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Estimating premiums for petrol with lower sulphur limits

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Executive Summary

The Ministry of Business, Innovation and Employment (MBIE) has asked what the impact may be on premiums for New Zealand specification petrol if sulphur limits were tightened from the current 50 ppm level to 10ppm.

Petrol is probably the most complex of all the refined products to make because it is the result of a blend of components produced in the refining process where the blend has to meet a range of specified parameters. An individual refiner's blending process will depend on the range of components it has available which will vary according to the type of refining processes used. The components themselves will have different qualities (e.g. different sulphur levels) and in some cases do not blend in a linear way which impacts on the blended fuel; this makes it difficult to isolate out the cost impact for any one component or specified parameter.

Petrol supplied in New Zealand is sourced from Refining NZ and finished product imported from Asia Pacific. These imports are priced using the major regional Singapore benchmarks for petroleum. Price reporting agencies such as Platts will publish these price benchmarks using a standard quality. The market will then price cargoes using the Platts benchmark, but with premia to reflect the actual quality of the product where it varies from the Platts standard.

To assess the impact on premiums for New Zealand specification petrol with 10 ppm sulphur we adopted the following approach:

- Compare New Zealand petrol specifications with Platts specifications to identify where the regional petrol benchmarks differ and what quality parameters could be impacted by tightening the sulphur specification compared to the Platts benchmark. The comparison identified that New Zealand specifications are more stringent, particularly for Motor Octane Number and the maximum allowable content of sulphur, benzene, aromatics and oxygenates.
- Consider the likely supply/demand balance for 10ppm sulphur petrol in the Asia Pacific region through to 2030. MBIE has commissioned a report by Stratas Advisors which indicates increasing export capability for 10ppm sulphur petrol in the region. In the period up to 2017 this is identified as coming mostly from India. As most of New Zealand's imports are currently from Singapore and South Korea there may be insufficient export capability to fully meet New Zealand's import requirements (if supply continues on this basis) until around 2017 to 2020, when Singapore is projected to have export capability alongside South Korea.
- Develop a cost of blending New Zealand specification petrol to estimate the likely cost impact of introducing 10ppm sulphur petrol H&T has developed a petrol blending model using standard industry formulas to calculate blending outcomes for the key specification parameters.

Our modelling indicates the cost impact for blending down to 10 ppm sulphur to be around 35 to 50 US cents per barrel. Supply availability from the region looks reasonable (particularly given New Zealand's small requirement) such that we would not expect quality premiums to reflect anything other than the blending cost dimension. Furthermore the current surplus in refining capacity, which is expected to continue for the medium term, should also exert competitive pressure on quality premia.

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1.0 Introduction

The Ministry of Business, Innovation and Employment (MBIE) is the Government agency that is responsible for the regulation of petroleum fuel standards for New Zealand via the Engine Fuel Specification Regulations 2011. These regulations set the specification and quality parameters for fuels (petrol, diesel, ethanol and bio-diesel) supplied to the New Zealand retail market. Periodically MBIE reviews these regulations to ensure they are aligned with global and regional trends and remain fit for purpose.

MBIE is currently reviewing the regulations and one specification being considered for change is a possible reduction of the sulphur limit in petrol from 50ppm[1] to 10ppm.

Petroleum specification changes (including sulphur level reductions) are a continuing feature of the market internationally. Some countries in Asia Pacific already require 10ppm sulphur petrol and others are planning to tighten sulphur content specifications. Higher specification product requires more complex refining processes which is reflected in premiums for the product versus standard grades. Before deciding on any changes to the sulphur content for New Zealand specification petrol, MBIE requires an assessment of what a tighter sulphur specification might mean for any premiums charged for petrol supply.

MBIE has commissioned consultants to undertake a review of the refining balance for supply of low sulphur petrol in the Asia Pacific region looking out to 2030. This estimates the supply and demand balance (volumetric impact) and what that might mean for the ability of the industry to meet sulphur trends in petrol in the region.

MBIE has asked Hale & Twomey (H&T) to estimate the impact on premiums if sulphur limits in petrol were tightened, based on the consultant's projected supply and demand balance.

