SETTING NATIONAL FUEL QUALITY STANDARDS

Paper 4

Discussion Paper on Operability Fuel Parameters (Petrol and Diesel)

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Department of Industry, Science and Resources

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1. INTRODUCTION

The set of guiding principles for the development of the *Fuel Quality Standards Act 2000* stated that fuel standards are intended to manage those fuel qualities/parameters that are known to have the potential to impact adversely on the environment. However, submissions received concerning the Commonwealth's preliminary proposal for petrol and diesel quality standards highlighted the need to develop standards for parameters that do not have a direct influence on emissions, but are linked to the more effective operation of engines. In recognition of this difference, Section 3 of the *Fuel Quality Standards Act 2000* specifies that the main object of the Act includes the regulation of fuel quality in Australia in order to allow the more effective operation of engines. It is also recognised that efficient engine operation assists in maintaining optimal emissions performance.

The Australian Institute of Petroleum (AIP) in consultation with the Federal Chamber of Automotive Industries (FCAI) developed an initial proposal for standards for fuel parameters linked to the more effective operation of engines, or 'operability' standards. Given the technical expertise of these organisations, their combined proposal provides a sound basis on which to commence the development of a set of national fuel quality standards that address engine operability. Accordingly, their proposal has been used as a starting point for development of the Commonwealth's preliminary position, through this discussion paper, for regulation of various petrol and automotive diesel parameters under the *Fuel Quality Standards Act 2000*.

2. THE PROCESS

This document is designed to stimulate discussion and encourage feedback. It is not prescriptive - though, to the extent possible, it does provide preliminary proposals concerning various fuel parameters.

In examining each fuel parameter, this paper:

- Provides a brief description of the basis for specifying controls/limits;
- Outlines the existing standards for the parameter in Australia, Europe and under the vehicle industry's World Wide Fuel Charter (WWFC); and
- Presents a proposed standard for consideration.

The preferred option for each parameter is to adopt the European fuel standards wherever possible, as this is consistent with the approach taken with the environmental fuel standards which recognise that European vehicle emission standards are the basis of the new Australian Design Rules for emissions from 2002. In some cases however, there is a valid case for adopting alternative requirements where they are not addressed in the European standards or local conditions warrant a different standard.

The first set of discussion papers on proposed 'environmental' standards for petrol and diesel, which were released for public comment in May 2000, were circulated to a wide range of stakeholders. This paper has been circulated to the same list of stakeholders and any additional interested parties.

Some of the standards proposed in this paper will be entirely non-contentious and have been specified by Standards Australia for some years. However, as they are important for efficient engine operability they have been included for comment as there may be reasons for reviewing them.

This paper launches a six-week consultation phase to give stakeholders the opportunity to make representations to Government. The Commonwealth Steering Committee will also hold one-on-one discussions with interested parties. Independent technical advice will be sought where necessary during the development process.

Following Government assessment of all relevant information, the 'operability' parameters will be finalised. The process should be completed towards the end of 2001.

2.1. Call for Public Submissions

In order to ensure that the most appropriate fuel quality standards are adopted in Australia, comment on the proposals put forward in this discussion paper is sought from all interested stakeholders and members of the public.

While comments are welcomed on any matter discussed in this paper, attention should also be directed to the specific questions raised throughout the text. **Please note that all submissions will be treated as public documents and will be made available to the Fuel Standards Consultative Committee.**

Written comments are requested by **24/09/2001** and should be sent to:

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3. BACKGROUND

The impending changes to Australian fuel specifications have been driven by a number of factors. In the main, these fall into three categories: environmental objectives, industry policy objectives and vehicle technology requirements.

The principal driver for change to fuel quality standards in Australia in recent years has been an environmental one. There has been widespread agreement in the community that we should all work towards achieving cleaner air. Transport activities have been identified as the most significant contributor to urban ambient air pollution in Australia.

The development of industry policy across the various levels of Government has had, and will continue to have, an impact on both the developments of clean fuel specifications and investment in clean fuels. A number of initiatives with respect to transport emissions were announced by the Commonwealth Government in May 1999 as part of A New Tax System (ANTS) for Australia. These initiatives, known as the *Measures for a Better Environment* (MBE), include timetables for Australian harmonisation with international vehicle emission standards, for both petrol and diesel engines, and the reduction of sulfur levels in diesel. The need for changes to petrol specifications was also foreshadowed.

The requirements necessary to accommodate technological change in the automotive sector have had a major impact on the development of clean fuel specifications. With increasingly global operations, there is significant pressure from automotive manufacturers to have high quality fuels available wherever cars are sold in order to allow for the manufacture of vehicles that can be marketed internationally.

During 1997 the Australian Government gazetted a timetable for the introduction of a series of vehicle emission standards. In order to meet these standards, vehicle manufacturers will need to introduce new vehicle technologies which will require a number of critical changes to fuel specifications. Specifically, diesel sulfur levels will need to be reduced to 500 ppm by the end of 2002 and to 50 ppm by 2006 for the adoption of Euro 2 and Euro 4 emission standards respectively. In addition, petrol sulfur levels will need to be reduced to 150 ppm by 2005 to allow for the adoption of Euro 3 emission standards.

Following a consultancy which looked at the costs and benefits of various clean fuel options, the Commonwealth released three discussion papers to facilitate public discussion and consultation on the setting of proposed national fuel quality standards:

Paper 1: Summary Report of the Review of Fuel Quality Requirements for Australian Transport

Paper 2: Proposed Standards for Fuel Parameters (Petrol and Diesel)

Paper 3: Proposed Model for Standards Implementation

These papers are available on the Environment Australia website at http://www.ea.gov.au/atmosphere/transport/fuel/index.html

During the public consultation period, the Federal Government met with key stakeholders to discuss issues of concern relating to the proposed standards, and interested parties were invited to make submissions to the Government. The Government then released a revised position for further consultation. This paper is also available on the Environment Australia website.

The first of two phases for developing improved fuel quality standards was completed with the introduction of the *Fuel Quality Standards Act 2000*.

The objects of the Act include the provision of fuel, which enables the effective operation of engines. During public consultations on setting environment-related petrol and diesel standards, stakeholders repeatedly called for standards to ensure that fuel sold in Australia is safe and suitable for vehicles. Following the finalisation of petrol and diesel standards with this 'environmental' focus, the next priority has been to develop fuel standards relating to vehicle operability.

This paper concentrates on developing petrol and diesel standards for those parameters, which are necessary for the proper operation of vehicles, often referred to as 'operability' parameters. It is intended that the process for developing 'operability' standards will be finalised in time for the making of the necessary Ministerial instruments to take effect from 1 January 2002.

The *Fuel Quality Standards Act 2000* establishes a Fuel Standards Consultative Committee which the Minister is required to consult about a range of actions that can be taken and decisions that can be made under the Act. Any proposals for 'operability' standards will need to be considered by the Committee.

4. FUEL DISPENSER LABELLING

At present, the description of fuels at the point of sale has not been an issue of widespread concern, given that the products themselves have enjoyed the benefit of being generally understood and being subject to an accepted terminology. The term's 'petrol' and 'diesel' as generic descriptions have not caused problems. The further specific terms of unleaded petrol (ULP), premium unleaded petrol (PULP) and lead replacement petrol (LRP) have been sufficient to describe these grades of petrol for most practical purposes. Where individual refiner/marketers have introduced other petrol products that fall outside the above parameters (eg Optimax, Ultimate, and Synergy 8000), this has been accompanied by promotional campaigns and bowser labelling that clearly distinguish these more specialised premium fuels.

Given the wide and changeable range of hydrocarbon compounds that may constitute petroleum fuels at any given moment, it would appear preferable to approach the question of when and how to label standard fuel products on an exclusion basis. If the fuel in question is in some respects non-traditional but has no characteristics that readily differentiate its in-vehicle performance from similar products, there seems little benefit in requiring additional labelling of such a product. This would not however waive the requirement that such fuels also meet mandatory environmental or operability specifications.

However, there are some circumstances where a particular fuel constituent may change the performance and behaviour of that fuel in vehicles. Perhaps the most familiar example of this is the use of ethanol in petrol. Ethanol has a lower energy density than petrol refined from crude oil. This can ultimately translate into lower levels of fuel economy. For example, a blend of 10% ethanol in ULP can result in as much as a 3.5% loss of energy efficiency. This may be masked by driving habits and even factors such as tyre pressures. However, a 20% ethanol blend that produces a 7% energy efficiency loss becomes more of an issue – particularly where the user is unaware of the penalty and where there is no commensurate price differential.

