REGULATING BIOFUEL QUALITY

A discussion document outlining the proposed biodiesel and ethanol specifications

Ministry of Economic Development

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2. Making a Submission

The Ministry is seeking comments on this discussion paper by 9 November 2007. Questions are provided to assist, but general comments are also welcome.

Please include your name, organisation's name (if applicable), and your address (postal and email, if applicable).

Please send your submission to:

- Postal address:

  Fuels and Crown Resources
  Ministry of Economic Development
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2.1 Confidential Information

Respondents should note that written submissions or comments provided to the Ministry of Economic Development on this discussion document will be subject to the Official Information Act 1982 (OIA). The OIA requires the information to be made available unless there is good reason, pursuant to the Act, to withhold the information; and that good reasons outweighs the public interest in making the information available.

If you want information that you provide to be treated as confidential, please clearly identify the material and explain to us why you believe the information should be withheld under the provisions of the OIA.

3. General

3.1 Purpose of Document

Biofuels are fuels that are derived from biomass (recently living organisms or their metabolic by-products). They are a renewable energy source, unlike petroleum fuels or fuel derived from coal or natural gas. In general, biofuels can be used as a substitute for, or additive to, petrol and diesel in most transport and non-transport applications. The most commonly used biofuels are biodiesel and bioethanol.

With the introduction of biofuels in New Zealand, aided by the Biofuels Sales Obligation from April 2008, and to build and maintain consumer confidence in the quality of biofuels it is necessary that appropriate regulated specifications are in place for biodiesel and ethanol. The ethanol specification should apply to both bioethanol and non-renewable ethanol. Biodiesel and ethanol specifications are not currently regulated in New Zealand. Petrol and diesel are regulated by the Petroleum Products Specifications Regulations (PPSR).

As for petrol and diesel, biodiesel and ethanol specifications should specify parameters to ensure consistency in fuel quality that is suitable for New Zealand's vehicle fleet, whilst addressing environmental, health and safety concerns. Specifications also provide certainty of expectations regarding fuel quality, which will protect consumers and help inform business planning and investment.

The purpose of this document is to discuss biodiesel and ethanol specifications appropriate for regulation in New Zealand. It also discusses diesel/biodiesel and petrol ethanol blends.

In considering the material covered in this document, it is important to keep the following key principles in mind:

- Biofuels should be of an appropriate quality for New Zealand's vehicle fleet.
- Quality standards should minimise impacts on the environment and public health.
- Biofuels should be competitive and affordable.
- Specifications should be performance based.
- The regulations should be consistent, where appropriate, with similar international fuels specifications.

While the focus of this discussion document is on the use of fuel in vehicles. It is recognised however that both petrol and diesel are used in a range of non-vehicular applications.

3.1.1 Next Steps

Once decisions on appropriate biodiesel and ethanol specifications have been made, the Petroleum Products Specifications Regulations (PPSR) will be re-issued under a new name incorporating these fuels and any other updates. This will likely be in early 2008.

As with petroleum petrol and diesel, specifications for biodiesel and ethanol will reflect the knowledge and experiences so far acquired. Thus, the process of standardising engine fuels of all natures can be regarded as a dynamic process, and so the specifications will be updated in future in line with domestic and international developments.

3.2 The Petroleum Products Specifications Regulations

The PPSR are issued pursuant to the Ministry of Energy (Abolition) Act 1989. They set a range of minimum requirements for the quality of petrol and diesel supplied in New Zealand. Each specified property has a corresponding limit and the test method used to measure it. Also included in the PPSR are requirements for retail fuel pumps and sampling.

The PPSR are very similar to fuel quality standards in Europe and Australia. The PPSR are considered to provide an appropriate level of protection for consumers while ensuring that the costs of supplying compliant fuel are reasonable.

The PPSR are available online, go to the regulations section of the New Zealand Legislation website (www.legislation.govt.nz/browse_vw.asp?content-set=pal_regs) and search for "petroleum products".

3.2.1 Retail vs. Non-Retail

The PPSR distinguishes between all fuel "supplied, or available or intended for supply" and fuel that is sold by retail. Retail sale is defined by the PPSR as the sale of fuel "to an end use who has no written supply agreement or written contract with the supplier". Fuel for retail sale must meet all the specification requirements of the PPSR. Petrol and diesel for all other types of sale must meet only those specifications that protect the environment, public health, and human safety; for example, the restriction on the use of lead in petrol and limits of sulphur levels.

This differentiation enables specially blended petrol and diesel fuel to be sold through commercial agreements, where there is a written agreement between the buyer and the supplier to supply fuel to specific requirements.

The PPSR includes an overarching 'fit for common purposes' requirement for petrol and diesel sold by retail. This strengthens the level of consumer protection, particularly in relation to fuel quality problems arising from properties not directly specified. It is common practice for the oil industry to have more stringent requirements than those in the PPSR to ensure that fuel is fit for common purpose. The 'fit for common purposes' requirement will also apply to retail biodiesel and ethanol, and associated blends.

3.3 Fuel Quality Testing

Petrol and diesel in New Zealand is currently monitored for quality compliance by the Measurement and Product Safety Service, a group within the Ministry of Economic Development (MED). Under its Fuel Quality Monitoring Programme, samples of petrol and diesel are collected from service stations around the country and tested to ensure that they meet the specifications provided in the PPSR. The penalty for non-compliance is up to $10,000.

The quality of biodiesel and ethanol, and blends, will similarly be monitored under the Fuel Quality Monitoring Programme.

3.3.1 Test Methods

Test methods for engine fuels have been developed by a number of internationally recognised standardisation organisations, including ASTM International (formerly the

American Society for Testing and Materials), CEN (European Committee for Standardization), ISO (International Organisation for Standardization) and JIS (Japanese Industrial Standards). The American, European and Japanese fuel standards generally specify the ASTM, CEN and JIS and test methods respectively.

The PPSR predominately specifies ASTM test methods for petrol and diesel. It is understood that most testing in New Zealand uses ASTM test methods. The individual test methods to be specified in the regulations for biodiesel and ethanol are discussed separately under the relevant sections.

For all engine fuels, in the event of a dispute where more than one method is specified, the first method in the appropriate table will take precedence.

4. Biodiesel and Biodiesel Blends

4.1 Introduction

Biodiesel is a renewable fuel with properties similar to petroleum diesel. It is obtained by esterification of oils or fats derived from plants or animals. Esterification involves producing a reaction of a vegetable oil or an animal fat with an alcohol, such as ethanol or methanol, in the presence of a catalyst to yield mono-alkyl esters, and glycerine, which is removed. Biodiesel is a generic name for mono-alkyl esters.

New Zealand's biggest source of biodiesel is tallow, an animal fat by-product from the meat processing industry. Vegetable based oils, such as rapeseed, and suitably processed used cooking oil from restaurants can also be made into biodiesel. There are currently only small amounts of biodiesel being produced in New Zealand and these are not yet part of the retail fuel mix.

There are currently no regulated biodiesel specifications in New Zealand, only a voluntary biodiesel standard - Automotive Biodiesel: Specification for manufacture and blending (NZS 7500).

NZS 7500 specifies requirements and test methods for biodiesel manufacture and its use either as automotive fuel for compression ignition engines at 100% concentration or as a blend component. It was prepared by a committee consisting of representatives from biofuel manufacturing companies, oil companies, the motor vehicle industry, the New Zealand Refining Company and government agencies.

It is considered that biodiesel blends containing up to five per cent by volume may be used in any diesel engine without modification. There is also the potential for higher blends of biodiesel to be used, for example, to power bus and truck fleets and for use in the fishing industry. As for petroleum diesel, it is proposed that a distinction is made in the regulations between all biodiesel "supplied, or available or intended for supply" and biodiesel that is sold by retail.

The conventional nomenclature for describing biodiesel blends is BX where the X is the volume percent of biodiesel in the blend. For example, B100 is neat biodiesel and B5 is a blend of 5% biodiesel and 95% petroleum diesel.

The following section discusses the proposed specification for B100, retail biodiesel blends, and non-retail biodiesel blends, in that order.

4.2 Scope of Regulations

Rather than replicate the analysis undertaken to develop NZS 7500, the proposed regulations use this standard as a starting point. The proposals discussed reflect new knowledge and developments and changes necessary to incorporate biodiesel and biodiesel blends in the PPSR.

Biodiesel is predominately produced by methanol esterification of natural product fatty acids, thus known as fatty acid methyl esters (FAME). However, other alcohols could be used in the production process, such as ethanol which would produce a fatty acid ethyl ester (FAEE). Bioethanol is of interest as this is a renewable resource, rather than methanol which is usually derived from fossil fuels. At present the use of methanol is an economic decision, as this is the cheapest alcohol. In addition, reactions proceed faster with the use of methanol over ethanol. Many of the methods used to measure biodiesel quality are not necessarily appropriate to analyse ethyl rather than methyl esters.

NZS 7500, while based on FAME, does not exclusively specify this type of ester. The European and Japanese diesel fuel standards specify the allowable biodiesel component as FAME. It is proposed that the New Zealand biodiesel specifications likewise specify the biodiesel component as FAME. This will be reviewed in line with international developments.

NZS 7500 applies only to biodiesel for use as an automotive fuel for compression ignition engines. Petroleum diesel as regulated in the PPSR is not limited to automotive use. For consistency in approach, and to ensure that all biodiesel sold in New Zealand is of a suitable quality, it is proposed that the regulated biodiesel specification does not make a distinction between automotive and other use. Hence, all biodiesel supplied in New Zealand will need to meet the specifications set out in the regulations. Note however that the non-retail specification (discussed in Section 4.5) for biodiesel will provide some flexibility for non-vehicular use of biodiesel (e.g. heating purposes and powering machinery).

4.3 Specification for B100

4.3.1 Background

The regulated B100 specification will specify requirements and test methods for B100 supplied in New Zealand. B100 will mainly be sold as a blend with petroleum diesel. The proposed requirements for retail and non-retail biodiesel blends are discussed in Section 4.4 and 4.5 respectively. It is also proposed to allow B100 to be sold via a written contract (i.e. non-retail only). Comments are sought on this approach.

Effort is underway internationally to harmonise biodiesel specifications. However, currently the appearance of specifications varies substantially between countries (see Table 1) due to differences in regulatory approach, climate, feedstock and vehicle technology. The specifications in NZS 7500 were developed to be consistent with the European automotive biodiesel standard (EN 14214) but be performance based rather than feedstock specific. The relatively few differences between NZS 7500 and EN 14214 are shown in Table 2. The Japanese and Australian specifications likewise look to EN 14214.

The other major standard for biodiesel is the ASTM D 6751, which is less comprehensive than EN 14214, containing only 14 parameters compared to the 22 in EN 14214. Being less comprehensive, this standard gives more flexibility for feedstock. However, ASTM D 6751 is only applicable for biodiesel used for blending with petroleum diesel up to 20% by volume, not as a final fuel in itself.

It is proposed that the New Zealand regulations incorporate the B100 specification as set out in NZS 7500. These parameters are considered to give B100 of an appropriate quality, while ensuring that the costs of supplying compliant fuel are reasonable.

Table 1: International B100 Specifications

Country	**B100 Specification**	Comments
Europe	**EN 14214**	For final fuel and blending component. 22 different parameters specified, based predominantly on rapeseed oil feedstock.
United States	**ASTM D 6751**	Applicable for biodiesel for blending in levels up to 20% by volume, not as a final fuel. Much less comprehensive than EN 14214, only 14 parameters specified. More flexibility in feedstock.
Japan	**JASO M 360**	Voluntary, based on EN 14214 but with oxidation stability and cold flow performance being agreed between producer and distributor.
Australia	**Fuel Standard (Biodiesel) Determination 2003**	For final fuel and blending component. Based on EN 14214 but not as comprehensive. Slightly tighter density requirement.
New Zealand	**NZS 7500**	For final fuel and blending component. Based on EN 14214 but some differences. Issued 2005.

