of fuel filters and deposits on the engine systems. Limit based on Australian production capabilities.
Water content	1% vol max	ASTM E203 ASTM E1064	Water content of denatured fuel ethanol must be limited when it is blended with petrol to reduce the risk of phase separation. Limit based on Australian production capabilities.
Denaturant Content	1 vol % min 5 vol % max		Denaturant allows for differentiation between industrial ethanol and potable beverage ethanol for tax purposes. Some denaturants can be harmful to engine operation. Australian producers use petrol and corrosion inhibitor as denaturants. Limit based on Australian industry practice and excise requirements.
Copper	0.1 mg/kg max	ASTM D1688A (modified)	Copper is a very active catalyst for the low-temperature oxidation of hydrocarbons, significantly increasing the rate of gum formation. Limit based on ASTM D 4806.
Acidity	0.007 % mass max	ASTM D1613	Very dilute aqueous solutions of low molecular weight organic acids, such as acetic acid, are very corrosive to a wide range of metals and alloys. Limit based on ASTM D 4806 and future EU standard for fuel ethanol.
pHe	6.5 - 9.0	ASTM D6423	Very low levels of strong acids might not always be detected by acidity test. pHe test is usually done after denaturing and addition of corrosion inhibitors. Limit based on ASTM D 4806.
Appearance	Clear without particles	ASTM D2090	Suspended or precipitated contaminants would have a detrimental effect on engines, increasing wear and causing blockages. Australian producers monitor appearance through similar tests.
Sulphur	50 mg/kg max	ASTM D5453-93	With sulphur limits in petrol tightening it is expected that ethanol specifications will include sulphur limits. ASTM is currently reviewing D 4806 specification to include sulphur. It is expected that the EU fuel ethanol standard will also contain a sulphur limit. Limit based on ASTM D 4806 Californian specifications.
Phosphorus	0.5 mg/L max	ASTM D3231 (modified) EN 14107 (modified)	The petrol standard limits the amount of phosphorus to protect catalysts systems from deactivation. With emissions standards tightening internationally fuel quality parameters that affect emissions control technology are becoming more important. The EU standard is expected to limit phosphorus. Limit based on this proposed EU standard.

Denatured ethanol

The Australian Taxation Office (ATO) defines fuel ethanol as ethanol which has been denatured (chemically treated to make it unfit for human consumption, usually by the addition of 1% - 5% petrol) for use in an internal combustion engine. Excise is levied at the point at which the fuel is entered into home consumption, at premises licensed by the Australian Taxation Office. Fuel ethanol may be further blended with petroleum or diesel (by licensed excise manufacturers) to create blended petroleum products.[1]

The IFQC report states that setting a standard for undenatured fuel grade ethanol would potentially provide more flexibility, however the focus of fuel standards under the Act is on supply. In Australia fuel grade ethanol for blending with petrol will be sold in the Australian marketplace as denatured fuel grade ethanol after paying any excise due. To be consistent with these established policies and industry practices, the proposed quality standard for fuel grade ethanol will be for denatured fuel grade ethanol.

Denaturants

Not all denaturants are suitable for fuel grade ethanol and some can be harmful to engine operation. ASTM D 4806 permits only hydrocarbons in the petrol boiling range to be used as denaturants, and lists certain materials that are not permitted as denaturants under any circumstances.[2] Other international experience points to allowing the use of a range of denaturants. In Europe, each country has its own national regulation for specific denaturants.

Australian producers currently use petrol and corrosion inhibitor as denaturants. The limit set in the proposed standard is based on Australian industry practice and excise requirements. Specifying denaturants in the standard that can and cannot be used is not considered necessary at this stage.

Corrosion Inhibitors

Manufacturers sometimes add corrosion inhibitors in order to provide adequate protection for some metal types. Corrosion inhibitors need to be suitable for the application as some may interact negatively with petrol and performance additives. The American Renewable Fuels Association recommends that its member companies add corrosion inhibitors to all their fuel grade ethanol at a treat rate sufficient to provide corrosion protection comparable to that of other available motor fuels.[3]

[1] http://www.ato.gov.au/businesses/content.asp?doc=/content/52768.htm.
[2] ASTM D4806-04a Standard Specification for Denatured Fuel Ethanol for Blending with Gasolines for Use as Automotive Spark-Ignition Engine Fuel.
[3] http://www.ethanolrfa.org/Final960501.pdf.

Renewable Fuels Australia anticipate that new entrants to the ethanol industry will use the ASTM D 4806 standard with a corrosion inhibitor, although this may not be required should fuel grade ethanol be sold directly to the major oil companies and blended with petrol as part of the refinery process.[4]

Corrosion inhibitors are allowed for use by the ATO as denaturant in neat ethanol E100. A client that uses 'straight' ethanol (E100) has permission to denature with ignition enhancer and corrosion inhibitor compounds.

Test methods

The IFQC report recommended that a group of test method experts review the various methods in use internationally in ethanol quality standards, and select those where the precision with respect to ethanol is consistent with the proposed specifications.