There have also been some concerns expressed by automotive manufacturers of the possible impacts that petrol with a high ethanol content may have on the integrity of vehicle fuel lines and associated components.

Similar concerns may be associated with the use of higher sulfur diesel in vehicles that have been designed to use low sulfur diesel, leading in particular to loss of effectiveness of catalytic converters or other emission control technologies. Other potential areas of concern relate to the use of diesohol (a 15% ethanol blend in diesel) and also to biodiesel (diesel made from recycled cooking oil, canola, rapeseed, soybean etc).

Failure to label non-standard fuel blends or types could give consumers a misleading impression or idea about what it is they are purchasing. This could lead to fuel retailers being liable to prosecution for breaching consumer protection provisions of the Commonwealth *Trade Practices Act* or the States and Territories Fair Trading Acts. Importantly, breaches of these acts include misleading consumers by leaving out or hiding important information.

To date the issue of labelling has not been canvassed extensively. It was however, discussed by industry and Government representatives at a meeting of the Australian and New-Zealand Minerals and Energy Council (ANZMEC) Downstream Petroleum Working Group convened in Canberra on 14 June 2001. There was general agreement that the issue was important because of the possible ramifications that fuel products such as ethanol blended petrol, higher sulfur diesel, diesohol and biodiesel may have for fuel economy and for vehicle manufacturers warranties. The Working Group strongly supported the consideration of labelling in the context of developing fuel operability standards and specifically endorsed the inclusion of the issue in this discussion paper.

While there has been insufficient detailed consideration of the issue of labelling to allow a preliminary proposal to be outlined here, the following principles are suggested as providing an appropriate framework for determining when and how fuel at the point of sale to end users should be labelled with additional information.

Labelling of fuel products to identify its origin (eg biodiesel) or to identify a significant non-petroleum additive (eg ethanol) should occur in the following circumstances:

- Where the added fuel constituent has an energy density that translates to a significant overall energy efficiency penalty.
- Where there is a risk that the added fuel constituent in the quantities being added can lead to fuel/water separation sufficient to impact on vehicle performance.
- Where the use of a fuel with a particular additive or from a particular source could void vehicle warranties.
- Where the use of the fuel could adversely affect the performance, function, or appearance of the vehicle in any other way.

Comments are invited on both the practicality (including a threshold fuel efficiency penalty which would be required to trigger a special labelling regime) and appropriateness of the above principles in addressing the need to label particular fuel blends. Similarly, feedback on additional considerations pertaining to labelling would be welcome.

5. TEST METHODS

Regulations to implement the *Fuel Quality Standards Act 2000* are currently being prepared. As part of this process consideration is being given to the most appropriate means of specifying permitted test methods to measure compliance against the fuel specifications. The method selected will apply to both the environmental parameters and the operability parameters currently being established. It is intended that the method selected will provide fuel suppliers with flexibility as well as recognise that new test methods are frequently developed and that these are typically more accurate and precise than their predecessors.

To assist in this process stakeholders are requested to provide feedback on the most appropriate means of specifying test methods as well as details of test methods that would be appropriate for the operability parameters discussed in this paper.

As a start, the preliminary proposals made in this paper include a range of test methods that are believed to be equivalent on the basis of information contained in the World Wide Fuel Charter (WWFC).

Oil Industry Manufacturing Specifications

Many of the parameters listed in this paper are currently managed through oil industry manufacturing specifications, which typically apply at the refinery or terminal gate. In certain instances these existing specifications are more stringent than the preliminary recommendations made within this paper. This should not be viewed as a lowering of standards as the preliminary recommendations made within this paper will apply along the entire distribution chain between the refinery and fuel bowser. Oil Industry manufacturing specifications are typically more stringent to allow for minor contamination and degradation during distribution.

6. DIESEL

Diesel fuel is a complex mixture of hydrocarbon chemicals with the main groups being paraffins, napthenes and aromatics, the latter including alkyl benzenes and polyaromatic (PAH) structures. Organic sulfur is also naturally present. Additives are generally used to influence properties such as the flow, storage and combustion characteristics of diesel fuel, to differentiate products and to meet trademark specifications.[1] The actual properties of commercial automotive diesel depend on the refining practices employed and the nature of the crude oils from which the fuel is produced.[2]

Standards have been developed under the *Fuel Quality Standards Act 2000* to manage diesel fuel parameters that have a direct influence on emissions. These standards come into effect progressively from 1 January 2002 and cover sulfur, cetane, density, distillation, PAHs, ash and suspended solids and viscosity.

The current Australian Standard for automotive diesel fuel (AS3570-1998) does not have any legislative basis. It is essentially an industry guideline and its main purpose is to specify requirements that are consistent with diesel engine development practice and reliable operation. The general requirements of the Australian Standard are presented in Table A.

Table A The Australian Standard – AS 3570 for Automotive Diesel

Property	Unit	Limit
Ash	% (by mass)	0.01 (max.)
Carbon residue (on 10% residuum)	% (by mass)	0.2 (max.) or 0.16 (max.)
Cetane index		45 (min)
Cloud point	°C	See Note 1 below
Cold filter plugging point	°C	See Note 2 below
Copper corrosion (3 h at 100°C)		2 (max.)
Density (at 15°C)	kg/L	0.82 to 0.87
Distillation (T90) (90% recovered)	°C	357 (max.)
Flash point	°C	As permitted by legislation (64 min)
Oxidation stability	mg/L	25 (max.)
Sulfur	% (by mass)	0.5 (max.)
Water sediment or Water and sediment	% (by volume)	0.05 (max.)
Viscosity kinematic (at 40°C)	CSt	1.9 to 5.5

Source: Standards Australia

1 The Australian Standard for Automotive Diesel specifies maximum limits for cloud point based on the 12 calendar months and the different climatic regions in Australia. The Standard lists 12 climatic regions and the limits range from -3°C to 15°C. The Standard also lists particular locations where fuel problems may possibly occur because of cold weather conditions.

2 Ordinarily, Australian automotive diesel fuels on average have a cold filter plugging point value that is about 2°C below the cloud point.[3]

[1] IPCS, 1996, Environmental Health Criteria 171 – Diesel Fuel and Exhaust Emissions, p.1.
[2] Standards Australia, 1998, AS 3570 (automotive diesel).
[3] Standards Australia, 1998, AS 3570 (automotive diesel).

7. DIESEL OPERABILITY PARAMETERS

The key diesel parameters which have been identified as having either a direct or indirect impact on vehicle operability are: carbon residue; water and sediment; cloud point; conductivity; lubricity; oxidation stability; colour; acidity; copper corrosion; flashpoint; and appearance.

7.1. Physical Parameters

7.1.1. Colour

Dyes are not added to diesel like they are to other petroleum products such as petrol. The colour of diesel is natural and varies quite markedly depending upon the crude from which it is manufactured and the blending components used. The management of diesel colour is necessary to detect contamination with fuel oil and it also provides a check on stability. If diesel contains 'unstabilised' cracked components it will go black when exposed to sunlight or when stored for an extended time.
The procedure for measuring colour involves comparison with a series of IP Standard glasses from which a colour rating is assigned.

7.1.1.1. The Australian Situation

Colour of diesel is not specified in Australian standard AS357 but is controlled by each of the Australian refiners and importers through their own standards or specifications which typically specify a maximum colour limit of 2.0 when measured in accordance with ASTM D1500.

The 1999 statistics from the AIP report diesel colour levels as:

Minimum colour:	0.5
Maximum colour:	2.0
Average colour:	0.6

7.1.1.2. World Wide Fuel Charter

The World Wide Fuel Charter (WWFC) does not specify the colour of automotive diesel.

7.1.1.3. European Standard

European standards (EN590:1999) do not specify colour of automotive diesel.

Preliminary Proposal

It is proposed that colour of diesel be controlled by the introduction of a specification requiring a maximum colour of 2.0. This level is consistent with the existing practice of the Australian oil refining industry, and it assists in quality control.

Proposed Permitted Test Method/s: ASTM D1500

7.1.2. Appearance

Appearance of diesel is used as a quick indicator of potential contamination and to ensure that there is no free or entrained water or particles (solids - rust etc). Water can result in higher corrosion or promote bacterial growth. Extreme cases of these contaminants can result in filter blockage. When it is refined, diesel can contain entrained water and the product has a cloudy appearance. The water normally drops out quickly but this is not always the case.

7.1.2.1. The Australian Situation

Appearance of diesel is not specified in Australian standard AS357-1998 but is controlled by each of the Australian refiners and importers through their own standards or specifications.

7.1.2.2. World Wide Fuel Charter

The WWFC does not specify appearance of automotive diesel.