Table 2: Comparison of EN 14214 and NZS 7500

The differences between EN 14214 and NZS 7500 B100 standards are highlighted in grey below.
The term "%m/m" is used to represent the mass fraction.
* parameters to be discussed further in the following section.

Property	Unit	EN 14214		NZS 7500	
		Minimum	Maximum	Minimum	Maximum
Ester content	% m/m	96.5	-	96.5	-
Density at 15ºC	kg/m³	860	900	860	900
Viscosity at 40ºC*	**mm²/s**	**3.5**	**5.0**	**2.0**	**6.0**
Flash point	**ºC**	**120**	**-**	**100**	**-**
Sulphur content*	**mg/kg**	**-**	**10**		**50, 10**
Carbon Residue (on 10% distillation residue)	**% m/m**	**-**	**0.3**	**-**	**0.3% m/m on 10% distillation or 0.05% m/m on 100% distillation[1]**
Cetane number		51.0	-	51.0	-
Sulfated ash content	% m/m	-	0.02	-	0.02
Water content	mg/kg	-	500	-	500
Total contamination	mg/kg	-	24	-	24
Copper strip corrosion (3 h at 50ºC)	rating		class 1		class 1
Oxidation stability, 110ºC	hours	6.0	-	6.0	-
Acid value	mg KOH/g	-	0.5	-	0.50
Iodine value*	g iodine/100 g	-	120	-	120
Linolenic acid methyl ester	% m/m	-	12.0	-	12.0
Polyunsaturated (>=4 double bonds) methyl esters*	**% m/m**	**-**	**1**	**-**	**Not specified**
Methanol content	% m/m	-	0.20	-	0.20
Monoglyceride content	% m/m	-	0.80	-	0.80
Diglyceride content*	**% m/m**	**-**	**0.20**	**-**	**Not specified**
Triglyceride content*	**% m/m**	**-**	**0.20**	**-**	**Not specified**
Free glycerol	% m/m	-	0.02	-	0.02
Total glycerol	**% m/m**	**-**	**0.25**	**-**	**0.24**
Group I metals (Na+K)	mg/kg	-	5.0	-	5.0
Group II metals (Ca+Mg)	mg/kg	-	5.0	-	5.0
Phosphorus content	mg/kg	-	10.0	-	10.0

[1] Provides for alternative means of measurement.

4.3.2 Discussion of specific parameters for B100 specification

4.3.2.1 Viscosity

Viscosity is a measure of a fuel's resistance to flow. High viscosity can cause poor injector spray atomisation leading to excessive coking and oil dilution. Low viscosity can cause increased wear of fuel system components, incomplete combustion and restart problems. These problems are associated with reduced engine life and increased emissions. The viscosity of biodiesel is typically higher than that of petroleum diesel, depending on feedstock.

EN 14214 and the Australian Biodiesel Determination set the limits of viscosity (at 40°C) to 3.5 – 5.0 mm²/s. The limits for viscosity in ASTM D 6751 are 1.9 – 6.0 mm²/s. NZS 7500 sets the limits of viscosity to 2.0 – 6.0 mm²/s, but this limit may be increased to 7.5 mm²/s if it is required to encompass a wider range of feedstocks or mono esters other than methyl esters.

The upper viscosity limit in NZS 7500 is set relatively high because at the time the standard was developed there was relatively little data on the viscosity of tallow based biodiesel. Another factor in this decision was that viscosity is also controlled in NZS 7500 at the B5 level (i.e. 2.0 – 4.5 mm²/s). NZS 7500 notes that the B100 viscosity limit would be reviewed once there is sufficient data on viscosity of biodiesel manufactured from locally produced tallow.

It is desirable that the biodiesel regulations are based on performance of the fuel, rather than feedstock characteristics. It has been suggested that good quality biodiesel, including that produced using tallow, should have a viscosity below 5.0 mm²/s.[2]

It is proposed that the B100 specification regulations limit viscosity (at 40ºC) to 3.5 – 5.0 mm²/s when measured by ASTM D 445 or ISO 3104. This seems appropriate for both biodiesel as a final fuel and as a blending component.

4.3.2.2 Cold Flow Performance

As diesel cools, paraffins start to form wax crystals which can lead to blockages of the fuel line and filters, leading to fuel supply interruption and problems with engine start-up. Hence, adequate cold flow performance is an important operability criteria.

The PPSR specifies two measurements of cold flow performance. The Cloud Point is the temperature at which wax crystals start to precipitate out and the fuel becomes cloudy. The Cloud Filter Plugging Point (CFPP) is the temperature at which the fuel crystallisation causes a fuel filter to plug.

Cold flow properties of biodiesel vary depending on the amount of saturated fatty acids in the feedstock. Generally, the amount of saturated fatty acids in a feedstock and cold flow performance have a negative correlation. Hence, biodiesel made from tallow tends to have poor cold flow properties.

Limits on cold flow properties in EN 14214 are dependent on climate, therefore differing between seasons and localities. The PPSR cold flow requirements for diesel are similar.

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[2] For example: Hale & Twomey, 2006, Investigation of Fuel Specification Waivers for Biofuel Blends.

NZS 7500 does not specify cold flow properties for B100, but notes that the CFPP will need to be measured and recorded so that diesel/biodiesel blends can be formulated to provide the required properties.

It is proposed that cold flow properties for New Zealand's B100 are as agreed between seller and purchaser to meet seasonal operability requirements. Accordingly, cold flow properties will not be included in the B100 specification regulations.

4.3.2.3 Sulphur

Sulphur limits are generally imposed for environmental reasons as combustion of fuel containing sulphur causes emissions of sulphur dioxide and particulate matter. In addition, sulphur in fuels can degrade the performance and durability of emissions control equipment.

Biodiesel produced from fresh vegetable oils should contain only traces of sulphur. There is limited data available on the sulphur content of biodiesel made from tallow, but it tends to be higher than that of vegetable oils due to the presence of protein and hair in the fats. Waste cooking oil may also have higher sulphur levels due to sulphur picked up during cooking. The limit for sulphur in NZS 7500 is aligned with the sulphur limits for petroleum diesel, i.e. presently 50 mg/kg, to be reduced to 10 mg/kg from January 2009.

It is proposed that the regulated B100 specification limits sulphur to 50 mg/kg maximum initially, to be reduced to 10 mg/kg from January 2009. This is considered appropriate due to the low levels of sulphur that should be in biodiesel and the necessity for biodiesel to be absorbed by the market as a blending component with 'sulphur-free' petroleum diesel.

4.3.2.4 Iodine Value

The iodine value is a measure of the degree of unsaturation in biodiesel. It is reported in terms of the grams of iodine that will react with 100 grams of fat or oil under specified conditions. Unsaturated fatty acids tend to polymerise when exposed to heat and pressure conditions leading to the formation of engine deposits or to deterioration of the lubricating oil.

Thus iodine value is a rough indicator of fuel stability, with highly unsaturated fuels (a high number of double bonds and therefore a high iodine value) having relatively poor oxidation stability. It is recognised, however, that fuel stability is better measured by parameters such as oxidation stability, linolenic acid methyl ester and polyunsaturated alkyl esters. A predominant reason for this is that polymerisation reactions appear to a significant extent only in fatty acid esters containing three or more double bonds[3] and the iodine value does not take into account the positions of the double bonds. However, it is also recognised that the current oxidation stability tests are seen by some as relatively weak, and there is as yet no test to measure polyunsaturated alkyl esters (as discussed below). Effort is underway internationally to develop these tests further.

Biodiesel of a suitable quality from feedstocks with a high degree of unsaturation, e.g. soybean which has an average iodine value of 117 – 143, might be unable to meet biodiesel specifications because of the iodine value requirements. The iodine value is limited to 120 maximum in NZS 7500 and EN 14214 (as the iodine value of rapeseed is

[3] IEA Bioenergy – Liquid Biofuels, 2004, 'Review on Biodiesel Standardization World-Wide'

generally less than 120). In Spain, the standards for biodiesel require a maximum iodine value of 140 to facilitate the use of soybean oil in the production of biodiesel. A number of other countries, for example Brazil and South Korea, have not specified an iodine value limit when adopting a biodiesel specification similar to EN 14214 to allow flexibility in feedstocks. Neither ASTM D 6751 nor the Australian Biodiesel Determination set a limit for iodine value.

It is proposed that the regulated B100 specification limit iodine value to 140 maximum, when measured by the test method EN 14111. This will allow for more flexibility in feedstocks, whilst still controlling the degradation performance of the biodiesel.

4.3.2.5 Polyunsaturated Alkyl Esters

As discussed above, unsaturated fatty acids tend to polymerise when exposed to the heat and pressure conditions within a compression ignition engine. This can lead to the formation of engine deposits or to deterioration of the lubricating oil, which can affect engine operability.

EN 14214 limits polyunsaturated methyl esters with four or more double bonds to 1% mass maximum, noting that a suitable test method is to be developed. NZS 7500 notes that polyunsaturated alkyl esters should be limited to 1% mass maximum but that an appropriate limit will be considered once a suitable test method is available. At the time of writing this document a suitable test method for polyunsaturated alkyl esters was still under development. Polyunsaturated alkyl esters are not specified in ASTM D 6751 or the Australian Biodiesel Determination.

It is proposed that the regulated B100 specification does not limit polyunsaturated methyl esters. This property will be reconsidered when a test method is available.

4.3.2.6 Diglycerides and Triglycerides

Diglycerides and triclycerides (and monoglycerides) are present in the biodiesel feedstock and small quantities can remain in the final product if the conversion reaction is incomplete. Thus, low concentrations of glycerides can be achieved by selecting optimum reaction conditions and/or distillation of the final ester product. Glycerides may adversely affect cold weather operability and can cause formation of deposits on injector nozzles, pistons and valves.

EN 14214 specifies a separate content limit for each of monoglycerides, diglycerides, triglycerides, free glycerol and total glycerol. NZS 7500 only specifies limits for monoglycerides, free glycerol and total glycerol. Total glycerol is the sum of the concentrations of free glycerol and glycerol bound in the form of monoglycerides, diglycerides and triglycerides. When NZS 7500 was developed, having a limit on total glycerol and monoglycerides content, rather than control on individual glyceride levels, was considered to give effective control of these properties. In addition, high glyceride contents in biodiesel have a positive correlation with values for viscosity and carbon residue. The NZ 7500 sets limits for both viscosity and carbon residue.

ASTM D 6751 and the Australian Biodiesel Determination both do not specify limits for diglycerides and triglycerides (or monoglycerides).

It is proposed that the B100 specification does not include a limit for diglycerides and triglycerides. Limiting total glycerol (which will indirectly measure diglycerides and triglycerides through the glycerol they contain) and monoglycerides is considered to give effective control for ensuring that the glyceride products of incomplete reaction are minimised.

4.3.3 Test Methods

While the test methods in NZS 7500 are being used as a starting point, where possible it is desirable to specify the same test methods for B100 as are currently in the PPSR.

NZS 7500 specifies ASTM, EN and ISO test methods for B100. In many cases, two or more test methods are specified for a single property. It is proposed to not specify some of the additional test methods which are similar or equivalent to those ASTM methods routinely used by the testing laboratories in New Zealand.

Table 3 below includes the proposed test methods for the B100 specification regulations. Comments are sought on the appropriateness of these test methods.

There are current international efforts to align ASTM and CEN test methods for describing biodiesel product. The New Zealand regulations will be updated as necessary to reflect international developments in this area.

4.3.4 Proposed B100 Specification

Table 3 on the following page shows the proposed B100 specification.

For the proposed B100 specification, please provide comment on the following:
a) Do you agree with the proposed requirements?
b) If not, what is an appropriate requirement (i.e. limit and test method)? Please provide an explanation of how this impacts on vehicle operability and / or biodiesel manufacturing.