2.0 New Zealand supply situation

New Zealand's petrol is supplied in part from New Zealand's sole refinery (Refining NZ) and from imported petrol that is usually sourced from the Asia Pacific region. New Zealand petrol is normally priced on import parity[2], reflecting the import petrol dynamic. The typical benchmark price used in the region as a basis for pricing is the Platts Singapore price for the relevant petrol grade.

Petrol supply for New Zealand commands a premium over the Platts benchmark price because New Zealand fuel regulations require a higher quality fuel than that specified for the Platts benchmark which reflects a generic (lower quality) grade of petrol. As each country has individual specifications for each parameter it is difficult to establish a traded grade which is truly fungible.

Petrol for each country will trade at a premium or discount to the common benchmark reflecting the different parameters (or qualities) being sought for the specified grade of petrol. Often suppliers will set more stringent parameters than those specified to ensure the fuel remains on specification and fit for purpose as it moves through the supply chain to the end customer.

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[1] Petrol sulphur limits reduced to 50 ppm in January 2008 following a review of the regulated specifications.

[2] Markets are typically priced on the marginal cost to supply, so for countries that import (like New Zealand), the cost to import will normally set the supply cost for the market.

3.0 Petrol blending

Finished petrol is not produced directly from the refining process, rather it is the result of blending a range of components produced in the refining process to meet the required specification. Of all the refined products, petrol is probably the most complex to make because it depends on the quality and quantity of components that an individual refinery has available to it (either produced or imported components) and how these are blended together to meet that petrol's specification parameters. These parameters are designed to address a range of considerations including:

1. Operability of the fuel
2. Seasonal influences (cold start)
3. Impact of the fuel on engine components (fuel and exhaust systems)
4. Environmental parameters (e.g. sulphur and benzene limits)

Hence the challenge for refiners is to optimally blend available components to meet specification and fit for purpose requirements. Higher quality and higher octane petrol will require refiners to use better quality (more expensive) components. As an example, for low sulphur petrol the amount of higher sulphur components like cat-cracked gasoline may need to be limited and higher quality components (like reformate or alkylate) used instead. In this example the components used would depend on other parameters too, so if the low sulphur petrol also required lower aromatics, this would constrain the amount of higher aromatic reformate that could be used.

Refiners and commodity traders blending up petrol will use complex blending models to find the best mix of components to make the required specification petrol at the lowest cost based on the components available. The final makeup of the petrol blend will be different for each refiner or commodity trader as this will depend on the availability and cost of the components at the time of blending. This makes it difficult to assess the cost impact for any one parameter.

Refiners may also seek higher quality premiums if the higher specification fuels cause additional refinery constraints such as needing to take extra precautions with blending operations to avoid contamination (e.g. from MTBE) and isolating high quality product streams for blending.

Because there is no actual reporting of particular premiums to the Platts quotes, the assessment of premium levels for petrol with different sulphur levels (including for 10ppm sulphur) requires examination of a range of factors, including consideration of the mix of components that could be used to make that petrol blend. The relevant factors are considered in this report.

4.0 New Zealand petrol specifications

This section examines the key specification parameters for petrol in New Zealand, how they differ from the Platts benchmarks and their influence on premium levels.

New Zealand's petrol specifications are set out in the Engine Fuel Specification Regulations 2011. Table 1 summarises the key parameters for New Zealand Regular Petrol (91 Octane) and Premium Petrol (95 octane) and how these compare with the regional benchmarks (Platts specifications for the standard 92 and 95 octane petrol grades).

The full specifications for New Zealand petrol are listed in Appendix A.

Table 1: Comparison of key parameters for New Zealand and Platts specifications

Parameter	New Zealand specification		Platts specification	
	Regular petrol	Premium petrol	MOGAS UNL 92	MOGAS UNL 95
RON	Min 91.0	Min 95.0	Min 92.0	Min 95.0
MON	Min 81.0	Min 85.0	No specification	No specification
Sulphur	Max 50 mg/kg		Max 0.05%$_{(WGT)}$ = 500 mg/kg	
Benzene	Max 1%$_{(VOL)}$		Max 5%$_{(VOL)}$	
Aromatics	Max avg 42%$_{(VOL)}$, max cap 45%$_{(VOL)}$		Report	
Oxygenates	Max 1%$_{(VOL)}$ [3]		Max 14%$_{(VOL)}$ incl. up to 10% MTBE	

In addition to these parameters the New Zealand petrol specifications place controls on vapour pressure and volatility to ensure driveability requirements are met and to limit evaporative losses. The Platts specifications also place limits on vapour pressure and volatility, which are compared with the New Zealand specifications in Table 2.