Stakeholder comment is requested specifically on the suitability of the test methods listed in Tables 1 and 2.

Ethanol petrol blends

The Government proposes to set a quality standard that applies to fuel grade ethanol for use as blendstock for blending with petrol up to the 10% level. Ethanol that will be used as blend stock/extender with petrol must meet this standard. When blending fuel grade ethanol with petrol, the petrol portion will be required to meet the Fuel Standard (Petrol) Determination 2001 and the ethanol portion will be required to meet the proposed Fuel Standard (Ethanol) Determination 2005. The Fuel Standard (Petrol) Determination 2001 includes a 10% ethanol limit.

When ethanol is added to petrol it impacts on a number of parameters including octane, fuel volatility, vapour pressure, distillation properties and water tolerance. Further discussion on volatility is set out below.

When fuel grade ethanol is blended with petrol the resultant blend will be required to meet the Fuel Standard (Petrol) Determination 2001. Service stations that supply ethanol blended petrol (containing more than 1% ethanol) are required to label these fuels in accordance with the Fuel Quality Information Standard (Ethanol) Determination 2003.

Higher ethanol blends and Flexible Fuel Vehicles (FFVs)

In the United States several manufacturers are marketing vehicles that are capable of operating on various blends of fuel ranging from 100% petrol to 15% petrol/85% denatured ethanol – commonly called E-85. These vehicles are called Flexible Fuel Vehicles (FFVs). The denatured ethanol content of these higher blends generally ranges from 75% - 85% (E75-E85) depending on the season to improve cold start and warm up performance. As stated in the IFQC paper "the main differences between ethanol FFVs and petrol vehicles are the materials used in the fuel management system and modifications to the engine calibration system".[5]

[4] http://www.deh.gov.au/atmosphere/ethanol/publications/pubs/submission-rfa.pdf.
[5] http://www.deh.gov.au/atmosphere/ethanol/publications/pubs/ifqc-report.pdf, p8.

Although sales of these vehicles are increasing in the US only a small proportion have been fuelled with E85 because of a limited ethanol distribution system.[6]

A separate specification for E-85 is set out in *ASTM D5798-99(2004) Standard Specification for Fuel Ethanol (Ed75-Ed85) for Automotive Spark-Ignition Engines*. Ed75-Ed85 fuel ethanol is produced from ethanol complying with ASTM D 4806 and contains additional specifications for parameters applicable to vehicles designed to operate with high percentages of ethanol in their fuel. These additional parameters include hydrocarbon volume, vapour pressure, lead, phosphorus, sulphur and total and inorganic chloride.[7]

There are no FFVs currently available in the Australian market. The proposed fuel grade ethanol standard set out has been developed for use in low level blends of ethanol up to 10% (E10). The need for the establishment of a separate standard for E-85 or similar fuel under the Act will be re-assessed if the need arises.

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.

Volatility is directly affected by regional temperatures. The more volatile a fuel, the greater the evaporative losses of hydrocarbons which contribute to photochemical smog. RVP is currently managed by the States and Territories and not under the *Fuel Quality Standards Act 2000*.

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 70ºC.

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.

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[6] "Automakers have produced millions of 'flexible-fuel' E85 vehicles. They presumably spur the market for increased use of ethanol. These vehicles can use any fuel from straight gasoline to a mixture of 85 percent ethanol and 15 percent gasoline. However, only about 130,000 of them have ever been fuelled with E85 because the distribution system for it is very limited. At present, there are only about 180 E85 refueling stations in the United States. Nevertheless, automakers have benefited from making E85 vehicles because the CAFÉ standards provide credits for them, even if they are not fueled with E85" – Colucci, 2004.

[7] http://www.deh.gov.au/atmosphere/ethanol/publications/pubs/ifqc-report.pdf, p21

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 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. 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. Fuel vaporisation may have a greater impact in carburetted or mechanical fuel injection engines than later model electronic fuel injection engines.

Although ethanol itself has a RVP less than that of petrol, its addition to petrol markedly increases the volatility 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 the neat petrol. The increase in RVP can be overcome if ethanol is blended with a petrol blendstock which has reduced volatility (usually lower butane). This is known as a Blendstock for Oxygenated Blends (BOB). This ensures that the final product (ethanol blendstock with petrol blendstock) does not exceed volatility requirements. This practice is utilised in the U.S. and Brazil.

Other issues

There were several other issues raised in response to the IFQC technical paper.

Biological vs Synthetic ethanol

The NSW Department of Environment and Conservation raised the issue of delineating between biological and synthetically produced ethanol.[8] It is technically possible to use synthetic ethanol that meets the anhydrous ethanol standard in automotive engines without adverse effects. As discussed above, the proposed fuel quality standard is not intended to restrict the type of feedstock used, as long as the ethanol produced meets the standard.