Table 3: Proposed B100 Specification

Note that the **Bold** text in this table indicates differences from NZS 7500.

Property	Unit	Minimum	Maximum	Test Method
Ester content	% m/m	96.5[4]	-	EN 14103
Density at 15ºC	kg/m³	860	900	ASTM D 1298
Viscosity at 40ºC	mm²/s	**3.5**	**5.00**	ASTM D 445
Flash point	ºC	100	-	ASTM D 93
Sulphur content	mg/kg	-	50[5]	**IP 497[6]** or ASTM D 5453
Carbon residue (on 100% distillation residue) or	% m/m	-	0.050	ASTM D 4530
Carbon residue (on 10% distillation residue)[7]		-	0.30	ISO 10370
Cetane number		51.0	-	ASTM D 613
Sulfated ash content	% m/m	-	0.02	ASTM D 874
Water content	mg/kg	-	500	ASTM D 6304
Total contamination	mg/kg	-	24	EN 12662
Copper strip corrosion (3 h at 50ºC)	rating	class 1		**ASTM D 130[6]**
Oxidation stability, 110ºC	hours	6.0	-	EN 14112
Acid value	mg KOH/g	-	0.5	ASTM D 664
Iodine Value	g iodine/100 g	-	**140**	EN 14111
Linolenic acid methyl ester	% m/m	-	12.0	EN 14103
Methanol content	% m/m	-	0.20	EN 14110
Monoglyceride content	% m/m	-	0.80	ASTM D 6584
Free glycerol	% m/m	-	0.02	ASTM D 6584
Total glycerol	% m/m	-	0.24	ASTM D 6584
Group I metals (Na+K)	mg/kg	-	5.0	EN 14108 and EN 14109
Group II metals (Ca+Mg)	mg/kg	-	5.0	EN 14538
Phosphorus content	mg/kg	-	10.0	ASTM D 4951

[4] The addition of non-biodiesel components to B100 other than additives is not allowed.
[5] 10 mg/kg from January 2009.
[6] For consistency with test methods specified in Schedule 3 of the PPSR.
[7] ASTM D1600 shall be used to obtain the 10% distillation residue.

4.4 Retail Biodiesel Blends

4.4.1 Background

There are currently no retail biodiesel blends being sold in New Zealand. NZS 7500 includes a specification for B5 biodiesel for retail sale which is largely the same as the diesel requirements in the PPSR. Internationally, it is common that low biodiesel blends are required to meet the relevant petroleum diesel specification. This is consistent with low level biodiesel blends being seen as totally fungible with petroleum diesel. A technical investigation was undertaken by Hale & Twomey[8] in 2006 to determine whether waivers were necessary for B5 blends to meet the density, viscosity and cold flow properties of the PPSR. The report concluded that no waivers to these properties are needed at this time.

In NZS 7500 the biodiesel component is required to meet the B100 specification in NZS 7500 and the petroleum diesel component the specification in the PPSR. As noted above this requirement is also common internationally. For example, B5 blend fuel in CEN member countries needs to meet the same standard as petroleum diesel (EN 590), with the biodiesel component meeting EN 14214 and the diesel component meeting EN 590. The United States does not currently have standards for biodiesel blends for use as automotive fuels but there are continued efforts to incorporate B5 into the diesel fuel standard (ASTM D 975).

There is currently no maximum blending limit set for biodiesel in Australia. Up to 100% by volume biodiesel can be marketed in Australia, but all blends must meet the Diesel Determination. Work is underway in Australia to standardise biodiesel blends, which includes the option of amending the Diesel Determination to allow for up to 5% by volume of biodiesel, subject to the biodiesel component of the blend meeting the Biodiesel Determination.

Japan has a mandatory standard for low biodiesel blends specified in the "Law on the Quality Control of Gasoline and Other Fuels" (Quality Assurance Law: JIS K 2204). JIS K 2204 allows up to 5% biodiesel blends but in contrast to the standards of Europe and New Zealand, the blends are required to meet a number of additional properties on top of those properties mandated for petroleum diesel, these being triglycerides, methanol, total acid number and individual acids (Formic, Acetic and Propionic acids).

These additional properties are considered necessary for controlling the quality of B5 blends as the Japanese B100 Standard is only voluntary and fuel quality is only tested by the relevant Government authority at the pump (i.e. as B5 blends). In contrast, New Zealand will have a mandatory B100 specification that all biodiesel must comply with before being blended with petroleum diesel. Thus, methanol, total acid number and glycerides will be controlled at the B100 level. Individual acids are discussed in Section 4.4.3.5.

[8] Hale & Twomey: Investigation of Fuel Specification Waivers for Biofuel Blends, available at http://www.med.govt.nz/templates/MultipageDocumentTOC____22711.aspx.

Table 4: International Diesel and Low Level Biodiesel Blend Specifications

Country	**Diesel Specification**	**Low Level Biodiesel Blends Specification**	Comments
Europe	**EN 590**	**EN 590** (maximum 5% by volume FAME)	
United States	**ASTM D 975**	**Under development**	
Japan	**JIS K 2204**	**JIS K 2204** (maximum 5% by volume FAME)	B5 blends are required to meet a number of additional properties.
Australia	**Fuel Standard (Diesel) Determination 2001**	**Under development**	
New Zealand	**PPSR – Schedule 3**	**NZS 7500** (maximum 5% by volume FAME)	NZS 7500 is very similar to both EN 590 and the PPSR.

It is proposed that in New Zealand regulations, low level biodiesel blends intended for retail sale be required to meet the petroleum diesel specification in Schedule 3 of the PPSR, with each of the blend components meeting their respective neat specifications.

4.4.2 Maximum blend limit

NZS 7500 requires that biodiesel blends for retail sale contain no more than 5% biodiesel by volume. A 5% limit applies for biodiesel blends for retail sale in Europe and Japan, and is under consideration in the United States and Australia. The World-Wide Fuel Charter recommendations for diesel fuel include 5% maximum FAME for category 1 to 3 vehicles. The New Zealand vehicle fleet could be considered as predominately a mix of category 2 and category 3.

At blend levels of above 5% there are concerns around vehicle compatibility and the potential for increased harmful (NO_x) emissions. Many engine, vehicle manufacturers and fuel injection equipment suppliers do not support biodiesel blends in excess of 5% biodiesel.

It is proposed that Schedule 3 of the PPSR be amended to allow up to 5% FAME by volume. It is recognised that higher level blends are being considered overseas for inclusion in petroleum diesel specifications e.g. CEN are currently considering increasing the allowable biodiesel component in EN 590 from 5% to 10%. The limit in Schedule 3 of the PPSR, along with other relevant property limits, will likely be reconsidered in future based on developments internationally. It is proposed that blends of over 5% by volume biodiesel be allowed, but only via written contract. The requirements for these blends are discussed in Section 4.5.

4.4.3 Discussion of specific parameters for Schedule 3 of the PPSR

4.4.3.1 Total Contamination

Total contamination is the insoluble material retained after filtration of a fuel sample. Impurities in biodiesel mostly result from the transesterification process. Contaminants include suspended catalyst residue and soaps, dirt, rust and scale. Soaps are formed from free fatty acids during the transesterification reaction and can be removed during ester washing, along with catalyst residue. Dirt, rust and scale can be removed by filtration.

Schedule 3 of the PPSR specifies particulates at 24 mg/L maximum using the test method ASTM D 6217. The B5 (and the B100) specification in NZS 7500 limit total contamination to 24 mg/kg using the test method EN 12662. The ASTM D 6217 test method is only applicable to petroleum diesel, whereas EN 12662 is applicable to petroleum diesel, biodiesel and biodiesel blends. Thus EN 12662 is the specified test method for total contamination in both EN 14214 and EN 590.

It is desirable to align the test methods specified for petroleum diesel and low level biodiesel blends wherever possible. This will help minimise compliance costs. Thus, it is proposed that Schedule 3 of the PPSR is amended from particulates at 24 mg/L maximum using test method ASTM D 6217, to total contamination at 24 mg/kg maximum using test method EN 12662.

It is recognised that ASTM D 6217 and EN 12662 are not considered as equivalent test methods. EN 12662 is less sensitive, using a smaller sample and weighing the filter to a lower level of precision. The lower precision of the EN 12662 test method is considered acceptable as insolubles are not an issue for petroleum diesel in New Zealand.

4.4.3.2 Cold Flow Properties

The cold flow requirements in the PPSR for petroleum diesel, although differing between winter and summer, are the same for all regions in New Zealand. The current requirements for cold flow properties are as follows:

- Winter (15th April to 14th October): cloud point +2ºC, CFPP -6ºC
- Summer (15th October to 14th April): cloud point +4ºC

B5 blends and petroleum diesel will be required to meet the same cold flow property limits specified in Schedule 3 of the PPSR. The requirements are considered by some as unnecessarily severe in Auckland/Northland[9] given the temperature range in these low lying coastal regions. The coldest ever temperature recorded in Auckland/Northland is -2.5ºC. The minimum summer temperature in these regions is 10ºC[10]. The more stringent the cold flow properties, the higher the costs are to produce diesel fuels that meet these requirements.

The oil companies have voluntary specifications to ensure ‘fit for common purpose’ requirements are met given New Zealand’s climatic conditions. These include a tighter

[9] As defined by regional council boundaries.
[10] NIWA climate data 1971-2000.

CFPP specification than those in the PPSR for all regions except Auckland/Northland during the coldest winter months.[11]

Having slightly less stringent cold flow properties in Auckland/Northland would also facilitate the introduction of B5 blends in these regions. It was identified in the technical investigation by Hale & Twomey of fuel specification waivers for biofuel blends (2006) that based on current average petroleum diesel stock, a large number of theoretical B5 blends would fail the cold flow specification in the PPSR, particularly in Auckland/Northland. In reality, oil companies would manage their petroleum diesel stock to ensure cold flow requirements are met, but sourcing diesel with more stringent cold flow properties has cost implications. This report noted that a waiver for cold flow properties in the Auckland/Northland regions may be appropriate.

However, due to the geography of New Zealand, there are no guarantees that customers who purchase fuel in Auckland/Northland will consume it entirely in these warmer climates. The cold flow properties thus need to be suitable for a customer who for example refuels a tank in Auckland/Northland, and then travels to the cooler climate of the central volcanic region. The cost per litre of managing the cold flow properties of petroleum diesel in Auckland/Northland to meet the current specification are considered small. The report from Hale & Twomey estimated that assuming a requirement to produce diesel with cold flow properties 2 ºC lower, the cost for oil companies would be about NZ 0.2c/l. It is uncertain whether customers will benefit in terms of cheaper diesel if the specification is relaxed.

Your comment is sought on whether cold flow properties should be relaxed in Schedule 3 of the PPSR for the Auckland/Northland regions. The limits in Schedule 3 would apply to both petroleum diesel and B5 blends. Also note that the cold flow properties of these fuels, as with all other properties, are required to be 'fit for common purposes'.

c) Should the cold flow properties for Auckland/Northland be relaxed in Schedule 3 of the PPSR?
d) If so, what should the limits be for cloud point in winter and summer, and CFPP in winter?

4.4.3.3 Filter Blocking Tendency

The Filter Blocking Tendency (FBT) test measures the filterability of diesel in order to ascertain what affect a fuel will have on a fuel filter's life. The FBT test was introduced into the PPSR in 2002 to provide additional protection for consumers against operating problems associated with diesel that has poor filterability. The regulations require retail diesel to meet a maximum FBT of 2.5 when tested by IP 387 or ASTM D 2068, and the fuel to be of acceptable filterability so that it is fit for common purposes. The 2.5 maximum at this time was 'indicative for monitoring purposes'. The indicative nature of this limit was removed in late 2006 by the Petroleum Products Specifications Amendment Regulations 2006.