Table 2: Comparison of volatility and vapour pressure parameters

Parameter	New Zealand specification		Platts specification	
	Minimum	Maximum	Minimum	Maximum
E70[4] / T10[5]	22%	48%	No specification	74 ^{o}C
E100[4] / T50[5]	45%	70%	80 ^{o}C	127 ^{o}C
Final boiling pt.	210 ^{o}C		225 ^{o}C	
Vapour pressure	45kPa	65kPa – 95kPa [6]	No specification	10 PSI $_{(RVP)}$ (~69 kPa)

A direct comparison can't be made between the volatility specifications as different test methods are used, but New Zealand volatility specifications are more stringent than the Platts specification whereas the vapour pressure requirements for New Zealand are (on average) less stringent.

4.1 Octane

The key octane parameters in the New Zealand petrol specifications are Research Octane Number (RON) and Motor Octane Number (MON), whereas Platts only specifies a RON parameter[7]. The RON test simulates driving under mild, cruising conditions, whereas the MON test is more severe, simulating under load and acceleration conditions. Some countries (like the USA) require the arithmetic average of RON and MON to be used, rather than RON or MON.

[3] Separate to the 1% maximum limit of oxygenates, New Zealand specification petrol allows up to 10% ethanol to be blended.

[4] E70 and E100 describe the volume percentage of petrol that will have evaporated at 70 or 100 degC.

[5] T10 and T50 describe the temperature (degC) at which 10% and 50% of the petrol will have evaporated.

[6] Maximum vapour pressure for New Zealand changes depending on location and season.

[7] A gasoline's octane number is a measure of its ability to resist knocking as it burns in the combustion chamber of an engine.

The MON specification can be more constraining for refiners to meet than RON and often the Platts quotes for Mogas UNL 92 and Mogas UNL 97 are used as benchmark prices for regular petrol (91 RON) and premium petrol (95 RON) to reflect the more difficult MON requirements that refiners face when blending New Zealand specification petrol.

4.2 Sulphur

The sulphur specification for New Zealand petrol is currently 50ppm compared to 500ppm in the Platts specification. At 500ppm sulphur levels there is significant petrol blending flexibility which should allow higher sulphur components like straight run naphtha and cat-cracked gasoline to be used, whereas for 50ppm sulphur petrol the blending flexibility is much less.

As refineries move towards making lower sulphur petrol they may need to invest in equipment like hydrotreaters[8] to remove sulphur from certain product streams. While hydrotreating is effective at removing sulphur the process also reduces the octane of the resultant product stream, which will require the use of higher octane components to offset the octane loss. Hydrogen is a key input into the hydrotreating process, so more hydrogen will also be required.

4.3 Benzene

The Platts specification for benzene allows up to 5% benzene by volume to be blended into petrol, compared to the New Zealand specification which limits benzene to 1% or less. There are several ways for a refinery to produce lower benzene petrol, including:

- Converting benzene precursors in the platformer feed into cyclohexane. Refining NZ operates a benzene removal unit (known as the BRU) that uses this approach.
- Removing the benzene from the produced reformate[9] for use in petrochemical applications before blending this reformate into petrol.
- By producing lower quality (lower octane) reformate by operating the platformer at a lower level of severity.

4.4 Aromatics

Aromatic compounds are high in octane, which makes them good octane enhancers in petrol. However, high concentrations of aromatic compounds have been linked to earlier degradation of some fuel system components. New Zealand specifications require aromatics to be less than 42% of the petrol blend on average over a period of time, with an absolute limit of 45% for any one petrol batch or cargo. The Platts specification for petrol doesn't place a limit on aromatics content.