7.1.2.3. European Standard

European standards (EN590:1999) do not specify appearance of automotive diesel.

Preliminary Proposal

It is proposed that the appearance of diesel be controlled by the introduction of a specification-requiring diesel at 25ºC to appear clear and bright. This level is consistent with the existing practice of the Australian oil refining industry, and it assists in quality control.

7.2. Corrosion

7.2.1. Acidity

The management of organic acids in diesel is necessary to avoid corrosion of vehicle fuel systems. It is less significant for low sulfur diesel because hydrotreating to reduce sulfur also destroys organic acids. Acidity is typically measured in terms of both strong acidity and total acidity. Strong acidity is a measure of particularly corrosive acidic components whilst total acidity is a measure of both these components and less corrosive acidic components.

7.2.1.1. The Australian Situation

Acidity of diesel is not specified in Australian standard AS357-1998 but is controlled by each of the Australian refiners and importers through their own standards or specifications.

The 1998 statistics from the AIP report acidity levels as:

Acidity		
Strong (avg and max)	0	mg KOH/g
Total (max)	0.07	mg KOH/g
Total (avg)	0.03	mg KOH/g

7.2.1.2. World Wide Fuel Charter

The WWFC recommends a maximum total acidity of 0.08 mg KOH/g but does not stipulate strong acidity. The permitted test methods are ASTM D974 or NFT 60 112-86.

7.2.1.3. European Standard

The European standards (EN590:1999) recommend a specification for strong acidity of nil but do not specify total acidity.

Preliminary Proposal

It is proposed that Australia adopts the European standards for strong acidity of nil and also the WWFC standard for maximum total acidity of 0.08 mg KOH/g.

Whilst this is more stringent than both the European and WWFC standards it is being proposed on the basis that strong and total acidity give separate indications of different potential problems.

Proposed Permitted Test Method/s: ASTM D974, NFT 60 112-86

7.2.2. Copper Corrosion

The copper corrosion test serves as a measure of possible corrosion of copper, brass, or bronze fuel system components.

7.2.2.1. The Australian Situation

Copper corrosion of diesel is managed by Australian standard AS357-1998 which specifies a maximum copper corrosion of class 2 (3hr at 100ºC) when measured in accordance with ASTM D 130.

The 1999 statistics from the AIP report copper corrosion levels as:

Average copper corrosion (3hr at 150ºC): 1
Maximum copper corrosion (3hr at 150ºC): 1

7.2.2.2. World Wide Fuel Charter

The WWFC recommends a maximum copper corrosion of class 1 (3hr at 50ºC). The permitted test methods are ISO 2160-98, ASTM D 130, and JIS 2513-91.

7.2.2.3. European Standard

The European standards (EN590:1999) requires a maximum copper corrosion of class 1 (3 hr at 50ºC).

Preliminary Proposal

It is proposed that Australia harmonises with the European standards by adopting a standard for copper corrosion of a maximum of class 1 (3 hr at 50ºC).

Proposed Permitted Test Method/s: ASTM D 130, ISO 2160-98, JIS 2513-91

7.3. Volatility

7.3.1. Flashpoint

Flashpoint is the lowest temperature at which a product gives off just sufficient vapour to form a flammable mixture with air under standard conditions. The flashpoint of diesel is not directly related to engine performance. It is, however, important in connection with safety precautions and legal requirements involved in fuel handling and storage under the Dangerous Goods Storage and Handling and Transportation Regulations, and is specified to comply with fire regulations and insurance requirements. Under dangerous goods legislation, diesel is classified as a combustible liquid. The definition of combustible liquids in AS 1940-1993 (The storage and handling of flammable and combustible liquids) specifies that the minimum flashpoint of diesel is 61.5^{o}C.

7.3.1.1. The Australian Situation

Flash point of diesel is not specified in Australian standard AS357-1998 but is controlled by each of the Australian refiners and importers through their own standards or specifications which typically specify a minimum flash point of 64ºC when measured in accordance with ASTM D93.

The 1999 statistics from the AIP report flash point levels as:

Flash point	
Maximum:	104ºC
Minimum:	62ºC
Average:	80ºC

7.3.1.2. World Wide Fuel Charter

The WWFC recommends a minimum flash point of 55ºC. The permitted test methods are ISO 2719-88, ASTM D93, and JIS K 2265-96.

7.3.1.3. European Standard

The European standard requires a flash point above 55ºC.

Preliminary Proposal

In order to maintain consistency with existing dangerous goods legislation in Australia, it is proposed that the flashpoint of diesel be controlled by the introduction of a specification requiring a minimum flashpoint of 61.5ºC.

Proposed Permitted Test Method/s: ASTM D93, ISO 2719-88, and JIS K 2265-96.

7.4. Stability

7.4.1. Oxidation Stability

Oxidation stability is an indication of a diesel's storage stability. Fuels with poor stability will form insolubles, which can block fuel filters. Diesel oxidizes in the presence of air and water, particularly if the fuel contains non-hydrotreated cracked products that are relatively unstable. High temperatures also accelerate the oxidation of diesel. Further, diesel degrades when in contact with copper or zinc because these two metals actively promote oxidation of diesel. Accordingly, prolonged storage of fuel in such an environment can result in the oxidation of diesel to form undesirable gums and sediment. Such undesirables can cause filter plugging, combustion chamber deposits formation, and gumming or lacquering of injection system components with resultant sticking and wear.

7.4.1.1. The Australian Situation

Oxidation stability of diesel is managed by Australian standard AS357-1998 that specifies a maximum oxidation stability of 25 mg/L when measured in accordance with ASTM D 2274.

The 1999 statistics from the AIP report diesel oxidation stability levels as:

Minimum oxidation stability:	0 mg/L
Maximum oxidation stability:	18 mg/L
Average oxidation stability:	4 mg/L

7.4.1.2. World Wide Fuel Charter

The WWFC specifies a maximum level for oxidation stability of diesel of 25 mg/L. The permitted test methods are ISO 12205-95 and ASTM D2274.

7.4.1.3. European Standard

The European standards (EN590:1999) specify a maximum level for oxidation stability of diesel of 25 mg/L.

Preliminary Proposal

It is proposed that Australian harmonises with the European standards by adopting a maximum diesel oxidation stability of 25mg/L.

Proposed Permitted Test Method/s: ASTM D 2274, ISO 12205-95

7.5. Combustion

7.5.1. Carbon Residue

Carbon residue gives a measure of the carbon-forming tendencies of a diesel when heated under prescribed conditions. While not directly correlating with the formation of deposits in fuel injectors and combustion chambers, this property is considered to be an indication of deposit-forming tendency.

7.5.1.1. The Australian Situation

The carbon-residue of diesel is managed by Australian standard AS357-1998 which recommends a maximum carbon-residue of 0.16% (by mass) when measured in accordance with ASTM D 189 or 0.2% (by mass) when measured in accordance with ASTM D 524.

The 1998 statistics from the AIP report carbon residue levels as:

Average carbon residue, mass%: 0.0437
Maximum carbon residue, mass%: 0.14
(Note: AIP statistics do not differentiate the results according to the test method used)

7.5.1.2. World Wide Fuel Charter

The WWFC recommends a maximum carbon residue in diesel of 0.2% (by mass) when measured in accordance with ASTM D 4530, ISO10370-93, or JIS K2270-90.

7.5.1.3. European Standard

The European specification EN590:1999 recommends a maximum carbon residue in diesel of 0.3% (by mass) as determined by EN ISO 10370 on 10% distillation residue. In a footnote EN590 also states that *"the limiting value for carbon residue given above is based on product prior to the addition of ignition improver, if used. If a value exceeding the limit is obtained on finished fuel in the market, EN ISO 13759 shall be used as an indicator of the presence of a nitrate-containing compound. The use of additives does not exempt the manufacturer from meeting the requirement of maximum 0.30% m/m of carbon residue prior to the inclusion of additives"*.

Preliminary Proposal

It is proposed that the existing Australian diesel carbon-residue specification of 0.2% (by mass) is retained. This proposal is tighter than the existing European specification.

Proposed Permitted Test Method/s: ASTM D 4530, ISO 10370-93, JIS K2270-90

7.6. Fluidity

7.6.1. Cloud Point and Cold Filter Plugging Point

Diesel fuel can have a high content of paraffinic hydrocarbons which, if cooled sufficiently, will form as wax in the solution. Therefore, adequate cold flow performance is one of the most fundamental criteria for fuel quality in relation to engine performance. As diesel fuel is cooled, there comes a point at which the waxes begin to separate and appear as a cloud or haze in the fuel. The temperature at that point is known as the cloud point.[4]

As diesel fuel is cooled beyond the cloud point, more of the waxes come out of solution and begin to agglomerate. If cooling is continued, a point is reached where wax begins to cover the filter thickly enough to impede the flow of fuel. The temperature down to which the fuel remains useable before the filter becomes blocked is known as the Cold Filter Plugging Point[5] (CFPP).