In following the PPSR, NZS 7500 also requires that B5 blends 'be of acceptable filterability so that it is fit for common purposes'. However, as NZS 7500 was developed before the 2006 PPSR amendments, the FBT maximum limit for B5 blends in NZS 7500 is still indicative, i.e. 'acceptable filterability can be expected if the result of the FBT test is less than 2.5'.

[11] Note that this isn't the entire winter period as specified in the PPSR (15th April to 14th October).

Some recent testing of New Zealand B5 blends has shown the unexpected formation of aggregates at room temperature. Thus these aggregates are separate from the flow problems that occur at cold temperatures, and are causing some sample B5 blends to fail the FBT test.

There is a paucity of information internationally relating to the FBT of biodiesel blends. Outside of New Zealand, Australia is the only other known jurisdiction that specifies a FBT limit in petroleum diesel standards. Biodiesel blend specifications are still under development in Australia.

Research into the filter blocking problems of soybean based B20 in the United States suggests that one possible root cause of the aggregate formation at temperatures above cloud point is the presence of sterol glucosides in biodiesel. Sterol glucosides are naturally occurring compounds found in vegetable oils and fats. It is unknown if sterol glucosides have a role in the filterability of biodiesel produced from animal fats.

To ensure vehicle operability, it is proposed that B5 blends be required to meet the same FBT requirements as petroleum diesel, i.e. filter blocking tendency of 2.5 maximum when tested by IP 387 or ASTM 2068, and the fuel to be of acceptable filterability so that it is fit for common purposes. It is recognised that neither of these test methods are particularly representative of the filters used in motor vehicles as the test method filter is much more sensitive, but also that a more suitable international test method does not presently exist. The suitability of the FBT limit and test will be reconsidered when more information is available.

4.4.3.4 Oxidation Stability

Oxidation stability is a measure of a fuel's resistance to degradation by oxidation. Oxidation of diesel can result in the formation of insoluble sediments and gums that are associated with fuel filter plugging and formation of deposits in fuel injection systems and combustion chambers. Oxidation of biodiesel increases fuel acidity which has shown to increase fuel system deposits and may increase the likelihood for corrosion in the fuel system and engine. The PPSR and NZS 7500 specify limits on oxidation stability for diesel, and biodiesel and biodiesel blends respectively.

The methods for testing oxidation stability vary between petroleum diesel and biodiesel based on suitability, and between countries. An oxidation stability test method that measures acidity measures the stability of the biodiesel component. Whereas an oxidation stability test that measures insolubles measures the stability of the petroleum diesel component. The limits for these tests are not directly comparable as suggested by the different analytical approaches.

The main oxidation stability test methods are as follows:

- EN 14112 (Rancimat procedure): accelerated oxidation stability test method that measures acidity of B100. This is expressed in hours, known as the induction period. Test temperature is 110ºC.
- ASTM D 2274: accelerated oxidation stability test method that determines the concentration of insolubles expressed in g/m^3. Test temperature is 95ºC, for 16 hours. Not suitable for biodiesel or biodiesel blends.

- ISO 12205: accelerated oxidation stability test that determines the concentration of insolubles expressed in g/m³. Test temperature is 95ºC, for 16 hours. Not suitable for biodiesel or biodiesel blends.

NZS 7500 specifies the Rancimat procedure as the test method for B100, with a limit of 6 hours minimum. NZS 7500 and the PPSR specify ASTM D 2274 as the test method for B5 and petroleum diesel respectively, with a maximum of 25 g/m³.

There are concerns by some that for biodiesel blends, even when the B100 has sufficient oxidation stability properties (i.e. induction period is >6 hours), the base diesel can impact on the stability of the biodiesel component. If B5 blends are only subject to a test method that measures insolubles, the growth in fuel acidity will not be controlled by the standard. Some research also suggests that such problems may be exacerbated when biodiesel is blended with ultra-low sulphur diesel fuels.

Thus to ensure that B5 blends have appropriate oxidation stability properties they could be required to meet an oxidation stability test that measures acidity. The unmodified Rancimat procedure, however, is not appropriate for biodiesel blends at this stage. Recent work in other jurisdictions has focussed on the modification of the Rancimat procedure and ISO 12205 / ASTM D 2274.

Due to concerns with oxidation stability, Japan has developed a test method for B5 blends that measures acidity. This test method was prepared with reference to ISO 12205, but requires a test temperature of 115ºC compared with 95ºC, and measures acidity instead of insolubles using JIS K 2501. This test method, which is equivalent to ASTM D 664, is based on the amount of potassium hydroxide required to neutralise 1g of FAME and measures the acid value growth. Hence the oxidation stability limit is expressed in mg KOH, i.e. 0.12 mg KOH/g maximum acid value growth. At the time of writing this document, the Japanese test method for oxidation stability was still in draft form. The summary of the test method is as follows:

‘A test fuel filtered beforehand is oxidatively degraded by injecting oxygen at 115ºC for 16 hours. The acid values before and after this oxidation stability test are determined by the acid value-potentiometric titration method according to JIS K 2501.’

The Japan Automobile Manufacturers Association (JAMA) have indicated that they consider an acceptable alternative to the B5 Japanese oxidation stability test detailed above to be a requirement that the B100 component of the blend meets an induction period of >10 hours (instead of >6 hours), as measured by the Rancimat test method.

Recent research by the National Renewable Energy Laboratory in the United States suggests that B100 stability is an excellent predictor of stability in B5 blends, i.e. if B100 meets the requirements of the Rancimat test in EN 14214 (induction period of >6 hours) then B5 blends will have good oxidation stability properties (induction period of >12 hours). Thus, acidity is not considered an issue for B5 blends and an induction period of below 6 hours may be suitable for B100. A final report on these findings has not yet been published.

There are several options available for oxidation stability requirements in Schedule 3 of the PPSR. Your comment is sought on which of the following is the most appropriate for New Zealand’s regulations:

i. Petroleum diesel and B5 blends are both required to have oxidation stability properties of 25 g/m³ maximum when measured by ASTM D 2274. The oxidation stability requirements for B5 blends will be reconsidered when the issue of the test method is settled by regulatory authorities in other jurisdictions.

ii. Petroleum diesel to meet 25 g/m^3 maximum when measured by ASTM D 2274 and B5 blends to meet a limit of 0.12 mg KOH/g maximum acid value growth when tested by the Japanese oxidation stability test method described above (16 hours at 115ºC). This requirement would be reviewed when other jurisdictions land on this issue (indicative 2009).

iii. Petroleum diesel to meet 25 g/m^3 maximum when measured by ASTM D 2274 and the B100 component of B5 blends to meet a minimum of 10 hours when tested by the Rancimat (EN 14112) procedure. To be reviewed indicative 2009.

iv. Petroleum diesel to meet 25 g/m^3 maximum when measured by ASTM D 2274 and B5 blends to meet the modified Rancimat procedure (EN 14112) or modified ASTM D 2274. To be reviewed indicative 2009.

e) In regards to oxidation stability for B5 blends, do you prefer option i, ii, iii or iv above? Please provide an explanation of why this is appropriate for New Zealand's regulations.

4.4.3.5 Formic, Acetic and Propionic Acids

Formic, Acetic and Propionic acids are organic volatile acids produced during biodiesel oxidation, and are associated with increased corrosion of fuel injection systems. As discussed above, oxidative degradation of biodiesel has also shown to increase fuel system deposits.

While the regulations will require B5 blends to meet an oxidation stability limit (refer Section 4.4.3.4), the percentage of formic, acetic and propionic acids in biodiesel could also be directly measured as another control on oxidation stability. The only example of these individual acids being mandated for B5 blends is in JIS K 2204. The limit in JIS K 2204 is 0.003% (in total) mass maximum when measured by the ion chromatography method. At the time of writing this document, the test method was still in draft form. The test method summary is as follows:

'A sample is mixed with water and shaken to extract formic, acetic and propionic acids into the water. The separated aqueous phase is injected into an ion chromatograph to separate and elute each component, of which a chromatogram corresponding to each acid ion is recorded. The concentration of each acid component is determined by comparing with a pre-determined calibration curve.'

There are two possible options in regards to these individual acids:

i. The regulations do not require B5 blends in New Zealand to meet a specific individual acid limit. This would be reconsidered if a test for individual acids is adopted internationally.

ii. The regulations require B5 blends in New Zealand to meet a limit of 0.003% (in total) mass maximum Formic, Acetic and Propionic acids, when tested by ion chromatography (to the test outlined above).

f) In regards to individual acids in B5 blends, do you prefer option i or ii above? Please provide an explanation of why this is appropriate for New Zealand's regulations.

4.4.3.6 Carbon Residue (on 10% distillation residue)

Carbon residue is an indicator of the tendency of the fuel to form carbon deposits in an engine. Deposit formation can lead to increased engine wear and impact on engine life, as well as reducing fuel efficiency and increasing particulate emissions.

The carbon residue for diesel was recently amended from 0.25% mass maximum to 0.2% mass maximum in the PPSR. This was for consistency with the ASTM D4530 requirements of reporting carbon residue to the nearest 0.1% mass only. NZS 7500 B5 specification limits carbon residue (on 10% distillation residue) to 0.25% mass maximum.

It is proposed that B5 blends meet the carbon residue (on 10% distillation residue) requirement of 0.2% mass maximum, as specified for petroleum diesel in Schedule 3 of the PPSR.

4.4.4 Test Methods

The B5 requirements in NZS 7500 specify a number of additional test methods to those in the diesel specification in Schedule 3 of the PPSR. Most of the additional test methods in NZS 7500 are ISO developed and are similar or equivalent to the ASTM test method already specified.

It is proposed to not specify in Schedule 3 some of these additional test methods which are similar or equivalent to those ASTM methods routinely used by the testing laboratories in New Zealand. In the event of a dispute where more than one method is specified, the first method in the appropriate table will take precedence. Table 5 includes the proposed test methods for petroleum diesel and B5 blends.

4.4.5 Proposed Schedule 3 of the PPSR

Table 5 on the following page shows the proposed Schedule 3 of the PPSR. The grey shaded rows are those properties discussed in the previous section where comments are specifically being sought. Note that the **Bold** text in this table indicates differences from the current PPSR.

For Schedule 3 of the PPSR, please provide comment on the following:
g) Do you agree with the proposed requirements?
h) If not, what is an appropriate requirement (i.e. limit and test method) for New Zealand's B5 specifications? Please provide an explanation of how this impacts on vehicle operability and / or biodiesel manufacturing.
i) Are there any other amendments that need to be made to Schedule 3 of the PPSR to incorporate B5 blends within the diesel specification?