The draft EU ethanol standard, which is under development, is also designed to apply to ethanol suitable for blending with petrol regardless of the source of the ethanol. However the mandate to (CEN) from the European Commission to develop a quality standard refers to bioethanol. Therefore a test method for determining the biologically sourced ethanol from non-biological ethanol may be required. Alternatively the establishment of an audit trail, including the use of marker chemicals, to determine provenance of the ethanol may be sufficient to validate its biological origin for administrative purposes.[9]

Discussion regarding the definition of ethanol for the purposes of other Government legislation and programs, i.e. production grants/excise concessions for ethanol, Biofuels Capital Grants etc, is beyond this scope of this position paper.

[8] http://www.deh.gov.au/atmosphere/ethanol/publications/pubs/submission-nsw-dec.pdf
[9] CEN/TC 19/WG 21 N 99 – CEN European Committee for Standardisation

E-diesel/Diesohol

Ethanol can be added to diesel in order to extend feedstock. Claims have been made that a 10-15% blend can increase engine efficiency and lower emissions. These blends, containing up to 15% fuel ethanol, blended with standard diesel and a proprietary additive, are called Diesohol or E-diesel. Generally hydrous ethanol is used, rather than the anhydrous ethanol used for blending with petrol.

Diesohol is defined as a fuel in the *Fuel Quality Standards Regulations 2001*, where it is described as a 'blend primarily comprising diesel and an alcohol'. It is intended that diesohol will be the subject of a separate fuel quality standard.

In May 2004, the Department sought comments on the use of diesohol as a transport fuel via the release of a public discussion paper *Setting National Fuel Quality Standards Paper 7: Discussion Paper on Diesohol*. This paper is available at http://www.deh.gov.au/atmosphere/cleaner-fuels/publications/diesohol.html.

Transportation, handling, storage and safety

There are a number of issues relating to transportation, storage and handling of fuel grade ethanol and ethanol blended petrol. The Northern Territory Department of Infrastructure, Planning and Environment raised concerns regarding use of ethanol and lightning strikes.[10] Darwin has one of the worlds' highest instances of lightning strikes.

The sensitivity of petrol ethanol blends to water requires certain precautionary steps to be taken to prevent phase separation. These steps include drying out wholesale storage tanks and proper preparation of retail storage tanks and dispensers. In addition, transport drivers should exercise proper precautions when making deliveries.

Renewable Fuels Australia states that the characteristics of fuel grade ethanol use and handling requirements are well known by both the ethanol and petroleum industry. With well tested and developed housekeeping practices, fuel grade ethanol will not draw water in and go off-specification sitting in a storage tank.[11]

The Australian Institute of Petroleum (AIP) has produced a guideline to promote safe, environmentally and operationally sound storage, blending, transport and dispensing of ethanol blends fuels so that ethanol blend fuels delivered to motorists are fit-for-purpose and meet regulated standards. The guideline includes information on the blending of ethanol into petrol. The *Storage, Transport and Handling of Fuel Ethanol and Ethanol Blend Fuels* guideline is available through the AIP (http://www.aip.com.au/pdf/publist_2005.pdf).

[10] http://www.deh.gov.au/atmosphere/ethanol/publications/pubs/submission-nt-dipe.pdf
[11] http://www.deh.gov.au/atmosphere/ethanol/publications/pubs/submission-rfa.pdf

The U.S. Department of Energy has also compiled a “Guidebook for Handling, Storage and Dispensing Fuel Ethanol”.[12]

Further detailed discussion of these issues is beyond the scope of this paper.

[12] www.afdc.nrel.gov

Attachment A: Test methods

ASTM D5501-04 Standard Test Method for Determination of Ethanol Content of Denatured Fuel Ethanol by Gas Chromatography

ASTM D1152-97 (2001) Standard Specification for Methanol (Methyl Alcohol)

BP2002 Non-volatile matter

ASTM D1353-03 Standard Test Method for Nonvolatile Matter in Volatile Solvents for Use in Paint, Varnish, Lacquer, and Related Products

ASTM E203-01 Standard Test Method for Water Using Volumetric Karl Fischer Titration

ASTM E1064-04a Standard Test Method for Water in Organic Liquids by Coulometric Karl Fischer Titration

ASTM D1688-02 Standard Test Methods for Copper in Water (modified)

ASTM D1613-03 Standard Test Method for Acidity in Volatile Solvents and Chemical Intermediates Used in Paint, Varnish, Lacquer, and Related Products

ASTM D6423-99 (2004) Standard Test Method for Determination of pHe of Ethanol, Denatured Fuel Ethanol, and Fuel Ethanol (Ed75-Ed85)

ASTM D2090-98 Standard Test Method for Clarity and Cleanness of Paint and Ink Liquids

ASTM D5453-04 Standard Test Method for Determination of Total Sulfur in Light Hydrocarbons, Motor Fuels and Oils by Ultraviolet Fluorescence

ASTM D3231-02 Standard Test Method for Phosphorus in Gasoline (modified)

EN 14107 Determination of phosphorus content by inductively coupled plasma (ICP) emission spectrometry (modified)