Due to developments in wax crystal modifier additives vehicles can now be started and operated at ambient temperatures far below the cloud point of the fuel. As a result the Cold Filter Plugging Point is now recognised as a more useful measure of cold temperature performance for fuel containing wax crystal modifier additives. The Cold Filter Plugging Point was developed for US and European requirements[6] and has since been accepted in the Australian Automotive Diesel Fuel Standard.

The Cloud Point test remains the relevant test for diesel that does not contain wax crystal modifier additives.

7.6.1.1. The Australian Situation

The Australian Standard for diesel (AS 3570) recommends maximum limits for Cloud Point based on the twelve calendar months and the various climatic regions in Australia. The Standard lists twelve climatic regions and the limits range from -3˚C to 15˚C. In selecting boundaries for these regions the vast temperature differences across Australia were taken into account as well as State boundaries and fuel distribution patterns. The Standard also lists particular locations where fuel problems may occur because of cold weather conditions.[7]

Acknowledging the ability of wax crystal modifier additives to enable the operation of diesel engines at temperatures below the cloud point, AS 3570 permits the cloud point to be relaxed based on the Cloud Point Cold Filter Plugging Point differential.

In 1998 the cloud point limits in the Australian Standard for Automotive Diesel were revised to provide better control of vehicle operability in cold conditions by more closely matching the fuel specification limits to the fuel distribution areas and the local weather patterns in those areas. Changes were also made to allow for the relaxation of cloud point limits on the basis of the Cold Filter Plugging Point. These changes were in response to a proposal from the AIP developed with the use of detailed computer analysis of long term weather data. The subsequent change to the standard incorporated a winter season lead time to ensure that diesel

[4] Standards Australia, 1998, AS 3570 (automotive diesel).
[5] Standards Australia, 1998, AS 3570 (automotive diesel), p. 25.
[6] CONCAWE Report No 99/55 p. 39.
[7] Environment Australia, 2000, Setting National Fuel Quality Standards Paper 2, Proposed Standards for Fuel Parameters (Petrol and Diesel), p 50

used within two to three months from the date of supply should not give cold weather operability problems.

The 12 climatic zones specified in AS3570-1998 are mapped in Figure 1. The permitted cloud point relaxation is detailed in Figure 2 and the maximum permissible cloud points, for each month of the year, in each of these regions is detailed by Figure 3.

Figure 1: Climatic zones for cloud point calculation

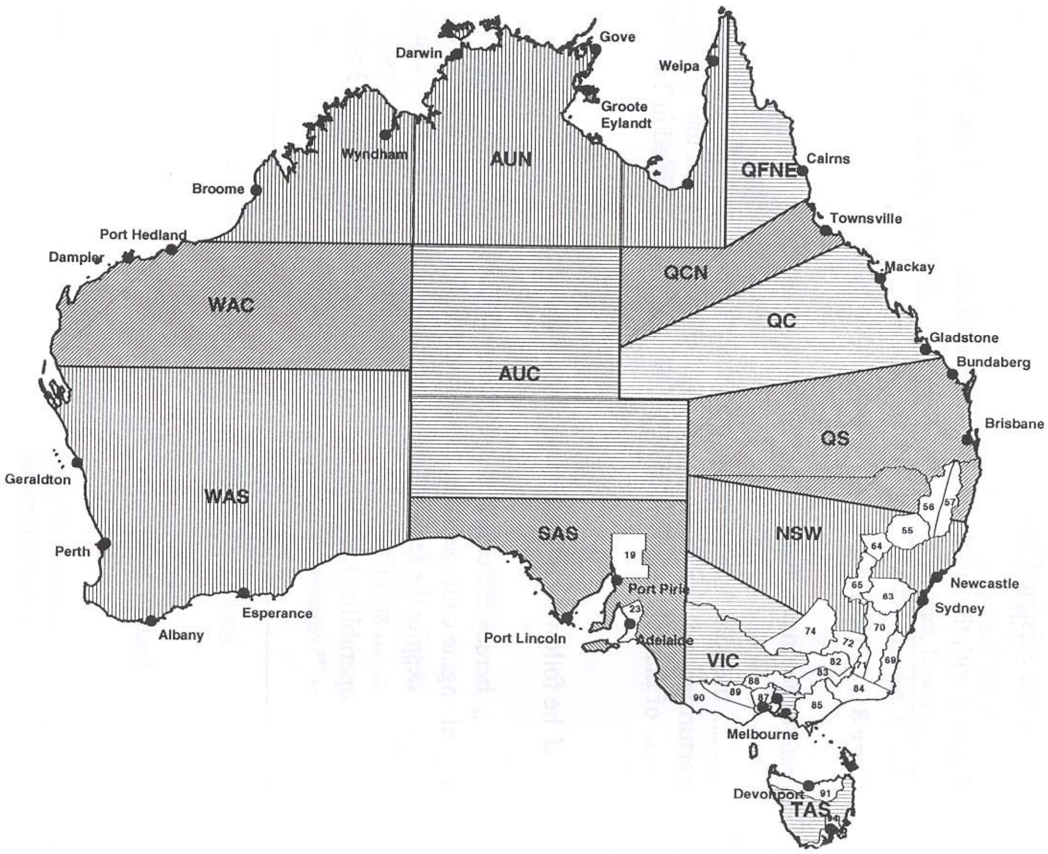


Figure 2: Cold Filter Plugging Point and Cloud Point Relaxation - Source AS 3570 -1998

CP-CFPP	CP Relaxation
0-3	0
4	1
5,6	2
7,8	3
9	4
>9	4

Figure 3: Maximum permissible cloud points

Locations	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
AUC	15	10	5	2	1	1	1	4	7	11	14	15
AUN	15	15	12	9	8	8	8	10	14	15	15	15
NSW	9	5	2	0	-1	-1	-1	0	2	5	7	9
QC	15	12	7	4	2	2	2	4	7	12	15	15
QCN	15	15	11	7	6	6	6	8	11	15	15	15
QNFE	15	15	12	7	7	7	7	9	12	15	15	15
QS	11	7	3	0	-1	-1	-1	0	2	7	9	13
SAS	8	6	4	2	1	1	1	2	4	5	6	9
TAS	3	1	-1	-2	-3	-3	-3	-3	-1	0	2	3
VIC	9	6	3	1	0	0	0	1	2	4	6	8
WAC	15	15	9	6	5	5	5	7	11	15	15	15
WAS	10	6	4	3	2	2	2	2	3	5	8	10

7.6.1.2. World Wide Fuel Charter

The WWFC recommends the use of either the Cloud Point, Cold Filter Plugging Point or the Low Temperature Flow Test (recommended for United States and Canada). The WWFC recommends that if the Cloud Point or Low Temperature Flow Test are used the level specified should be no higher than the lowest expected ambient temperature and if the Cold Filter Plugging Point is used it should be set equal to, or lower than the lowest expected ambient temperature.

7.6.1.3. European Standard

The European standards (EN590:1999) specify cold flow properties for diesel by using the Cold Filter Plugging Point based on local ambient conditions. Cloud point in addition to CFPP is only used to define the low temperature properties of arctic diesel grades, based on seasonal and locational factors.

Preliminary Proposal

It is proposed that the Australian specification for cloud point of diesel will be as per the existing Australian standard AS 3570 noting this allows for cloud point relaxation based on the cloud point Cold Filter Plugging Point differential. There is a recognition in all standards that these parameters need to be developed to meet local conditions and the requirements in AS3570 are based on Australian conditions.

Proposed Permitted Test Method/s: ASTM D2500, ISO 3015-92, JIS K 2269-87

Stakeholders are requested to pay particular attention to the AIP proposal (see box following) in regard to the management of diesel stocks to avoid waxing problems.

Recent ‘Waxing’ Issues in Western Australia

Following unseasonably cold weather in Western Australia during 2000 a significant number of farmers experienced difficulties with the starting of diesel-powered farm equipment. These problems arose from the formation of wax crystals, which blocked fuel filters and lines. These problems resulted in delays and expense to affected parties who had to either wait until the temperature rose and the wax crystals dissolved or had to mix heating oil into the diesel to avoid the problems occurring. Heating oil has a very low wax content and when mixed with diesel acts to reduce the overall wax content of the mixture.