Table 5: Proposed Schedule 3 of the PPSR

Property	Unit	Minimum	Maximum	Test Method
Density at 15ºC	kg/m³	820	850	ASTM D 1298[12]
Distillation – 95% volume recovered at (ºC) (T95)	ºC	-	360	ASTM D86
Cetane[13]		51 minimum cetane index or 51 minimum cetane number and 47 minimum cetane index	-	Cetane number: ASTM D 613 Cetane index: ASTM D 976
Water content	mg/kg	-	200	ASTM D 6304
Total contamination	**mg/kg**	**-**	**24**	**EN 12662**
Colour (ASTM colour)		-	3.0	ASTM D 1500
Cloud point[14]	ºC	-	Summer: +4 Winter: +2	ASTM D 5773
Cold Filter Plugging Point[14]	ºC	-	Winter: -6	IP 309
Sulphur[15]	mg/kg	-	50[16]	IP 497 or ASTM D 5453
Polycyclic aromatic hydrocarbons	% m/m	-	11	IP 391
Filter blocking tendency	-	-	2.5; fuel must be of an acceptable filterability so that it is fit for common purposes.	IP 387 or ASTM D 2068
Lubricity – HFRR wear scar diameter at 60ºC	µm	-	460	IP 450
Viscosity at 40ºC	mm²/s	2.0	4.5	ASTM D 445
Oxidation stability	g/m³	-	25	ASTM D 2274
Carbon residue (on 10% distillation residue)	% m/m	-	**0.2**	ASTM D 4530
Copper strip corrosion (3 hours at 50ºC)	rating		class 1	ASTM D 130
Ash content	% m/m	-	0.01	ASTM D 482
Flash point	ºC	61	-	ASTM D 93
FAME content[17]	**% m/m**	**-**	**5.0**	**EN 14078**

12 For B5 blends ASTM D 4052 to be used instead.
13 Only Cetane number applicable for B5 blends.
14 These are maximum criteria; cold flow properties of a fuel must be fit for common purposes in the region and the season in which it is sold. Diesel that complies with the previous season's quality, and that is stored in a filling station tank to which fewer than 3 deliveries of diesel have been made since 6 weeks before the beginning of the season, is regarded as complying with this specification. Sales for marine use may be summer grade at any time of the year.
15 The limit for sulphur does not apply to sale for marine use.
16 10 mg/kg from 1 January 2009.
17 FAME content must meet the specification requirements for B100.

4.5 Non-Retail Biodiesel Blends

4.5.1 Background

As discussed already, the PPSR distinguishes between all fuel “supplied, or available or intended for supply” and fuel that is sold by retail. The requirements relating to all diesel fuel (as opposed to diesel for retail sale) in the PPSR are that it must meet the property limits specified for sulphur and polycyclic aromatic hydrocarbons.

NZS 7500 includes a non-retail specification for biodiesel blends but, in contrast to the two required properties for petroleum diesel in the PPSR, eleven properties are specified. This, in part, recognises that blending two on-specification fuels does not guarantee the fuel quality of the resultant blend. Post-blending quality testing provides greater certainty to the market. In NZS 7500, blends for non-retail sale must also have a diesel component that meets the non-retail requirements in the PPSR and a biodiesel component that meets the B100 specification.

Blend concentrations greater than 5% by volume may be used in compression ignition engines designed or subsequently adapted to run on such blends. B20 dominates the international supply of biodiesel blends over 5% by volume biodiesel.

At present, biodiesel blends are being produced in New Zealand for the contracted market, albeit in relatively small volumes. In the main, these blends are manufactured to meet the requirements of NZS 7500 and range from 5% to 100% by volume biodiesel. These biodiesel blends are being supplied to a large variety of end users, including bus fleets, trucking and earthmoving companies and the agriculture and forestry sector.

There are very limited examples of biodiesel blend specific fuel quality standards in the world. ASTM and the Australian regulatory authorities have been working on B20 standards. The United States military, a major user of biodiesel, have developed their own B20 specification. The United States Engine Manufacturers Association (EMA) has also proposed a specification for biodiesel blends up to B20.

It is considered prudent to have a greater level of regulation for non-retail biodiesel blends than exists for non-retail petroleum diesel in the PPSR. There is limited information available for higher blend levels made from tallow based biodiesel. Particularly in the early stages of a biofuels market in New Zealand, it is vital to build and maintain consumer confidence and to protect the reputation of the industry as a whole. Hence the regulations for non-retail biodiesel blends should include vehicle operability and safety parameters, as well as environmental parameters.

4.5.2 Proposed non-retail biodiesel blend specification

As is the case with NZS 7500, it is proposed that the regulations allow non-retail biodiesel blends to consist of petroleum diesel and biodiesel in any proportion as agreed between seller and purchaser, from less than 5% up to and including B100. This gives greater flexibility for supply by the biodiesel industry and use by consumers with contractual agreements. The supply of biodiesel blends above B20 is currently subject to ERMA approval.

As in NZS 7500, the regulations will require blends for non-retail sale to have a diesel component that at least meets the non-retail requirements in the PPSR, and a biodiesel component that meets the B100 specification. The resultant blend must then meet the proposed regulated requirements for non-retail biodiesel blends at the point of sale to the user.

It is proposed that the regulated specification for non-retail biodiesel blends incorporate the requirements of NZS 7500. These requirements are as follows (refer Table 6):

> Non-retail biodiesel blends must meet the requirements from Schedule 3 of the PPSR for cetane number, colour, sulphur content, lubricity and viscosity.
>
> In addition, non-retail biodiesel blends must meet the following requirements:
>
> - acid value of 0.1 + *X* / 250 (where *X* is the percentage of biodiesel in the blend);
> - total glycerol of 0.05 + *X* / 500 (where *X* is the percentage of biodiesel in the blend); and,
> - water and sediment limit of 0.015% volume maximum when measured by ASTM D 2709.
>
> Cold flow properties (cloud point and cold filter plugging point) are to be as agreed between seller and purchaser to meet seasonal operability requirements[18].

It is proposed that the test methods in NZS 7500 for non-retail biodiesel blends are incorporated in the regulations. The exception to this is where a test method differs unnecessarily from those for B100, B5 and petroleum diesel. In addition some test methods are not proposed to be referenced where a similar or equivalent test method is already specified. Table 6 shows the proposed test methods for non-retail biodiesel blends. Comments are sought on the suitability of these.

4.5.3 Discussion of specific parameters for non-retail biodiesel blends

4.5.3.1 Filter Blocking Tendency

Filter blocking tendency is currently specified in NZS 7500 for non-retail blends as follows, ‘fuel shall be of acceptable filterability so that it is fit for common purposes’. In the PPSR the ‘fit for common purposes’ requirement only applies to fuel for retail sale. This is consistent with allowing for flexibility in fuel sold via a written contract or supply agreement. The suitability of the fuel (for any intended purpose) needs to be agreed between the seller and purchaser. Thus, it is proposed that filter blocking tendency is not specified for non-retail biodiesel blends.

4.5.3.2 Flash Point

Flash point is the lowest temperature at which contact with an ignition source causes the vapour of the fuel specimen to ignite. Hence, flash point is an important parameter for assessing hazards throughout the fuel distribution system.

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[18] Accordingly, the cold flow properties of non-retail blends will not be included in the specification regulations.

Diesel is much more flammable than biodiesel, with the flash point for biodiesel being approximately twice that of diesel depending on the feedstock and processing. Typical values for biodiesel manufactured from feedstocks available in New Zealand are expected to be greater than 120°C. A limit of 100ºC is specified in NZS 7500 for B100. The PPSR requires the flash point of diesel to be more than 61ºC.

Flash point does not blend linearly and usually tends to the value of the lowest component, hence that of petroleum diesel. There is a risk that alcohol is added to biodiesel blends to assist homogenising the blend, especially in cold weather, which would reduce the flash point of the biodiesel blend further.

It is proposed that non-retail biodiesel blends are required to also meet the flash point minimum of petroleum diesel as specified in the PPSR (61ºC), because of the importance of this parameter for health and safety.

Table 6: Proposed Non-Retail Biodiesel Blend Specification

Note that the **Bold** text in this table indicates differences from NZS 7500.

Property	Unit	Minimum	Maximum	Test Method
Cetane Number		51	-	ASTM D 613
Water and Sediment	% vol	-	0.015	ASTM D 2709
Colour (ASTM colour)		-	3.0	ASTM D 1500
Sulphur[19]	mg/kg	-	50[20]	**IP 497** or ASTM D 5453
Lubricity – HFRR wear scar diameter at 60ºC	µm	-	460	IP 450
Viscosity at 40ºC	mm²/s	2.0	4.5	ASTM D 445
Flash point	**ºC**	**61**	**-**	**ASTM D 93**
Acid value	mg KOH/g	-	0.1 + *X* / 250	ASTM D 664
Total glycerol	% m/m	-	0.05 + *X* / 500	ASTM D 6584

For non-retail biodiesel blends specifications regulations, please provide comment on the following:
j) Do you agree with the proposed requirements?
k) If not, what are the appropriate requirements (i.e. limit and test method) for New Zealand's non-retail biodiesel blend specification? Please provide an explanation of how this impacts on vehicle operability or other non-automotive uses of biodiesel and / or biodiesel manufacturing.

[19] The limit for sulphur does not apply to sale for marine use.
[20] 10 mg/kg from 1 January 2009

5. Ethanol and Petrol/Ethanol Blends

5.1 Introduction

Ethanol (ethyl alcohol or the chemical compound C_2H_5OH) can be used as a fuel in neat form or high level blends in specifically designed vehicles or in conventional petrol vehicles when blended at low-levels. When used as a fuel, ethanol is generally denatured (made unsuitable for human consumption) so as to distinguish it from drinking alcohol and avoid the significant rate of excise that applies to alcoholic beverages.

Ethanol can be made in a variety of ways and is either bioethanol (made from biomass) or non-renewable ethanol (made from a non-renewable feedstock). Only bioethanol will count towards the Government's Biofuels Sales Obligation.[21] Bioethanol is currently produced in New Zealand from whey. In the future it may be produced from other feedstocks such as wood waste. Overseas bioethanol is made predominately from sugar or maize.

There is no existing regulated specification in New Zealand for ethanol for blending with petrol. The Energy Efficiency and Conservation Agency (EECA) has however developed a voluntary specification based on the ASTM standard for denatured fuel ethanol (ASTM D 4806).

As for biodiesel, the conventional nomenclature for describing ethanol blends is EX where the X is the volume percent of ethanol in the blend, for example E100 is neat ethanol and E5 is a blend of 5% ethanol and 95% petrol.

The following sections discuss retail petrol/ethanol blends, a specification for ethanol for blending, non-retail petrol/ethanol blends and the use of E100 as a fuel, in that order.

5.2 Petrol/Ethanol Retail Blends

An ethanol content of up to 10% is generally considered the maximum suitable for use in conventional petrol engines. It is recognised however that not all petrol powered vehicles or equipment are suitable for ethanol blends up to 10%. The suitability of a particular vehicle for use with petrol/ethanol blends of different blend levels, as with appropriate octane requirements, varies and is best determined by the vehicle manufacturer or supplier.

Petrol/ethanol blends with up to 10% ethanol are permitted in a range of overseas jurisdictions including Australia, the United States, Canada and Thailand. A lower ethanol limit of 5% currently applies in Europe although increasing this to 10% is currently being considered. A 3% limit applies in Japan although there are also plans to increase this to 10% in the future. Brazil is the only major jurisdiction where over 10% ethanol is blended into petrol on a widespread basis, and Brazilian vehicles have been developed on that basis.

The PPSR allow for up to 10% ethanol to be blended with petrol for retail sale. Such blends are required to meet the specifications currently provided in Schedules 1 and 2 of the PPSR. It should be noted that since May 2007 the PPSR have included limited

[21] For more information on the Biofuels Sales Obligation see http://www.transport.govt.nz/biofuels-440-index/

waivers for petrol/ethanol blends between 1% and 10% ethanol. These are to facilitate the blending of ethanol with existing petrol stocks. The waivers are as follows:

- Vapour Pressure: 7 kPa for summer and transition seasons;
- E70: Increase maximum by 1% per % ethanol; and,
- Flexible Volatility Index (FVI): Increase by 5 in transition seasons and by 15 in winter.

It is proposed that the ethanol component of a retail petrol/ethanol blend be required to meet the proposed ethanol specification discussed in the Section 5.3. The petrol component will also be required to meet the petrol specification and the blend will be required to meet the specification provided for petrol containing up to 10% ethanol.

5.3 Specification for Ethanol for Blending

5.3.1 Background

As noted above it is proposed that the ethanol component (E100) of any retail petrol/ethanol blend be required to meet a regulated specification for ethanol for blending. The rest of this section discusses that proposed specification.