4.5 Oxygenates

New Zealand specification petrol allows up to 10% ethanol blends for retail sales, but all other oxygenates (such as methanol and MTBE[10]) must be less than 1%. The Platts specification allows for a higher concentration of oxygenates with a cap of 14%, of which up to 10% may be MTBE.

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[8] Hydrotreating is a chemical process where the product stream to be treated is mixed with hydrogen and chlorine, heated and then passed through a catalyst to break the sulphur away.

[9] Reformate is the product stream produced from the platforming process. Platformers use platinum based catalyst to covert the platformer feedstock into higher octane reformate.

[10] MTBE is shorthand for Methyl Tertiary Butyl Ether

The use of oxygenates gained favour in the 1980's as refiners looked for ways to increase octane in petrol following the removal of lead additives. More recently oxygenates like MTBE have become less acceptable due to environmental concerns on the risk of ground water contamination.

5.0 Other fuel standards

Useful comparisons for New Zealand's fuel standards include the Australian and European petrol specifications and also the World Wide Fuel Charter (WWFC) [11] recommended specifications for petrol. For the WWFC specifications the following categories are considered:

- **WWFC - category 2:** Markets with some emission control requirements or other market demands (e.g. markets requiring US Tier 1, EURO 2, or EURO 3).
- **WWFC - category 3:** Markets with more stringent emission control requirements or other market demands (e.g. markets requiring US LEV, California LEV or ULEV, EURO 4, or JP 2005).
- **WWFC - category 4:** Markets with advanced emission control requirements (e.g. markets requiring US Tier 2, US Tier 3, California LEV II, EURO 4, EURO 5, EURO 6, or JP 2009).

The objectives set out in the Sixth Community Environment Action Programme are to reduce emissions of harmful air pollutants so that air quality does not create significant impacts or risks on human health and the environment in Europe. Contrast that with the WWFC where the objectives are to develop common worldwide recommendations for fuels that meet customer requirements and also vehicle requirements for performance and engine emission technologies.

New Zealand's current petrol specifications are similar to the Euro 4 and WWFC – category 3 requirements.

5.1 Key comparisons

Below is a comparison between the key parameters in the New Zealand petrol specifications and the specifications for Australia, Europe and the recommended specifications in the WWFC.

Octane

In all cases the octane requirements are the same as for New Zealand for both the RON and MON parameters for regular and premium petrol.

Sulphur

New Zealand specifies a maximum sulphur content of 50ppm, whereas the maximum sulphur content for each of the comparator specifications are:

- Australia: 150ppm for regular petrol, 50ppm for premium petrol
- Europe: 10ppm for regular and premium petrol
- WWFC – category 2: 150ppm
- WWFC – category 3: 30ppm
- WWFC – category 4: 10ppm

Benzene

[11] The World Wide Fuel Charter (5th edition, 2013) provides fuel quality recommendations and is published by the WWFC Committee, whose membership is mostly automotive and engine manufacturers

Other than for WWFC- Category 2 (which allows benzene up to 2.5%), the benzene requirements are all specified as a maximum of 1.0%, which is the same as the benzene limits required for the New Zealand specifications.

Aromatics

The maximum aromatics content for each of the specifications are:

- Australia: Max avg 42%$_{(VOL)}$, max cap 45%$_{(VOL)}$
- Europe: 35%$_{(VOL)}$
- WWFC – category 2: 40%$_{(VOL)}$
- WWFC – categories 3, 4: 35%$_{(VOL)}$

The Australian specification for aromatics is identical to the New Zealand specifications, which allow aromatics to be less than 42% on average over a period of time, with an absolute limit of 45% for any one batch or cargo.

6.0 Price benchmark trends

Platts is the price reporting agency that is most commonly used to provide benchmark prices for petroleum product sales in the Asia Pacific region. There are three key Platts benchmarks that are used for petrol - Mogas UNL 92, Mogas UNL 95 and Moas UNL 97. A review of the specifications that underpin these benchmarks shows the key parameters have remained largely unchanged despite the trend towards higher quality fuels in recent years. The key changes that have occurred to these specifications since 2006 are shown in Table 3.