These problems led to calls from the farming community for the introduction of more stringent cloud point requirements in the affected region of Western Australia. The AIP investigated these concerns and found that the existing cloud point requirements were adequate. Rather it concluded that the problems arose due to the sale and subsequent use of a ‘summer blend’ of diesel during winter.

To avoid the recurrence of these ‘waxing’ problems, the AIP has proposed that during the period January - March of any year, distributors of diesel should not accept orders from a customer for diesel that exceed one month’s stock cover for the customer. After March, winter diesel will generally be available. If winter diesel is not available after the end of March, distributors should advise customers of this, and should restrict supply appropriately to the circumstances.

Stakeholders are requested to provide particular comment on the adequacy of the AIP proposal or the need to further review appropriate cloud point levels.

7.6.2. Lubricity

Diesel fuel lubricates some moving parts of diesel pumps and injectors. To avoid excessive wear, the fuel must have some minimum amount of lubricity. (Lubricity is the ability to reduce friction between solid surfaces in relative motion.)[8] In the absence of sufficient lubricity in diesel, vehicles can suffer excessive pump wear and, in some cases, engine failure. In addition, certain modes of deterioration in the injection system could also affect the combustion process and hence emissions.[9]

Lubricity enhancing compounds are naturally present in diesel derived from crude oil but not necessarily in diesahols or synthetic diesel produced in "gas to liquids" plants. The process of hydrotreating to reduce sulfur levels destroys some of these natural lubricants. Accordingly, to prevent problems arising from the introduction of low sulfur grades of diesel, lubricity additives have been developed to compensate for the deterioration in natural lubricity of low sulfur diesel. It should be noted that these lubricity additives do not stop certain rubber seal failures that can result from lowering the aromatics content of diesel.

The High Frequency Reciprocating Rig (HFRR) test has been developed to enable the wear characteristics to be tested in the laboratory and ensure that lubricity levels are satisfactory.

Because of its importance to diesel engine performance and, ultimately, emissions, lubricity is considered to be an important fuel performance property.

7.6.2.1. The Australian Situation

Lubricity of diesel is not specified in Australian standard AS357-1998 as this standard was prepared for the management of diesel containing sulfur levels in excess of 500 ppm. Such fuels typically provide sufficient natural lubricity from their polar compounds. It is expected that as Australian fuel quality standards are progressively tightened, and sulfur levels are reduced, the need to use additives to manage diesel lubricity will increase.

7.6.2.2. World Wide Fuel Charter

The WWFC controls lubricity by specifying a maximum wear scar diameter in the HFRR test at 60ºC of 400 microns when measured in accordance with ISO 12156, ASTM D6079 or CEC F-06-A-96.

7.6.2.3. European Standard

The European standard EN590:1999 specifies a maximum wear scar diameter corrected for ambient conditions of 460 microns in order to control lubricity in diesel.

Preliminary Proposal

It is proposed that Australia harmonises with the European specifications by adopting a maximum diesel lubricity of 460 microns.

Proposed Permitted Test Method/s: IP 450

[8] Diesel Fuels Technical Review (FTR-2)

[9] Environment Australia, 2000, Setting National Fuel Quality Standards Paper 2, Proposed Standards for Fuel Parameters (Petrol and Diesel), p 24

Impact of Low Sulfur Diesel on Fuel Pumps Seals

Western Australia moved to 500 ppm sulfur diesel in January 2000 and Queensland moved to 500 ppm sulfur diesel in July 2000. The introduction of this lower sulfur diesel has led to a number of fuel pump seal failures. These problems should **not** be confused with insufficient lubricity.

The process of hydrotreating to reduce sulfur levels also saturates some of the aromatics in the diesel, which can cause some types of rubber seals in diesel fuel pumps to shrink and leak. The most common type of high pressure rotary pump found in small diesel engines, the Bosch VE and Japanese equivalents, depends upon rubber seals and gaskets to retain the fuel within the pump body. They are made of a material that has a degree of elasticity and is resistant to the fuel. Modern fuel pump seals and gaskets are generally made of a fluoroelastomer such as 'Viton' but fuel pumps on equipment more than 5-7 years old may contain seals and gaskets made of buta-n rubber and other materials. Aromatics react with buta-n rubber seal materials causing them to swell and change shape ensuring that they form a tight seal. This is a normal process and occurs all the time without affecting performance.

Fuel pump seals age and harden with use and will need to be replaced as part of normal maintenance. However, as they age, they do not respond as quickly to changes in aromatics levels. The result is that when the aromatics content is reduced, the rubber loses elasticity and may not seal effectively and the pumps can start to leak. The reduction in aromatics content varies depending upon the type of process selected by the refiner to reduce sulfur content and the problems will be worse with some diesel than others.

Unfortunately no additive helps and the only solution is to replace the seals. However once these seals have been replaced with appropriate fluoroelastomer seals, the problem will not re-occur.

7.7. Conductivity

7.7.1. Conductivity

The management of the conductivity of diesel is necessary to avoid electrostatic charge build-up and spark formation during pumping and loading of tankers. Diesel has a low electrical conductivity.

Refiners add anti-static additives to diesel to manage conductivity levels. If insufficient anti-static additives are present, there can be a build up of static electricity during pumping and loading. If this charge discharges as a spark it may ignite hydrocarbon vapour causing an explosion. This is an issue when tankers 'switch' loads between petrol and diesel and there are petrol vapours in the tank that can readily ignite if the vapour is in the flammable range.

7.7.1.1. The Australian Situation

Conductivity of diesel is not specified in Australian standard AS357-1998 but is controlled by each of the Australian refiners and importers through their own standards or specifications which typically specify a minimum conductivity of 50 pS/m (when tested using ASTM D2624) and appropriate handling procedures. The AIP advise that this minimum level is necessary to minimise the risk of tanker explosions during unloading from the build up of static electricity.

The 1999 statistics from the AIP report diesel conductivity levels as:

Minimum conductivity:	50 pS/m
Maximum conductivity:	840 pS/m
Average conductivity:	178 pS/m

7.7.1.2. World Wide Fuel Charter

The WWFC does not specify a level for conductivity in diesel.

7.7.1.3. European Standard

The European standards (EN590:1999) do not specify a level for conductivity in diesel however it is included in a separate specification related to diesel handling.

Preliminary Proposal

It is proposed that conductivity of diesel be controlled by the introduction of a specification requiring its conductivity to be a minimum of 50 pS/m. The introduction of such a standard appears warranted on safety grounds.

Proposed Permitted Test Method/s: ASTM D2624

7.8. Particulates

7.8.1. Water and Sediment

The presence of water and sediment in diesel, over the longer-term, has the ability to block fuel filters and injectors.

Water contamination can occur as a result of moisture-laden air entering fuel storage facilities during breathing of a tank due to daily temperature variations. Water in fuel can cause corrosion of the injection system components as well as promote fungal and bacterial growth leading to filter blocking.

Sediment contamination can cause premature blocking of filters. It can also cause deposits, and wear in both the injection system and the engine itself. Generally, sediment consists of carbonaceous material, metals, or other inorganic material. Instability and resultant degradation of fuel in contact with air contribute to the formation of organic sediment, particularly during storage and handling at elevated temperatures.

7.8.1.1. The Australian Situation

Water and sediment of diesel is managed by Australian standard AS357-1998 which recommends either a maximum water content of 0.05% (by volume) and a maximum sediment content of 0.01% (by mass) or a maximum water and sediment content of 0.05% (by volume).

The 1998 statistics from the AIP report water and sediment levels as:

Average water and sediment, mass%:	0.0092
Maximum water and sediment mass%:	0.05

7.8.1.2. World Wide Fuel Charter

The WWFC recommends maximum water content of 200 mg/kg and a maximum sediment content of 24 mg/L.

7.8.1.3. European Standard

The European specifications recommend maximum water content of 200 mg/kg and a maximum sediment content of 24 mg/L.

Preliminary Proposal

It is proposed that Australia adopts a maximum water and sediment content in diesel specification of 0.05% (by volume). Although this level is above the level recommended by the WWFC and European specifications it is being proposed on the basis that it is consistent with the current Australian standard which has been adequate in the past.

Proposed Permitted Test Method/s: ASTM D2709

8. PETROL

Petrol is a complex mixture of volatile hydrocarbons (compounds containing carbon and hydrogen atoms) used as a fuel in internal combustion engines. It is one of a large number of petroleum products made in a refinery from crude oil. Other terms for petrol are gasoline and less commonly, motor spirit.