A number of standards or specifications for fuel grade ethanol for blending with petrol are in use or development around the world. Prominent standards are shown in Table 7. All these standards apply to ethanol for blending with petrol and are for “anhydrous” ethanol, which means that the water content is minimised. “Hydrous” ethanol, which has a significant water content, is not suitable for blending with petrol but can be used as a fuel in neat form in specially developed vehicles and is discussed further in Section 5.5.

Table 7: International Ethanol Specifications

Country	Ethanol Specification	Comments
Australia	**Draft Australian Fuel Standard Determination for Ethanol**	Based on ASTM D 4806 and for blends up to 10% ethanol. Expected to be finalised soon.
Brazil	**Brazilian Specification for Anhydrous Fuel Ethanol**	Undenatured specification. Brazil blends 25% ethanol into petrol.
Europe	**Pr EN 15376**	Draft European Standard for ethanol as a blending component for petrol up to 5%. Expected to be finalised in 2008.
Japan	**JASO M 361 (2006)**	Undenatured specification.
United States	**ASTM D 4806-07**	Standard Specification for Denatured Fuel Ethanol for Blending with Gasolines for Use as Automotive Spark-Ignition Engine Fuel

The voluntary specification for ethanol for blending with petrol developed by EECA uses ASTM D 4806 as a basis and requires that corrosion inhibitor also be added. ASTM D 4806 has been in place for a number of years and in addition to applying in the United States it has been used as the basis of standards in other jurisdictions including Canada, Australia and China. It has been updated over time, with the current version having been published this year.

The approach taken to the different ethanol standards/specifications vary in that some apply to denatured ethanol (ASTM D 4806 and the Draft Australian Standard) and some apply to undenatured ethanol (Pr EN 15376 and the Brazilian and Japanese specifications). They also have relevant to different blend levels. For example, whereas ASTM D 4806 and the Draft Australian Standard apply to ethanol used in petrol/ethanol blends of up to 10% ethanol, Pr EN 15376 is only for blends up to 5%. The Brazilian Specification applies to ethanol used in blends containing 25% ethanol.

As noted above it is proposed that a regulated specification be introduced for ethanol that is blended with petrol. Because it is not possible to determine all of the parameters of the ethanol component once it has been blended with petrol, suppliers would be responsible for ensuring that the ethanol met the specification prior to blending.

Specifications for ethanol used for blending with petrol apply to either denatured or undenatured ethanol. The approach taken in different jurisdictions depends on the nature of the relevant distribution system and where ethanol is tested for compliance. The advantage of a denatured ethanol specification is that fuel ethanol may only able to be traded or transported in that form (to avoid excise) and so it will likely be in that form immediately prior to being blended with petrol. The advantage of an undenatured specification is that different countries can have different requirements for denaturing ethanol.

As ethanol in New Zealand is required to be denatured to avoid being subject to alcohol excise duty it is assumed that the ethanol to be used for blending with petrol will be denatured. Accordingly it is proposed that the ethanol specification be for denatured ethanol. It is recognised however that distribution systems for ethanol have yet to develop significantly in New Zealand and so comment is sought on the appropriateness of the proposed approach.

ASTM D 4806, which forms the basis of the current voluntary EECA Standard and the Draft Australian Standard is considered to have the most relevance as a basis for an ethanol specification for New Zealand for the following reasons:

(i) It is for denatured ethanol and is relevant to ethanol used in petrol/ethanol blends with up to 10% ethanol;

(ii) It has been widely used since 1988 and has been updated a number of times to take account of experience and technical developments; and,

(iii) New Zealand fuel suppliers and testing laboratories have significant experience with ASTM test methods.

l) Is it appropriate that the ethanol specification for blending apply to denatured ethanol? If not please provide an explanation.

5.3.2 Discussion of specific parameters for ethanol for blending

It is proposed that the regulated specification for ethanol for blending with petrol be a specification for high purity denatured anhydrous ethanol and be based on ASTM D 4806. The parameters of the proposed ethanol specification are discussed below.

The specification parameters provided in ASTM D 4806 and the Draft Australian Standard are shown in Table 8 below and form the basis of the discussion of individual parameters that follows. The Draft Australian Standard is generally only referred to when different from ASTM D 4806. The specification parameters provided in other ethanol standards noted above are not provided in the table but are referred to in the pursuing discussion where relevant.

Table 8: Comparison of ASTM D 4806 and the Draft Australian Standard

Property	Unit	ASTM D 4806	Draft Australian Standard
Denaturant content	volume %, min	1.96	1
Denaturant content	volume %, max	5	1.5
Ethanol	volume %, min	92.1	95.6
Methanol	volume %, max	0.5	0.5
Solvent-washed gum	mg/100 ml, max	5	5
Sulphate	mg/kg, max	4	4
Water content	volume %, max	1	1
Inorganic Chloride content	mass (mg/L), max	32	32
Copper content	mg/kg, max	0.1	0.1
Acidity (as acetic acid CH3COOH)	mass %, max	0.007	0.007
pHe		6.5 – 9.0	6.5 – 9.0
Appearance		Clear and bright	Clear and bright
Sulphur	mg/kg, max	30	30

5.3.2.1 Denaturant Content

As noted previously, some fuel ethanol specifications apply to undenatured ethanol and some to denatured ethanol. Those that apply to denatured ethanol (such as ASTM D 4806) tend to list approved denaturants and provide a lower minimum ethanol content to recognise the presence of the denaturant. ASTM D 4806 provides for denaturant content of between 1.96% and 5% by volume, which is substantially higher than that required in New Zealand.

Excise Item 99.35.45C of the Third Schedule to the Customs and Excise Act 1996 provides for duty free ethyl alcohol (ethanol) when denatured in accordance with a formula approved by the Chief Executive of Customs. A long list of approved denaturants are provided, including the addition of 1% by volume regular or premium grade petrol.[22] It is proposed that only the addition of at least 1% petrol is permitted for denaturing ethanol for blending with petrol. Petrol is widely available and the use of petrol as the denaturant avoids the possibility of another denaturant having adverse impacts on fuel stability, fuel systems or engine operability. It is also proposed that denaturant content be limited to a maximum of 1.5%.

m) Are there any reasons to allow denaturants other than petrol to be used for denaturing ethanol for blending with petrol? If so please provide an explanation.

5.3.2.2 Ethanol Content

A minimum ethanol content is required to provide proper combustion and to ensure that other components that may have detrimental effects on operability or fuel performance are minimised. Higher ethanol contents are desirable from a vehicle operability point of view but increasing the purity beyond a certain point can have significant production cost implications with potentially few operability advantages.

ASTM D 4806 provides for a minimum ethanol content of 92.1% post denaturing. Allowing for the minimum amount of denaturant, the effective minimum ethanol content prior to denaturing is 94%. This is lower than that found in other standards. For example Pr EN 15376 requires a minimum content of 98.7% of ethanol and higher alcohols (discussed further below), giving an effective minimum required ethanol content of 96.7%. It should also be noted that as Pr EN 15376 applies to undenatured ethanol, the minimum ethanol requirement is higher as no denaturant is present. The Draft Australian Standard is based on ASTM D 4806 but only 1% denaturant is required in Australia for Customs purposes (as in New Zealand) and so the minimum ethanol requirement is increased to 95.6%.

It is proposed that the specification for ethanol for blending with petrol require a minimum ethanol content of 95.6%. This is essentially consistent with ASTM D 4806 after allowing for the reduction in the maximum denaturant content from 5.0% to 1.5%.

Higher alcohols can also be present in manufactured ethanol. They can be created during the fermentation process and removing them completely can impose significant costs. As these generally have little effect on operability at low levels and can be costly to remove, allowing a small amount of higher alcohols is considered appropriate.

Pr EN 15376 specifically allows up to 2% higher alcohols (C3 – C5) by volume and requires that at least 98.7% be either ethanol or higher alcohols. Neither ASTM D 4806 or the Draft Australian Standard impose a specific limit on higher alcohols but they are effectively limited to a few percent by other parameters. The presence of a small percentage of higher alcohols is unlikely to be harmful and so allowing a certain amount of higher alcohols whilst providing a high limit for both ethanol and higher alcohols could have some advantages. Nonetheless, to maintain consistency with ASTM D 4806 and the Draft Australian Standard it is not proposed that a specific parameter be provided for higher alcohols.

[22] http://www.customs.govt.nz/about/News/alcohol+150404.htm

n) Is 95.6% by volume an appropriate minimum ethanol content requirement? If not, please provide an explanation of how this impacts on vehicle operability and / or ethanol manufacturing.

5.3.2.3 Methanol Content

Methanol (CH_3OH) can cause corrosion of metals and deterioration of elastomers.

ASTM D 4806 provides a methanol limit of 0.5% by volume whereas Pr EN 15376 allows up to 1%. The methanol content in the blend however will be the same as Pr EN 15376 is only for blends up to E5.

Blends up to E10 are allowed for retail sale in New Zealand and so it is proposed that a methanol limit of 0.5% by volume be imposed.

5.3.2.4 Solvent Washed Gum

Solvent washed gum can contribute to deposits on the surface of components, for example on carburettors, fuel injectors, intake manifolds and valves. The test for solvent washed gum measures the amount of residue after evaporation of the fuel and following a heptane wash. ASTM D 4806 provides a limit of 5 mg/100 ml, which is the same limit applied to petrol and petrol/ethanol blends under the PPSR.

It is proposed that a limit of 5 mg/100 ml be imposed for solvent washed gum.

o) Is the proposed limit of 5 mg/100 ml for solvent washed gum appropriate? If not, please provide an explanation of how this impacts on vehicle operability and / or ethanol manufacturing.

5.3.2.5 Sulphate

Sulphates have been associated with service station pump filter clogging and fuel injection problems with some vehicles in the United States. To safeguard consumers a 4 mg/kg limit for sulphates was included within ASTM D 4806 in 2006. This limit was considered to provide sufficient safeguards whilst not creating significant problems for ethanol producers.

It is proposed that the regulated ethanol specification limits sulphates to a maximum of 4 mg/kg.

5.3.2.6 Water Content

The water content of ethanol for blending with petrol must be limited to reduce the risk of phase separation. Phase separation occurs because of the solubility of petrol, alcohol and water. The likelihood of phase separation occurring with a petrol/ethanol blend varies with changes in ethanol content, temperature and the level of aromatics in the petrol.

ASTM D 4806 permits a maximum of 1% water by volume but recommends that the production specification needs to be below 1% to allow for water-pick up in distribution.

New Zealand conditions and likely blend levels suggest that no more than 1% water content should be permitted and this is what is proposed. Any limit would apply up to when ethanol was blended with petrol and so it would be sensible for buyers and sellers to agree that at the time of production and delivery the ethanol contain significantly less than 1% water.

p) Is a maximum water content of 1% by volume appropriate for New Zealand's circumstances? If not, please provide an explanation.

5.3.2.7 Inorganic Chloride Content

Chlorides are corrosive to metals used in fuel systems such as stainless steel. ASTM D 4806 provides a limit on inorganic chlorides of 32 mg/l whereas Pr EN 15376 provides a lower limit of 20 mg/l. Because of the possible impacts, vehicle and equipment manufacturers generally support a low limit for this parameter. The likely blend level is also relevant as chlorides blend linearly.

It is proposed that the ASTM D 4806 limit of 32 mg/l be included in the regulated ethanol specification.

q) Is a maximum permitted inorganic chloride content of 32 mg/l appropriate for New Zealand's circumstances? If not, please provide an explanation.

5.3.2.8 Copper Content

Copper is an active catalyst for the low temperature oxidation of hydrocarbons, significantly increasing the rate of gum formation.

The majority of relevant ethanol standards provide for a maximum copper content of 0.1 mg/kg. Only the Brazilian Specification differs with a lower limit of 0.07 mg/kg. It should be noted however that Brazil allows significantly higher ethanol content in blends (25%) and so the effect of the ethanol on the blend is more significant.

A limit of 0.1 mg/kg appears appropriate and it is therefore proposed that this limit is provided for copper in the regulated ethanol specification.