Table 3: Comparison of key Platts parameters over time

Platts parameter	Q4 2006	Q4 2014
Density (g/ml)	Report	0.720
T50%	Max 127 degC	Min 80 degC, max 127 degC
Sulphur (%)	0.10%$_{(WGT)}$ (or 1,000ppm)	0.05% (or 500ppm)
MTBE (%) Oxygenates (%)	Max 10%$_{(VOL)}$ -	- Max 14%$_{(VOL)}$ incl. up to 10% MTBE

The main change is the reduction of sulphur content from 1,000ppm to 500ppm. While this reduction is significant, in the context of sulphur reductions that have occurred in the region (and internationally) over that period, the current sulphur limit of 500ppm in the Platts benchmark price is still high.

In comparison, for diesel new Platts quotes were established over time to cover reducing sulphur requirements. While the original 5,000ppm diesel quote is no longer available, there are newer quotes for 2,500ppm, 500ppm, 50ppm and 10ppm diesel. This approach has allowed the market to more transparently price the sulphur reductions for diesel.

Platts does amend its product specifications periodically to ensure these continue to reflect typical market requirements for that particular type of fuel. While we are not aware of any pending

changes to the petrol benchmark specifications, it would seem likely that the current specifications for petrol in the region will change at some stage in future to reflect the reducing sulphur requirements in Asia Pacific. In the meantime the use of quality premiums to adjust for the higher quality fuels will continue to be a market feature.

7.0 Stratas Advisors report

Stratas Advisors (Stratas) have reviewed the refining balance for supply of low sulphur petrol in the Asia Pacific region looking out to 2030. This report shows that currently six countries have 10ppm sulphur petrol capability with four of these (Japan, South Korea, Taiwan and India) able to export some 10ppm sulphur petrol. By 2025 Stratas projects nine countries in Asia Pacific will have 10ppm sulphur petrol capability with six able to export. Table 4 shows the projected 10pmm sulphur petrol profile for countries with export capability in the Asia Pacific region.

Table 4: Asia Pacific region export capability (kbd)

Country	2014	2017	2020	2025
India	70 - 120	100 - 150	150 – 200	270 – 310
Taiwan	20 – 40	20 – 50	20 – 55	20 – 55
South Korea	24 – 75	30 – 80	30 – 80	30 – 80
Japan	0 -10	0 – 30	0 – 45	0 – 45
Singapore	0	0 – 30	20 – 40	20 – 40
China	0	0	0 - 50	20 – 50
Singapore + South Korea	25 – 75	30 – 110	50 – 120	50 – 120
Total	115 – 245	150 – 340	220 – 470	360 - 580

While the profile shown in Table 4 shows there is a growing surplus of capacity for 10ppm sulphur petrol much of this is from India, whereas most of the New Zealand imports currently come from Singapore and South Korea. If the New Zealand imports continue to mostly come from Singapore and South Korea there may be insufficient export capability to fully meet the New Zealand import requirement (~16 – 20 kbd[12] [13]) until around 2017 to 2020, when Singapore is projected to also have export capability alongside South Korea. Over that period we may also see Indian surpluses being made available for blending in the Singapore market.

The Stratas report assumes Australia will move to 10ppm sulphur petrol around 2020 to 2025, which perhaps reflects current uncertainty around the outlook for the Australian refining sector and the significant investment required for Australian refiners to make 10ppm sulphur petrol.

8.0 Estimated premiums for lower sulphur petrol

[12] Refining NZ manufactured petrol is not constrained by sulphur (Reviewing aspects of the Engine Fuel Specifications regulations 2008 Discussion Paper December 2010 | Z Energy, formally Greenstone Energy)

[13] The volume shown is the estimated import requirement for New Zealand based on current demand and the expected Refining NZ petrol production following the completion of CCR project, Te Mahi Hou.

To estimate the likely cost impact of New Zealand specifications requiring a low sulphur (10ppm) petrol H&T has developed a petrol blending model. The model allows various blend components to be mixed together to make a petrol blend, with key parameters of the blend calculated to ensure the blended petrol met the required specifications.