Standards have been developed under the *Fuel Quality Standards Act 2000* to manage petrol fuel parameters that have a direct influence on emissions. These standards come into effect from 1 January 2002 and cover octane (RON), distillation, olefins, aromatics, benzene, lead, sulfur, and oxygen content.

The current Australian Standard for petrol (gasoline) for motor vehicles, AS 1876, does not have any legislative basis. Like the Australian Standard for automotive diesel fuel, it is essentially an industry guideline, the purpose of which is to ensure that difficulties in engine function associated with petrol use will be minimised. The standard relates to both leaded and unleaded petrol and was last reviewed in 1990. It is not a comprehensive specification as it does not address all parameters relating to petrol engine performance. Those parameters specified in the standard are confined to general composition, limits on chemical content, limits on some performance properties (including antiknock), colour identification and marking. The general requirements specified in the Australian Standard are presented in **Table B** below.

The actual properties of Australian petrol differ in part both from the specifications in the Australian Standard, AS1876-1990, and between refineries.

Table B General requirements for petrol (AS 1876)

Petrol type	**Parameter**	**Limit**
Leaded and unleaded	Benzene	Max 5% (by volume)
	Copper corrosion	Max, Class 1 (3 h at 50°C)
	Existent gum	Max 40 mg/L
	Oxidation stability	Min 240 minutes
Leaded	Lead content	As permitted by legislation
Unleaded		Max 13 mg/L
Unleaded	Phosphorus content	Max 1.3 mg/L
Leaded	Sulfur content	Max 0.2% by mass
Unleaded		
Leaded	Research octane number (RON)	96 minimum
Unleaded		
Regular	Motor octane number (MON)	82 minimum
	Research octane number (RON)	91 minimum 93 maximum
Premium	Motor octane number (MON)	82 minimum
	Research octane number (RON)	95 minimum
Leaded	Colour	Red
Unleaded Regular (ULP)		Purple
Premium (PULP)		Yellow

9. PETROL OPERABILITY PARAMETERS

The key petrol parameters which have been identified as having either a direct or indirect impact on vehicle operability are: octane(MON); flexible volatility index; driveability index; phosphorus; copper corrosion; existent gum; induction period; colour; and appearance.

9.1. Physical parameters

9.1.1. Colour

Dyes are used for easy identification of each of the various grades of petrol thereby assisting to ensure that the right fuel grade is delivered into the right service station tank.

9.1.1.1. The Australian Situation

Colour of petrol is managed by Australian standard AS1876-1990, which specifies leaded petrol be red, unleaded petrol be purple and premium unleaded petrol be yellow.

The 1998 statistics from the AIP report that these colour requirements were met.

In practice, imported unleaded petrol often initially appears yellow in colour. Once standard unleaded petrol dye is added, to tint it purple, it then appears bronze. Accordingly it is proposed that the colour of unleaded petrol be either purple or bronze.

9.1.1.2. World Wide Fuel Charter

The WWFC does not make recommendations of the colour of the various grades of petrol.

9.1.1.3. European Standard

The European standards (EN590:1999) do not make recommendations of the colour of the various grades of petrol.

Preliminary Proposal

It is proposed that handling of the various grades of petrol be assisted by the introduction of a specification requiring premium unleaded petrol to be yellow, unleaded petrol to be purple or bronze and lead replacement petrol to be red. Colours shall be assessed visually without the need for great precision.

9.1.2. Appearance

Appearance of petrol is used as a quick indicator of potential contamination and to ensure that there is no free or entrained water or particles (solids - rust etc). Water can result in higher corrosion or promote bacterial growth. Extreme cases of these can result in filter blockage. Petrol, when it is refined, can contain entrained water and the product has a cloudy appearance. The water normally drops out quickly but this is not always the case.

9.1.2.1. The Australian Situation

Appearance of petrol is not specified in Australian standard AS357-1998 but is controlled by each of the Australian refiners and importers through their own standards or specifications.

9.1.2.2. World Wide Fuel Charter

The WWFC specifies petrol to appear clear and bright based on a visual assessment.

9.1.2.3. European Standard

European standards (EN590:1999) specify petrol to appear clear and bright.

> **Preliminary Proposal**
>
> It is proposed that Australia harmonises with the European specifications by adopting a standard for the appearance of each grade of petrol of clear and bright when assessed visually at an ambient temperature of 25ºC.

9.2. Corrosion

9.2.1. Copper Corrosion

The copper corrosion test serves as a measure of possible corrosion of copper, brass, or bronze fuel system components.

9.2.1.1. The Australian Situation

Copper corrosion of petrol is managed by Australian standard AS357-1998 which specifies a maximum copper corrosion of Class 1 (3hr at 100ºC) when measured in accordance with ASTM D 130-IP 154.

The 1999 statistics from the AIP report copper corrosion levels as:

Average copper corrosion (3hr at 50ºC):	Class 1
Maximum copper corrosion (3hr at 50ºC):	Class 1

9.2.1.2. World Wide Fuel Charter

The WWFC recommends a copper corrosion of Class 1 (3 hours at 50ºC) when measured in accordance with ISO 2160, ASTM D130 or JIS K2513.

9.2.1.3. European Standard

The European standards (EN590:1999) specify copper corrosion as Class 1 (3 hours at 50ºC).

> **Preliminary Proposal**
>
> It is proposed that Australia harmonises with the European specifications by adopting a maximum petrol copper corrosion specification of Class 1.
>
> Proposed Permitted Test Method/s: ASTM D130 (3 hours at 50ºC)

9.3. Volatility

9.3.1. Flexible Volatility Index

Excessively high petrol volatility can cause hot fuel handling problems such as vapour lock, canister overloading, and higher emissions. Vapour lock occurs when too much vapour forms in the fuel system (fuel pump, fuel line, carburettor or injector) and fuel flow to the engine is reduced or interrupted. This results in the air/fuel ratio being too lean and may cause loss of power, rough engine operation or backfiring. Once the fuel supply is interrupted and the engine stops, it may be difficult to restart until the fuel system has cooled and the vapour recondensed. This is more of an issue with carburettor vehicles and not with modern fuel injected engines as the fuel is kept under pressure in the fuel injection system.

There are a number of different correlations used around the world to ensure good hot weather operability. Australian refiners, with the agreement of the FCAI, manage petrol volatility through the use of a flexible volatility index (FVI). FVI is an alternative to Vapour/Liquid Ratio, which is a significantly more difficult test to undertake. FVI is calculated as:

FVI = RVP + 0.70 x E70
Where: RVP = Reid vapour pressure (Kpa)
E70 = % evaporated at 70ºC

FVI was developed by the oil industry in Europe during the 1970's based on studies of hot weather vehicle performance.

In the US, Vapour Liquid Protection Temperature (VLPT) is used to estimate hot weather operability. VLPT can either be tested or calculated from the distillation and vapour pressure (as long as the fuel does not contain oxygenates). In Europe, a Vapour Lock Index has been used - this is essentially the same as FVI (multiplied by 10).

9.3.1.1. The Australian Situation

FVI of petrol is not specified in Australian standard AS1876-1990. Since the 1980's Australian refiners, with the agreement of the FCAI, have managed petrol volatility through the use of a FVI. The Australian levels for FVI, outlined in Table 4, were developed using European FVI levels and Australia's climatic and geographical conditions.

Several States currently control petrol RVP levels in certain areas of their jurisdiction during summer months through regulation or through a Memorandum of Understanding with the oil industry. In these instances FVI is not specified, rather volatility in controlled exclusively by the State's RVP requirements. The RVP specifications that apply in these circumstances are also specified in Table 4.

9.3.1.2. World Wide Fuel Charter

The WWFC specifies a vapour liquid ratio as opposed to a FVI. The actual level specified is dependent on locational and seasonal factors.

9.3.1.3. European Standard

The European fuel standards specify the use of a vapour lock index - this is essentially the same as FVI (multiplied by 10). The actual level specified is dependent on locational and seasonal factors.

Preliminary Proposal

Given the difficulties with the determination of the Vapour/Liquid ratio and the need to consider local climatic conditions, it is proposed that hot weather driveability problems be managed through the introduction of a FVI specification and that permissible limits of FVI be as per the existing AIP/FCAI agreement, detailed in Figures 3 and 4.