5.3.2.9 Acidity

Dilute aqueous solutions of low molecular weight organic acids, such as acetic acid, are very corrosive to a wide range of metals and alloys. Accordingly it is necessary to keep such acids at a very low level and ethanol standards generally include an acid specification.

All relevant standards identified provide for an acidity (as acetic acid CH_3COOH) limit of 0.007 mass % maximum. This level appears appropriate and it is proposed that this limit is required in the regulated ethanol specification.

5.3.2.10 pHe

Low levels of strong acids might not always be detected by the acidity test and can contribute to the corrosion of some fuel system parts. Whilst total acidity (as acetic acid) is limited to 0.007 % mass, this is not always sufficient to detect more aggressive sulphuric based acids, and ethanol meeting the acidity requirement may still be of low pHe.

The test method for pHe measures acid strength and reports a pHe value. The pHe test is often done after denaturing and addition of corrosion inhibitors. Note that pHe is not directly comparable to pH values for water solutions.

All relevant standards identified require the pHe value of the ethanol to be between 6.5 and 9.0 and it is proposed that this is required by the regulated ethanol specification.

5.3.2.11 Appearance

All ethanol standards require that the ethanol be visibly free of suspended or precipitated contaminants. This is often expressed as requiring that the ethanol be “clear and bright”. This is determined by visual inspection. It should be noted that fuels in New Zealand are not required to be coloured, as is the case in some jurisdictions for tax purposes.

It is proposed that the regulated ethanol specification require that ethanol for blending be clear and bright.

5.3.2.12 Sulphur Content

Ethanol is naturally low in sulphur when compared with refined petroleum products such as petrol. However, even at relatively low levels, sulphur can affect the performance of some emissions control equipment.

Sulphur limits for ethanol for blending with petrol tend to align with the sulphur limits applying to petrol in those jurisdictions. ASTM D 4806 limits sulphur to 30 ppm (mg/kg) whereas Pr EN 15376 limits sulphur to 10 ppm, which is the European petrol sulphur limit from 2009. The Japanese ethanol specification also limits sulphur to 10 ppm, making it consistent with the petrol sulphur limit.

The current sulphur limit under the PPSR for petrol is 150 ppm, but this is reduced to 50 ppm from 1 January 2008. Sulphur will ultimately be limited to 10 ppm, although the timing for this has yet to be determined.

It is proposed that the maximum sulphur limit for ethanol for blending be set initially at 30 ppm. This is consistent with ASTM D 4806 and the Draft Australian Standard and tighter than the petrol sulphur limit applying from 2008, meaning that the ethanol component won’t cause a blend to be off specification. It is envisaged that the sulphur limit for ethanol will be reduced to 10 ppm when the petrol limit is reduced to 10 ppm to ensure that blends remain on specification.

5.3.2.13 Corrosion Properties

Petrol/ethanol blends can be more corrosive than petrol because of their tendency to attract water, and their conductive properties. Use of corrosion inhibitors can ensure that the corrosion properties of petrol/ethanol blends are no worse than that of neat petrol.

The Renewable Fuels Association (RFA) in the United States recommends the use of corrosion inhibitors at a treat rate sufficient to provide corrosion protection comparable to that of other available motor fuels. The RFA provides a list of eight corrosion inhibitors recommended for fuel grade ethanol but permits other corrosion protection additives of similar performance to be used.[23] The criterion used for inclusion of additives in the list is to add ethanol to an E rated gasoline (NACE Standard Test Method TM-01-72), the additive must then raise the NACE rating of the blend to B+ or better for the recommended additive treat rate.[24]

To ensure that petrol/ethanol blends do not cause corrosion it is proposed that corrosion inhibitor be added so that the corrosion properties are no worse than that of neat petrol. It is not proposed that a specific list of corrosion inhibitors be provided. It would also be desirable to specify a test method for determining the corrosion properties of a petrol/ethanol blend.

r) Is it more appropriate to add corrosion inhibitor to neat ethanol or to the petrol/ethanol blend?
s) Is it necessary for a corrosion inhibitor to be added in all cases?
t) Is it necessary to specify a list of approved corrosion inhibitors?
u) What would be the most appropriate test method for determining the corrosion properties of a petrol/ethanol blend, to ensure that they are no worse than that of petrol?

5.3.3 Test Methods

It is proposed that test methods provided in ASTM D 4806 be included in the regulated specification. It is proposed to specify ASTM D 5453 as the only test method for sulphur. This is one of the methods already specified in the PPSR for testing sulphur in petrol and diesel. No test method is provided for denaturant content, the content is set by volumetric addition during the denaturing process.

The test methods proposed for ethanol for blending are shown in Table 9. Comments on these are sought.

5.3.4 Proposed Specification for Ethanol for Blending

The proposed specification for ethanol that is to be blended with petrol is shown in Table 9 on the following page.

[23] http://www.ethanolrfa.org/industry/resources/guidelines/
[24] http://www.ethanolrfa.org/objects/pdf/newRFA%20Fuel%20Ethanol%20960501.pdf

Table 9: Proposed Regulated Ethanol Specification for Blending

The grey shaded rows are those properties discussed in the previous section where comments are specifically being sought.

Property	Unit	Limit	Test Method
Denaturant content	volume %, min	1	
Denaturant content	volume %, max	1.5	
Ethanol	volume %, min	95.6	ASTM D 5501
Methanol	volume %, max	0.5	ASTM D 5501
Solvent-washed gum	mg/100 ml, max	5	ASTM D 381
Sulphate	mg/kg, max	4	ASTM D 4806 Annex A1 – A3
Water content	volume %, max	1	ASTM D 203
Inorganic Chloride content	mg/L, max	32	ASTM D 512C (as modified in ASTM D 4806)
Copper content	mg/kg, max	0.1	ASTM D 1688A (as modified in ASTM D 4806)
Acidity (as acetic acid CH3COOH)	mass %, max	0.007	ASTM D 1613
pHe		6.5 – 9.0	ASTM D 6423
Appearance		Clear and bright without particles	ASTM D 4806
Sulphur	mg/kg, max	30	ASTM D 5453

5.4 Non-Retail Petrol/Ethanol Blends

No limit on ethanol content is currently specified in the PPSR for petrol supplied via a written contract or supply agreement (i.e. non-retail). It is proposed that this approach continue. It should be noted, however, that use of ethanol blends above E10 would be subject to approval by the Environmental Risk Management Authority and compliance with any requirements.

The PPSR currently require that petrol/ethanol blends (regardless of the proportion of ethanol) meet the specification parameters provided for non-retail regular or premium petrol.[25] It is proposed that this requirement continue. As noted previously these parameters address primarily environmental and safety issues rather than engine operability issues. As such the purpose of requiring the neat ethanol in these blends to meet particular specifications would be instead to ensure vehicle operability.

Allowing flexibility with regard to ethanol used in non-retail petrol/ethanol blends might have some cost advantages. However, in the interests of building confidence in biofuels it is proposed that ethanol used for blending with petrol in non-retail blends (for example E20 or E85) also be required to meet the proposed specification for E100 discussed in this document. It is recognised that this specification is intended primarily for blends with up to 10% ethanol and that there is an ASTM specification for E85 (ASTM D 5798).

v) Is it appropriate to require ethanol used in non-retail blends to meet the specification for ethanol for blending?

5.5 E100 as a Fuel

Neat ethanol can be used as a fuel, although vehicles must be specifically designed for this purpose. For example a large number of vehicles in Brazil (known there as “flex-fuel” vehicles but different from the E85 flex-fuel vehicles sold elsewhere) and some diesel engine buses in Sweden run on neat ethanol. The neat ethanol used in Brazil is “hydrous”, which means it has a significantly higher water content than the “anhydrous” ethanol specification discussed in this document and is therefore unsuitable for blending with petrol due to phase separation issues.

Vehicles suitable for operating on neat ethanol are not currently available in the New Zealand market. It is therefore not considered necessary at this time to introduce a regulated specification for hydrous or anhydrous ethanol to be used a fuel in neat form (i.e. unblended).

[25] Clause 6 of the PPSR provides that “petrol must have properties in respect of sulphur, lead, benzene, total aromatic compounds, manganese, olefins, vapour pressure, phosphorus, and total oxygenates except ethanol that conform to the limits specified in Schedule 1 from the relevant date set out in that schedule when tested by the methods specified in that schedule.”

6. Biodiesel and Ethanol Labelling

6.1 Introduction

The current labelling requirements in the PPSR are that petrol and diesel being sold by retail sale must have a dispensing pump or container that is clearly marked. Clearly marked in this context means having a label that is able to be easily seen by the person dispensing the fuel.

This section provides a discussion of the considerations for labelling biodiesel and ethanol, and for blends, at point of sale, and proposed wording for labels. The purpose of the labelling requirements is to protect the consumer from unknowingly filling their vehicle with fuel that may be unsuitable for their vehicle. As for petroleum petrol and diesel, it is proposed that labels for the alternative fuels discussed below must be in place on the dispensing pump or container where they can be easily seen and read. Note that Cabinet has agreed that blends containing one percent or less biofuels by volume must not be promoted or advertised as “containing biofuels” or “biofuel blend”.[26]

6.2 Retail Biodiesel and Ethanol Blends

6.2.1 Biodiesel blends up to B5

Cabinet has agreed that biodiesel blends up to B5 do not require labelling.[27]

6.2.2 Ethanol blends up to E10

Currently the PPSR require that if petrol is blended with ethanol, the seller of the petrol must ensure that the dispensing pump or container displays the words “contains ethanol”.

The labelling of petrol/ethanol blends was further discussed in the Biofuels Sales Obligation Discussion Paper (September 2006). Cabinet has since agreed that ethanol/petrol blends must be labelled as containing ethanol, if the blend comprises more than one per cent ethanol.[28]

It is suggested that the term “bioethanol” is used on the label to match consumer information and emphasise the renewable nature of the blending component. While it is unlikely that non-renewable ethanol will enter the market, if the ethanol added is not from a renewable source it is proposed that the ethanol be termed “non-renewable ethanol” on the label. If the proportion of non-renewable ethanol in the ethanol blending component is greater than 20% by volume, the ethanol shall also be termed “non-renewable ethanol”. The other alternative is to simply retain the use of the word “ethanol” in the label, but this would not enable consumers to distinguish between renewable and non-renewable ethanol.

Dispenser labels should differentiate between different levels of ethanol in the blend to allow consumers to identify ethanol levels that are stated as compatible with their vehicle type. In recognising that vehicle compatibility varies with different ethanol levels and also

[26] See, http://www.transport.govt.nz/assets/NewPDFs/Biofuels-Cabinet-Papers-posted-June-2007.pdf
[27] Ibid.
[28] Ibid.

to allow for variation in blend levels in the distribution process, particularly at service stations, a 3% blend could be labelled as “up to 10% ethanol” should the supplier wish. However, a higher ethanol blend could not be labelled as a lower blend, for example a 7% blend could not be labelled as a 5% blend.

It is proposed that retail pumps dispensing petrol/ethanol blends containing more than 1% ethanol by volume up to maximum 10% ethanol are labelled as:

> “Contains up to X% bioethanol. May not be suitable for all vehicles/engines. Check with the manufacturer”
>
> or
>
> “Contains up to X% non-renewable ethanol. May not be suitable for all vehicles/engines. Check with the manufacturer”

where X may be any number between 1 and 10.

6.3 Non-Retail Biodiesel and Ethanol

As already discussed non-retail biodiesel and ethanol, and their associated blends, are those for which there is a written contract for supply. Where there is a written contract, biofuel or oil companies are able to negotiate and supply commercial customers with neat or high level blends of biodiesel or ethanol. Under the new regulations, fuels that will not be able to be supplied for retail sale but may be sold via a written contract include B20, E85, and E100.