The blend components provided in the model were:

- **Butane** - a refinery produced stream mostly composed of normal butane and/or isobutene, although it may also contain propane and/or natural gasoline
- **Straight run naphtha** – a light, low octane, petrol component separated out of crude oil by distillation
- **Cat-cracked gasoline** - produced from catalytic cracking to produce a component with a moderate octane rating, high olefins and moderate aromatics levels
- **Various octane reformates** - a high octane, highly aromatic component produced by a catalytic or thermal reformer
- **Isomerate** – a component produced by converting normal pentane and normal hexane into isopentane and isohexane
- **Alkylate** - a high octane, low volatility component produced from an alkylation reaction
- **MTBE** - methyl tertiary butyl ether is an oxygenate manufactured from the chemical reaction of methanol and isobutylene

For each of these blend components the key blending parameters were defined and a price set derived based upon benchmark and other relevant prices for 2014.

To determine the suitability of the petrol blend the parameters below were calculated. Some of these parameters (such as octane) do not blend linearly so industry standard formulas were used to calculate the blend result.

- Octane, both RON and MON have been calculated
- Vapour pressure
- Volume of benzene, aromatics and olefins
- Sulphur content (parts per million)

It was beyond the capability of the model to calculate distillation parameters, however the above parameters were considered sufficient for making an assessment of the likely cost impact for low sulphur petrol.

8.1 Modelling

Initially the model was calibrated by blending 92 and 95 Octane petrol to the Platts specifications. Once calibrated blends were then made for the current New Zealand 50ppm sulphur content petrol (for 91 and 95 Octane) and then blends made for a 10ppm sulphur content petrol.

As expected the Platts specification petrol was able to use large quantities of cat-cracked gasoline and in the case of the 95 octane grade also MTBE. For the New Zealand 50ppm sulphur petrol higher quality (lower sulphur) blend components were required, although a small proportion of lower quality components were able to be used. For the final blends (10ppm sulphur petrol) only the higher quality blend components could be used and more care was required with managing other constraints like vapour pressure and aromatics content.

The modelling indicates that reducing the sulphur content of New Zealand specification petrol from 50 to 10ppm requires refiners to use higher quality (more expensive) blending components. The cost impact for moving from 50ppm to 10ppm sulphur petrol (2014 price basis) would be

around 35 to 50 US cents per barrel, with the low end more closely aligned with high octane petrol and vice versa. The cost impact tends to be lower for premium petrol as this fuel already requires the use of higher quality blend components to meet the higher octane requirements.

9.0 Other market considerations/comparisons

9.1 Competitive Pressure on Refining in Asia Pacific

While the results in Section 8.0 provide an indicative cost it is also important to bear in mind the competitive dynamic for refining and the influence that might have on pricing. Current market conditions for refining in Asia Pacific are challenging with capacity additions getting ahead of demand growth for petroleum fuels. As well as that, new refineries are being built on a much larger scale giving improved economics compared to smaller refineries which is increasing the competitive pressure on refining margins. This dynamic is expected to continue for a number of years. This should also see downward pressure on any premiums a refiner might look for in seeking to maintain throughput.

9.2 Singapore diesel experience

While the reduction in sulphur content in diesel in the Asia Pacific region is not directly comparable with the reduction in sulphur content in petrol it is useful to compare the price trends seen for diesel, in part because of the much more transparent benchmark price information that is available for different sulphur diesels, and also because the ability of refiners to produce lower sulphur diesel has been the result of investment in refining capability to remove sulphur.

Of particular interest is the price spread between 50ppm sulphur diesel and 10ppm sulphur diesel benchmark prices. Since 2009 the gap between the 10ppm and 50ppm sulphur diesel benchmark prices has reduced from 50 US cents to 24 US cents per barrel, with an average spread of 40 US cents per barrel observed, over the last six years.

9.3 ACCC monitoring of Australian petrol prices

The Australian petroleum industry is monitored by the ACCC. As part of their monitoring the ACCC gathers data and reports[14] on the import parity price for Australian specification regular petrol, including what the ACCC has observed are the applicable quality premiums. While the reported information gives an indication of how quality premiums have changed over time it doesn't assist with understanding what may be the quality premium impact of reducing petrol sulphur levels. Hence it is not possible to derive any guidance from the Australian data.