Calculated = RVP + 0.7*E70

Table 3 : Product Distribution Regions

	Main Region	Terminals Included
ULPNL	NSW Low Volatility Zone, ACT	Parramatta, Newcastle
ULPNC	New South Wales Country	Parramatta, Newcastle
ULPNT	Northern Territory	Darwin
ULPQN	Queensland – North	Gladstone, Mackay, Cairns, Townsville
ULPQS	Queensland – South	Pinkenba
ULPSA	South Australia	Birkenhead, Port Lincoln
ULPTS	Tasmania	Devonport, Hobart
ULPVC	Victoria	Newport, Geelong
ULPWC	Western Australia – Central	Geraldton
ULPWN	Western Australia – North	Port Hedland, Dampier, Broome
ULPWP	Western Australia – Perth	North Fremantle
ULPWS	Western Australia – South	Albany, Esperance

Table 4 : ***Preliminary Proposal for Flexible Volatility Index***

IRIS	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
ULPNL See Note 1												
2001 +	**62**	**62**	**62**/102	107	114	120	120	117	110	105	102/**62**	**62**
ULPNC	98	100	102	107	114	120	120	117	110	105	102	98
ULPNT	90	94	98	102	102	102	100	98	96	92	90	90
ULPQN	96	98	102	105	108	110	108	106	103	98	96	96
ULPQS See Note 1												
2001	**76**	**76**	**76**/104	108	113	116	116	112	108	104	100/**76**	**76**
2002	**76**	**76**	**76**/104	108	113	116	116	112	108	104	100/**67**	**67**
2003 +	**67**	**67**	**67**/104	108	113	116	116	112	108	104	100/**67**	**67**
ULPSA see Note 2												
2001+	**67**	**67**	**67**	104	114	119	119	114	109	100	95	**67**
ULPTS	106	106	112	117	124	127	127	125	121	117	114	110
ULPVC	95	96	102	110	119	124	125	121	116	109	104	99
ULPWC	92	94	98	106	112	118	114	112	108	100	94	92
ULPWN	90	92	94	96	104	108	104	100	94	88	88	88
ULPWP see Note 3												
2001+	**67**	**67**	**67**	**67**/107	112	118	119	118	114	108/**67**	**67**	**67**
ULPWS	100	100	108	116	120	122	122	120	118	110	106	100

Note 1: numbers in **bold** above are **RVP** (kPa), the changeover date are 15th November and 15th March. Individual batches may be released with a **RVP** 2kPa higher providing the summer monthly average on a volumetric basis meets the specification for that month. Individual blends of more than 2 kPa under the required average will be counted as [average RVP - 2 kPa] for averaging purposes.
Note 2: numbers in **bold** above are maximum average **RVP** (kPa), the changeover dates are 30th November and 31st March. For the purposes of calculating the average RVP, an RVP below 62 kPa must be considered as an RVP of 62 kPa
Note 3: numbers in **bold** above are **RVP** (kPa), the changeover date are 15th October and 15th April.

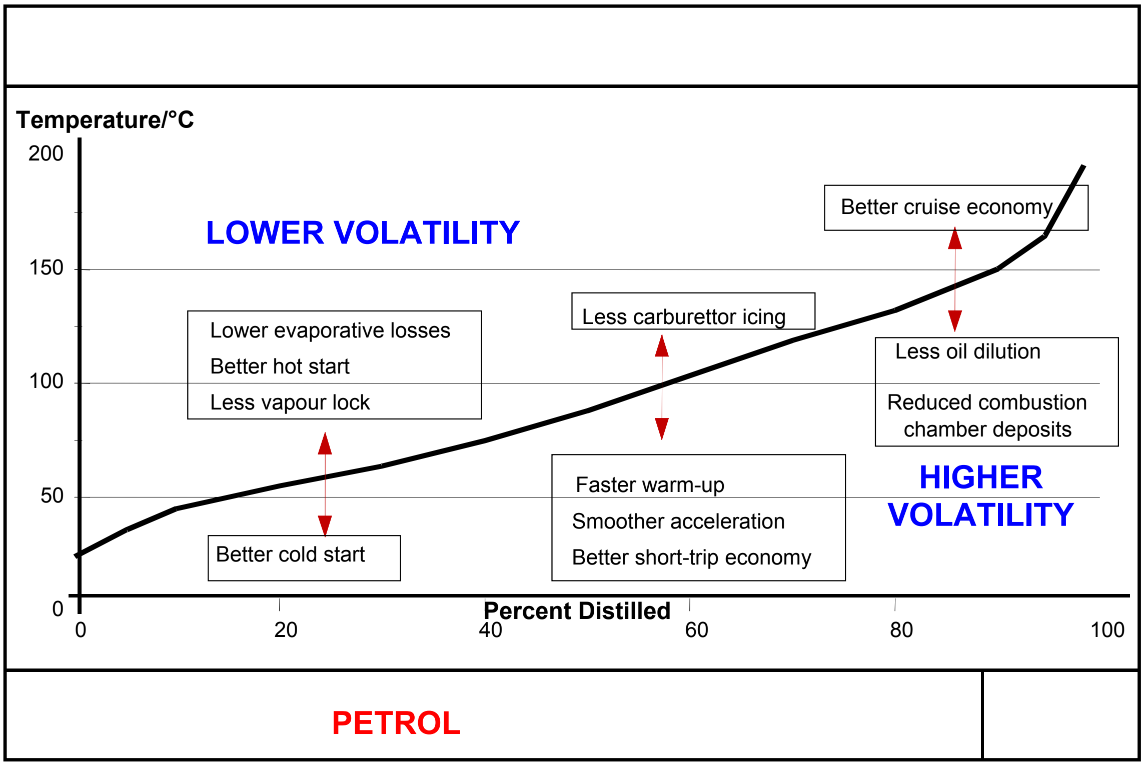
9.3.2. Driveability Index

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. As shown in Figure 5, petrol boils or distils over a range of temperatures. If the 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. Also, drivers will experience problems if the petrol does not have a smooth distillation curve and is a 'dumb-bell' blend of front end (light) and back end (heavy) components with no mid-range components.

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

Figure 5: Typical petrol distillation profile



9.3.2.1. The Australian Situation

Driveability index of petrol is not included in Australian Standard AS1876-1990 but is controlled by each of the Australian refiners and importers through their own standards or specifications.

9.3.2.2. World Wide Fuel Charter

The WWFC recommends the use of a driveability index with a maximum level of 570 during summer and a maximum level of 560 during winter. The WWFC notes that the oxygenate correction, in the DI equation, does not apply to ethers.

9.3.2.3. European Standard

The European fuel standards have more rigorous distillation point requirements than are being adopted for Australia. As a consequence the specification of a driveability index in Europe is not necessary.

Preliminary Proposal

It is proposed that Australia harmonises with the WWFC by adopting a driveability index for petrol and that its maximum permissible level be 570 during summer (mid-Nov until mid-March) and 560 during winter(all other periods).

Where: DI = 1.5*T10 + 3*T50 + T90 + 11* Oxygenates
(Note: oxygenate correction does not apply to ethers)

9.4. Stability

9.4.1. Existent ('washed') Gum

Petrol can slowly oxidise in the presence of air to form undesirable oxidation products such as peroxides or gums. These products are soluble in the fuel, but can appear as sticky residue when the petrol evaporates. The residues can deposit on carburettors, injectors, intake port valves and impact the vehicle's performance. These problems can be managed through a specification on existent gum.

Gums are typically specified as either washed or unwashed. Unwashed gum is measured by evaporating a sample of petrol and weighing the residue. This not only measures the gum formation, but it also measures the additives (detergents etc). To determine the inherent gum, the sample is then washed with a solvent, which removes the additives - this is 'washed gum'.

9.4.1.1. The Australian Situation

Existent ('washed') gum levels in petrol are managed by Australian standard AS1876-1990 which specifies a maximum level of 40 mg/L when measured in accordance with ASTM D 381.

The 1998 statistics from the AIP report existent gum levels as:

Average existent gum (unleaded petrol): 3.9 mg/L
Maximum existent gum (unleaded petrol): 34.0 mg/L

9.4.1.2. World Wide Fuel Charter

The WWFC recommends a maximum unwashed gum content of 300 mg/L and a maximum washed gum content of 50 mg/L.

9.4.1.3. European Standard

The European standards (EN590:1999) specify existent gum (washed) at a maximum of 50 mg/L.

Preliminary Proposal

It is proposed that management of oxidation products in all grades of petrol be through the introduction of an existent ('washed') gum specification and that the maximum level be 40 mg/L.

Although this level is inconsistent with the European and WWFC level of 50mg/L it is being recommended in response to reports from the AIP of historical problems with gum deposits in Australia. Accordingly it was considered prudent to retain the more conservative specification currently used in Australia.