It is expected that fuel companies will ensure that any dispenser offering non-retail biodiesel or ethanol, or associated blends, is not accessible to retail customers and that their commercial customers are able to differentiate between various fuels. As noted previously, some non-retail fuels and blends of fuels do not yet have approval from the Environmental Risk Management Authority under the Hazardous Substances and New Organisms Act.

It is proposed that there be no regulated labelling requirements or standardised wording for non-retail biodiesel and ethanol, or for their associated blends. This is consistent with the current approach for non-retail petrol and diesel. Labelling is not considered necessary given that customers must have a written contract or supply agreement. Comments are sought on this approach.

w) For labelling requirements of biodiesel and ethanol blends at the point of sale, please provide comment on whether you agree with the proposals. If not, please provide an explanation and alternative requirement (if appropriate).

7. Questions for feedback

This discussion document is seeking feedback on a number of specific questions, these are listed below. General comments are also welcome.

Biodiesel

For the proposed B100 specification, please provide comment on the following:

a) Do you agree with the proposed requirements?
b) If not, what is an appropriate requirement (i.e. limit and test method)? Please provide an explanation of how this impacts on vehicle operability and / or biodiesel manufacturing.

Cold flow properties for Schedule 3 of PPSR:

c) Should the cold flow properties for Auckland/Northland be relaxed in Schedule 3 of the PPSR?
d) If so, what should the limits be for cloud point in winter and summer, and CFPP in winter?

Oxidation stability for B5 blends:

e) In regards to oxidation stability for B5 blends, do you prefer option i, ii, iii or iv? Please provide an explanation of why this is appropriate for New Zealand’s regulations.

Individual acids (formic, acetic and propionic) in B5 blends:

f) In regards to individual acids in B5 blends, do you prefer option i or ii? Please provide an explanation of why this is appropriate for New Zealand’s regulations.

For Schedule 3 of the PPSR, please provide comment on the following:

g) Do you agree with the proposed requirements?
h) If not, what is an appropriate requirement (i.e. limit and test method) for New Zealand’s B5 specifications? Please provide an explanation of how this impacts on vehicle operability and / or biodiesel manufacturing.
i) Are there any other amendments that need to be made to Schedule 3 of the PPSR to incorporate B5 blends within the diesel specification?

For non-retail biodiesel blends specifications regulations, please provide comment on the following:

j) Do you agree with the proposed requirements?
k) If not, what are the appropriate requirements (i.e. limit and test method) for New Zealand’s non-retail biodiesel blend specification? Please provide an explanation of how this impacts on vehicle operability or other non-automotive uses of biodiesel and / or biodiesel manufacturing.

Ethanol

Scope of ethanol specification for blending:

l) Is it appropriate that the ethanol specification for blending apply to denatured ethanol? If not please provide an explanation.

Denaturant content:

m) Are there any reasons to allow denaturants other than petrol to be used for denaturing ethanol for blending with petrol?

Ethanol content:

n) Is 95.6% by volume an appropriate minimum requirement for ethanol? If not, please provide an explanation of how this impacts on vehicle operability and / or ethanol manufacturing. If not please provide an explanation.

Solvent Washed Gum:

o) Is the proposed limit of 5 mg/100 ml for solvent washed gum appropriate? If not, please provide an explanation of how this impacts on vehicle operability and / or ethanol manufacturing.

Water content:

p) Is a maximum water content of 1% by volume appropriate for New Zealand's circumstances? If not, please provide an explanation.

Inorganic chloride content:

q) Is a maximum permitted inorganic chloride content of 32 mg/l appropriate for New Zealand's circumstances? If not, please provide an explanation.

Corrosion properties:

r) Is it more appropriate to add corrosion inhibitor to neat ethanol or to the petrol/ethanol blend?
s) Is it necessary for a corrosion inhibitor to be added in all cases?
t) Is it necessary to specify a list of approved corrosion inhibitors?
u) What would be the most appropriate test method for determining the corrosion properties of a petrol/ethanol blend, to ensure that they are no worse than that of petrol?

Non-retail ethanol/petrol blends:

v) Is it appropriate to require ethanol used in non-retail blends to meet the specification for ethanol for blending?

Labelling

w) For labelling requirements of biodiesel and ethanol blends at the point of sale, please provide comment on whether you agree with the proposals. If not, please provide an explanation and alternative requirement (if appropriate).

8. Glossary of Terms

% m/m: represents the mass fraction for the purposes of this discussion document.

ASTM: ASTM International – formally the American Society for Testing and Materials.

ASTM D 664: Standard Test Method for Acid Value of Petroleum Products by Potentiometric Titration.

ASTM D 975: Standard Specification for Diesel Fuel Oils.

ASTM D 2274: Standard Test Method for Oxidation Stability of Distillate Fuel Oil (Accelerated Method).

ASTM D 4530: Standard Test Method for Determination of Carbon Residue (Micro Method).

ASTM D 4806: Standard Specification for Denatured Fuel Ethanol for Blending with Gasolines for Use as Automotive Spark-Ignition Engine Fuel

ASTM D 5798: Standard Specification for Fuel Ethanol (Ed75-Ed85) for Automotive Spark-Ignition Engines.

ASTM D 6217: Particulate Contamination in Middle Distillate Fuels by Laboratory Filtration.

ASTM D 6751: ASTM standard for Biodiesel Fuel (B100) Blend Stock for Distillate Fuels (up to 20% by volume).

Biodiesel: esters made from vegetable oils or animal fats (i.e. tallow); most commonly blended with diesel for use in compression-ignition (diesel) engines.

Bioethanol: ethyl alcohol produced by the fermentation and distillation of sugars and starches.

Biofuels: biofuels are fuels that are derived from biomass (recently living organisms or their metabolic by-products). They are a renewable energy source, unlike other natural resources such as petroleum fuels.

Biomass: the biodegradable fraction of products, waste and residues from agriculture (including vegetal and animal substances), forestry and related industries, as well as the biodegradable fraction of industrial and municipal waste.

BX: a blend of X% biodiesel in diesel, e.g. B5 contains 5% biodiesel, 95% petroleum diesel.

CEN: European Committee for Standardization.

Cold Filter Plugging Point (CFPP): an indicator of the temperature at which the precipitation of wax crystals in distillate fuel may lead to blocking or plugging of equipment filters and fuel lines.

Cloud Point: cloud point defines the temperature at which a clear diesel fuel becomes hazy or cloudy due to the formation of wax crystals.

Denaturant: a substance added to ethanol to make it undrinkable, or unsuitable for human consumption, e.g. petrol.

Diesel: a refined petroleum distillate having a viscosity and distillation range that is intermediate between those of kerosene and light lubricating oil, whether or not it contains additives, and that is intended for use as fuel in internal combustion engines ignited by compression.

E70: the percentage volume evaporated at 70ºC. The PPSR set lower and upper limits to ensure good starting and engine performance when warm.

EECA: The Energy Efficiency and Conservation Authority.

EN: European Standard.

EN 12662: Method of test for liquid petroleum and its products. Determination of contamination in middle distillates.

EN 14112: Fat and oil derivatives. Fatty acid methyl esters (FAME). Determination of oxidation stability (accelerated oxidation test).

EN 14214: Automotive fuels - Fatty acid methyl esters (FAME) for diesel engines – Requirements and test methods.

EN 590: Automotive fuels. Diesel. Requirements and test methods.

ERMA: Environmental Risk Management Authority.

Ethanol: bioethanol or non-renewable ethyl alcohol which can be used as a fuel in neat form or high level blends in specifically designed vehicles or blended at low levels with petrol for use in vehicles with spark ignition engines.

EX: a blend of X% ethanol in petrol, e.g. E10 contains 10% ethanol and 90% petrol.

FAEE: Fatty acid ethyl ester, biodiesel produced by ethanol esterification of natural product fatty acids.

FAME: Fatty acid methyl ester, biodiesel produced by methanol esterification of natural product fatty acids.

FVI: Flexible Volatility Index is a function of VP and E70. It is an indicator of hot running performance, or the tendency for fuel to vaporise in the fuel lines when the engine is hot (known as vapour lock) and impede fuel flow.

Fuel Quality Monitoring Programme (FQMP): responsibility of the Measurement and Product Safety Service, a group within the Ministry of Economic Development. It routinely tests petrol and diesel samples from around the country to monitor that the fuel available to consumers complies with the regulations.

Glycerides: esters formed from glycerol and fatty acids. Glycerol can be esterified with one, two or three fatty acids to form monoglycerides, diglycerides and triglycerides.

Glycerol (or glycerine): an alcohol that is the main by-product of the transesterification process. Biodiesel may contain free glycerol and/or bound glycerol (i.e. contained in the mono-, di- and triglycerides).

Hydrous ethanol: neat ethanol that has a higher water content than "anhydrous" ethanol, and is therefore generally unsuitable for blending with petrol.

IP: Energy Institute, formally Institute of Petroleum.

ISO: International Organisation for Standardization.

ISO 12205: Petroleum products - Determination of the oxidation stability of middle-distillate fuels.

JAMA: Japan Automobile Manufacturers Association.

JASO M 360: Japanese B100 standard based on EN 14214.

JASO M 361: Japanese E100 standard.

JIS: Japanese Industrial Standards.

JIS K 2204: Japanese mandatory petroleum diesel and B5 specification – "Law on the Quality Control of Gasoline and Other Fuels" or the "Quality Assurance Law".

JIS K 2501: Petroleum Products and Lubricants - Determination of Neutralisation Number.

MED: Ministry of Economic Development.

NZRC: New Zealand Refining Company.

NZS 7500: The New Zealand Standard on Automotive Biodiesel – Specification for Manufacturing and Blending.

OEM: Original Equipment Manufacturer

Non-retail sale: all fuel sold via a written contract or supply agreement.

Polymerise: the chemical reaction in which a compound is made into a polymer, which is a natural or synthetic compound that consists of large molecules made of many chemically bonded smaller identical molecules.

Petrol: means a refined petroleum distillate, normally boiling within the limits of 15ºC to 220ºC, whether or not it contains additives, that is intended for use as a fuel in spark-ignition internal combustion engines.

Petroleum Products Specifications Regulations (PPSR): These regulations specify the technical requirements to be met in respect of petrol and diesel supplied for use other than as an aviation fuel, for motor car racing, for powerboat racing and jet boats, and for motorcycle racing.

Premium grade petrol: means petrol supplied with a research octane number of 95 or higher.

Pr EN 15376: Automotive fuels - Ethanol as a blending component for petrol.

Regular grade petrol: means petrol supplied with a research octane number of at least 91 but less than 95.

Renewable: an energy source that is inexhaustible and is contantly replenished by natural processees; includes non carbon technologies such as solar energy, hydro power and wind as well as technologies based on biomass (i.e. biofuels).

Retail sale: means a sale to an end user who has no written supply agreement or written contract with the supplier in respect of the sale.

Saturated fatty acids: all carbons contain as many hydrogens as possible (hence a saturated fat is 'saturated' with hydrogen atoms). The fatty acids do not contain any double bonds or other functional groups along the chain.

Unsaturated fatty acids: a fat or fatty acid in which there are one of more double bonds in the fatty acid chain (hence eliminating hydrogen atoms). A fat molecule is monosaturated if it contains one double bond and polyunsaturated if it contains more than one double bond. The greater the degree of unsaturation in a fatty acid (i.e. the more double bonds in the fatty acid), the more vulnerable it is to oxidative degradation.

Vapour pressure (VP): this is a measure of the pressure exerted by the vapours delivered from a liquid at a given temperature and pressure.

WWFC: World-Wide Fuel Charter – The Charter is released on behalf of a large number of vehicle and engine manufacturers. Its stated purpose is to promote greater understanding of the fuel quality needs of motor vehicle technologies and to harmonise fuel quality worldwide in accordance with engine and vehicle needs.