[14] Monitoring of the Australian petroleum industry, Report of the ACCC into the prices, costs and profits of unleaded petrol in Australia | various years

Appendix A - engine fuel specification regulations

Schedule 1
Requirements for petrol

rr 7, 8, 13, 14, 19(1)

Property	Limits	Test method
Research octane number (RON)	Regular grade fuel: 91.0 minimum	ASTM D2699
	Premium grade fuel: 95.0 minimum	ASTM D2699
Motor octane number (MON)	Regular grade fuel: 81.0 minimum	ASTM D2700
	Premium grade fuel: 85.0 minimum	ASTM D2700
Colour	Not to be mistaken for water	Visual
Percentage volume evaporated at 70°C (E70)	22 minimum[1] 48 maximum[2]	ASTM D86
Percentage volume evaporated at 100°C (E100)	45 minimum 70 maximum	ASTM D86
Percentage volume evaporated at 150°C (E150)	75 minimum	ASTM D86
End point (°C)	210 maximum	ASTM D86
Residue (% volume)	2 maximum	ASTM D86
Flexible volatility index[3] [VP (kPa) + (0.7 × E70)]	115.0 maximum	ASTM D86 and ASTM D5191
Vapour Pressure[4] (VP) (kPa)	Maxima: Auckland and Northland: 65 kPa summer; 80 kPa autumn and spring; 90 kPa winter; rest of North Island: 70 kPa summer; 80 kPa autumn and spring; 90 kPa winter; South Island: 75 kPa summer; 85 kPa autumn and spring; 95 kPa winter Minimum: 45 kPa all year	ASTM D5191
Copper strip corrosion (3 hours at 50°C)	Class 1 maximum	ASTM D130
Sulphur (mg/kg)	50 maximum	IP 497 or ASTM D5453
Existent gum (solvent washed) (mg/100 ml)	5 maximum	ASTM D381
Oxidation stability induction period (minutes)	360 minimum	ASTM D525
Lead (mg/ℓ)	5 maximum	IP 224
Benzene (% volume)	1 maximum	ASTM D5580
Total aromatic compounds (including benzene) (% volume)	42 maximum pool average and 45 maximum cap	ASTM D5580
Ethanol (% volume)[5]	10 maximum	ASTM D4815
Other oxygenates (% volume)	1 maximum	ASTM D4815
Olefins (% volume)	18 maximum	ASTM D1319
Manganese (mg/ℓ)	2.0 maximum	ASTM D3831
Phosphorus (mg/ℓ)	1.3 maximum	ASTM D3231

1 For regular and premium grade petrol in summer, a minimum E70 of 20% is permitted. Petrol that complies with the previous season's quality, and that is stored in a filling-station tank to which fewer than 3 deliveries of petrol have been made since 6 weeks before the beginning of the season, is regarded as complying with this specification for up to 6 weeks after the beginning of the season.

2 For regular and premium grade petrol blended with more than 1% and not more than 10% volume ethanol, the E70 maximum is increased by 1% per 1% volume ethanol in the blend.

3 For regular and premium grade petrol blended with more than 1% and not more than 10% volume ethanol, the flexible volatility index maximum allowed is: 115.0 summer; 120.0 autumn and spring; 130.0 winter. Petrol that complies with the previous season's quality, and that is stored in a filling-station tank to which fewer than 3 deliveries of petrol have been made since 6 weeks before the beginning of the season, is regarded as complying with this specification for up to 6 weeks after the beginning of the season.

4 For regular and premium grade petrol blended with more than 1% and not more than 10% volume ethanol, the maximum vapour pressure allowed is: Auckland and Northland: 72 kPa summer; 87 kPa autumn and spring; 97 kPa winter; rest of North Island: 77 kPa summer; 87 kPa autumn and spring; 97 kPa winter; South Island: 82 kPa summer; 92 kPa autumn and spring; 102 kPa winter. Petrol that complies with the previous season's quality, and that is stored in a filling-station tank to which fewer than 3 deliveries of petrol have been made since 6 weeks before the beginning of the season, is regarded as complying with this specification for up to 6 weeks after the beginning of the season.

5 Regulation 8(c) provides that ethanol must comply with Schedule 4: Requirements for denatured ethanol for blending.