Proposed Permitted Test Method/s: ASTM D381

9.4.2. Induction period

Induction period is an indication of storage stability. Fuels with poor stability will form insolubles that can block fuel filters. Petrol oxidises in the presence of air and water, particularly if the fuel contains non-hydrotreated cracked products, which are relatively unstable. High temperatures also accelerate the oxidation of petrol. Further, petrol degrades when in contact with copper or zinc because these two metals actively promote oxidation of petrol. Accordingly, prolonged storage of fuel in such an environment can result in the oxidation of petrol to form undesirable gums and sediment. Such undesirables can cause filter plugging, combustion chamber deposit formation, and gumming or lacquering of injection system components with resultant sticking and wear.

9.4.2.1. The Australian Situation

Induction period of petrol is not included in Australian Standard AS1876-1990 but is controlled by each of the Australian refiners and importers through their own standards or specifications which typically specify a minimum induction period of 240 minutes.

The 1998 statistics from the AIP report induction periods of:

Average induction period:	>400 minutes
Maximum induction period:	1440 minutes

9.4.2.2. World Wide Fuel Charter

The WWFC recommends minimum oxidation stability (induction period) of 480 minutes.

9.4.2.3. European Standard

The European standards (EN590:1999) require an induction period of a minimum of 360 minutes.

Preliminary Proposal

It is proposed that Australia harmonises with the European specifications by adopting an induction period specification for petrol of a minimum of 360 minutes.

Proposed Permitted Test Method/s: ASTM D525

9.5. Combustion

9.5.1. Motor Octane Number (MON)

During initial consultations for the development of the ‘environmental’ parameters of the Commonwealth fuel standards, some stakeholders proposed that due to advancements in vehicle technologies it was no longer necessary to specify MON levels. In addition, evidence was also provided to show that in most cases, MON is the limiting octane specification and in order to meet MON, there is RON giveaway (loss). In response to these concerns, the Commonwealth’s revised position, released in September 2000, proposed that MON levels would not be mandated under the Commonwealth standards.

Further submissions on the revised position raised considerable concern that this proposal would have adverse effects on older engines. Although it is not intended to revisit any parameters that were considered under the ‘environmental’ standards, an exception is being made in respect of MON in this case due to the associated operability issues that have been raised.

Octane is a measure of petrol's ability to resist abnormal combustion and in particular, auto-ignition. There are two laboratory test methods to measure petrol octane numbers: one determines the Research Octane Number (RON) and the other the Motor Octane Number (MON). RON correlates best with low speed, mild-knocking conditions and MON correlates with high-temperature knocking conditions and with full-throttle / high-speed operation. RON values are typically higher than MON and the difference between these values is the sensitivity.

Refiners generally obtain an increase in RON from aromatics (ex the reformers) and aromatics have a relatively poor MON compared to isoparaffins. Thus, to produce a 95/85 RON/MON fuel, refiners may in fact need to raise the RON to 97 to ensure an 85 MON figure is achieved. This is often referred to as an 'octane penalty'.

The octane requirements vary from one market to another depending upon the type of vehicles being sold and typical loads and driving conditions. In Australia, the octane requirements are monitored by a joint auto/oil program, ACORC (Australian Cooperative Octane Requirement Committee) which determine the customer satisfaction level for the Australian vehicle fleet. Based on data from over 30 years of testing, the auto and oil industries propose to retain the MON specification but reduce the minimum MON requirement for ULP by 1 to 81.

An alternative method of managing MON and RON levels is to use an Anti-Knock Index (AKI) which is calculated as (RON+MON)/2. This approach is utilised in the US where three grades of unleaded with different AKIs are available - 87 regular, 89 mid, 91 to 94 premium. Using this approach Australia's 91/82 grade would be 86.5 AKI and the 95/85 grade would be 90 AKI. Use of an AKI achieves the same outcome for vehicle operability as specifying both RON and MON whilst avoiding the 'octane penalty'.

9.5.1.1. The Australian Situation

The MON of petrol is managed by Australian Standard AS1876-1990 which specifies the following levels when measured in accordance with ASTM D 2700/IP 236.

Leaded petrol:	No limit specified
Unleaded petrol:	82 minimum
Premium unleaded petrol:	85 minimum

The 1999 statistics from the AIP report MON levels as:

	Premium unleaded	Unleaded
Average	85.6	82.4
Maximum	89.7	84.8
Minimum	82.0	81.7

9.5.1.2. World Wide Fuel Charter

The WWFC recommends the following MON levels:

	Premium unleaded (min 98 RON)	**Premium unleaded (min 95 RON)**	**Unleaded (min 91 RON)**
Minimum	88	85	82.5

9.5.1.3. European Standard

The European fuel standards specify the following MON levels: [Note: EN590 only defines octane numbers for the premium; for regular the octane specifications are set in national specifications and not on a European level.]

	Premium unleaded (min 95.0 RON)
Minimum	85.0

Preliminary Proposal

It is proposed that the following MON specifications be adopted:

Premium unleaded	**Unleaded**	**Lead replacement petrol**
85 min	81 min	82 min

This proposal reflects a reduction in the MON specification by 1 point for unleaded petrol. This proposal is in response to extensive testing of Australian vehicles by the FCAI, which concluded that the lower MON specification would not adversely effect vehicle operability.

Stakeholders are particularly requested to provide comment on issues associated with MON including the need for it to be specified.

Proposed Permitted Test Method/s: ASTM D2699

10.SUMMARY OF PRELIMINARY PROPOSAL

With respect to diesel, recommendations have been put forward for the management of 10 key parameters: carbon residue; water and sediment; cloud point; conductivity; lubricity; oxidation stability; colour; acidity; copper corrosion; flashpoint; and appearance. It is recommended that these parameters be regulated under the *Fuel Quality Standards Act 2000* from 1 January 2002 and that the proposed specifications apply at the pump. The proposed specifications are presented in Table C.

Table C: Summary of Recommendations for Diesel Specifications

Fuel Parameter	**Specification**	**Test method (or equivalent)**	**Reason for limit**
Carbon Residue (10% distillation residue)	0.2 mass % max	JIS K 2270-90, ASTM D4530, ISO 10370-93	Engine deposits
Water and sediment	0.05 vol % max	ASTM D2709	Blocking of fuel systems
Cloud point	As per seasonal and location tables in AS3570	ASTM D2500 ISO 3015-92 JIS K 2269-87	Low temperature driveability
Conductivity @20^{0}C	50 pS/m (Min)	ASTM D2624	Safety during handling
Oxidation Stability	25 mg/L max	ASTM D2274 ISO 12205-95	Storage stability
Colour	2 max	ASTM D1500	Identify contamination
Acidity	Total 0.08 mg KOH/g (Max) Strong nil	ASTM D974 NFT 60112-86 ASTM D974	Corrosive wear of fuel systems
Copper Corrosion (3 hrs @50^{0}C)	Class 1 max	ASTM D130 ISO 2160-98 JIS 2513-91	Corrosive wear of fuel systems
Flashpoint	61.5^{0}Cmin	ASTM D93 ISO 2719-88 JIS K 2265-96	Safety during handling
Appearance @ 25^{0}C	Clear and bright	Visual	Identify contamination
Lubricity	460 microns (max)	IP450	Minimise pump wear

In the case of petrol, recommendations have been put forward for the management of nine key parameters: MON; flexible volatility index; driveability index; phosphorus; copper corrosion; existent gum; induction period; colour; and appearance. It is recommended that these parameters be regulated under the *Fuel Quality Standards Act 2000* from 1 January 2002 and that the proposed specifications apply at the pump. The proposed specifications are presented in Table D.

Table D: Summary of Recommendations for Petrol Specifications

Fuel Parameter	**Fuel grade**	**Specification**	**Test method (or equivalent)**	**Reason for limits**
Motor octane number	PULP	85 (min)	ASTM D2699	Driveability under heavy load
	ULP	81 (min)	ASTM D2699	Driveability under heavy load
	LRP	82 (min)	ASTM D2699	Driveability under heavy load
Flexible Volatility Index	All	As per seasonal and location tables (Figure 4)	Calculated = RVP + 0.7* E70	Hot engine driveability
Driveability Index	All	570 (max Summer) 560 (max Winter)	Calculated = 1.5*T10+3*T50+ T90+11*OXY	Cold start and warm up driveability
Copper Corrosion (3 hrs @ 50^{0}C)	All	Class 1 (max)	ASTM D130	Corrosion of fuel system
Existent Gum (washed)	All	40 mg/L (max)	ASTM D381	Engine deposits
Induction Period	All	360 mins (min)	ASTM D525	Storage stability
Colour	PULP	Yellow	Visual	Misfueling
	ULP	Purple / Bronze	Visual	Misfueling
	LRP	Red	Visual	Misfueling
Appearance @ 25^{0}C	All	clear and bright	Visual	Identify contamination

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