



8 July 2013

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FCAI Response to Mandatory Petroleum Reporting Regime – Discussion Paper

The Federal Chamber of Automotive Industries (FCAI) is the peak industry organisation representing vehicle manufacturers and importers of passenger vehicles, light commercial vehicles and motorcycles in Australia.

The FCAI recognises that the main purposes of a Mandatory Petroleum Reporting Regime (as outlined in both the Regulation Impact Statement and Discussion Paper) are:

- To provide evidence base for development and review of liquid fuels related policy.
- For the Australian Government to meet its international liquid fuels reporting obligations.

The FCAI is making a submission to the Public Discussion Paper as market fuel quality is an important input into reducing the environmental impact of motor vehicles and as such a whole of government approach is required to deliver the Government's stated environmental objectives.

In the lead up to the 2010 federal election, the Prime Minister announced that CO₂ emissions standards for light vehicles (i.e. passenger cars, sport utility vehicles and light commercial vehicles) would be mandated as a complementary measure to the Government's Clean Energy Future Plan. The industry supports this approach as it provides the certainty needed in this important policy area to plan for product development and deployment in a practical timeframe.

The Government has also introduced the European (Euro 5 and Euro 6) vehicle air pollutant emission standards (phased-in from 1 November 2013) as the latest in a series of air pollutant emission standards. Attachment B provides further detail on the vehicle emission and fuel quality standards.

While air pollution emission standards have been introduced into Australian legislation and CO₂ targets are being considered, the Government has not introduced the concomitant fuel quality standards.

The FCAI and member companies consider that a whole of Government approach is required to incorporate all associated issues, including fuel quality standards, which have a significant impact on vehicles' ability to meet both CO₂ targets and air pollution emission standards. If the appropriate market fuel quality is not available, higher exhaust emissions (both CO₂ and pollutants) will be generated with lower than expected improvements to air quality and health outcomes thus negating the expected benefits of CO₂ targets and air pollution emission standards.

The potential for degraded performance, operability and durability of some vehicles due to the use of market fuel of a lower quality (than the vehicle was designed to operate on) could lead to reputational damage of the brand. To protect against such damage, some brands may choose to restrict from Australia the introduction of new technologies that require higher fuel standards.

As such it is important that vehicle brands are aware of the fuel quality that is available in the market in Australia. In the past, the vehicle industry has relied on the appropriate fuel quality standards being legislated via the Fuel Quality Standards Act. With the increasing range of fuel products, such as multiple grades of gasoline and biofuels (both ethanol and biodiesel blends), there is a wider choice of fuels for consumers. Therefore, it is important that consumers also have access to information about the important market fuel parameters to assist their decision when choosing a fuel to purchase.

As a guide to the fuel quality standards that should be reported, the FCAI suggests that the Department consider the fuel quality parameters reported by New Zealand in their 'Fuel Quality Monitoring Program' (Attachment C). The parameters reported include:

- Petrol; RON and MON, Evaporation Percentage, Final Boiling Point, Residue, Dry Vapour Pressure, Flexible Volatility Index, Sulphur, Benzenes and Total Aromatics, Olefins.
- Diesel; Density, Distillation, Cetane Index, Water, Total Contamination, Sulphur, Cloud Point, Cold Filter Plugging, Hydrocarbons, Filter Blocking Tendency, Lubricity, Flash Point.

If you require any additional information please do not hesitate to contact the FCAI's Technical Director, Mr James Hurnall on T: (02) 6229 8214 or E: james.hurnall@fcai.com.au.

Yours sincerely



Tony Weber
Chief Executive

Attachments:

- A - Overview of Automotive Industry
- B - Vehicle Fuel and Emission Standards
- C - New Zealand Fuel Quality Monitoring Program Test Results 2010-11

The FCAI is the peak industry organisation representing vehicle manufacturers and importers of passenger vehicles, light commercial vehicles and motor cycles in Australia.

The automotive industry is a major contributor to Australia's lifestyle, economy and community and is Australia's largest manufacturing industry. The industry is wide-ranging and incorporates importers, manufacturers, component manufacture and distribution, retailers, servicing, logistics and transport, including activity through Australian ports and transport hubs.

In 2011, the Australian automotive sector exported around \$3.3 billion in vehicles and components and turnover in the industry exceeds \$160 billion. The industry directly employed almost 52,000 people through Australia's three vehicle manufacturers, dozens of importers and thousands of related component manufacturers. Further, the automotive industry employs nearly 280,000 people directly and indirectly throughout Australia. In 2011, around \$470,000 worth of product was generated per employee, a significant contribution to the Australian economy. The industry paid around \$3 billion in wages and salary in 2009/10 and since 2007 the industry has invested more than \$4.5 billion on research and development¹.

As the tariff barriers on automotive products have reduced from 57.5 per cent in the 1980's to effectively between 3 and 4 per cent the number of vehicle brands and models in the Australian market has increased.

There are now over 67 brands in the Australian market, with just over 1.1 million new vehicle sales per year. That is a lot of brands to service a market of our size equating to only around 16,000 new vehicles sold per brand. The following table provides a comparison of the competitiveness of global markets with double the number of new vehicles sold per brand in Canada, almost three times as many in the UK and more the 255,000 new vehicles sold per brand in the USA.

Table A.1 Competitiveness of Global Vehicle Markets²

	Australia	Canada	UK	USA
No. of brands in market	67	49	53	51
Sales	1,112,032	1,620,221	2,249,483	13,040,632
Market size per brand	16,597	33,066	42,443	255,699

¹ Australian government, Department of Industry, Innovation, Climate Change, Science, Research and Tertiary Education, Key Automotive Statistics 2011.

² Australian government, Department of Industry, Innovation, Climate Change, Science, Research and Tertiary Education, March 2013 Automotive Update.

In 2012, only 13 per cent of new vehicles sold were manufactured locally with the remaining 87 per cent of new vehicles imported from many countries and regions of the world including Asia (more than 60 per cent), Europe (14 per cent) and North and South America (3 per cent) (Table A.2).

Table A.2 Country/Region of Origin for New Vehicle Sales in 2012³

Country/Region of Origin	% of New Vehicle Sales
Japan	35%
Thailand	15%
Europe	14%
Korea	13%
Australia	13%
Americas	3%
Other Asia (incl China and India)	3%
Other (incl South Africa)	3%

The motor vehicle is increasingly a global product and one of the most comprehensively regulated products. In considering regulations, the government's role is to balance social and economic benefits with safety and environmental performance.

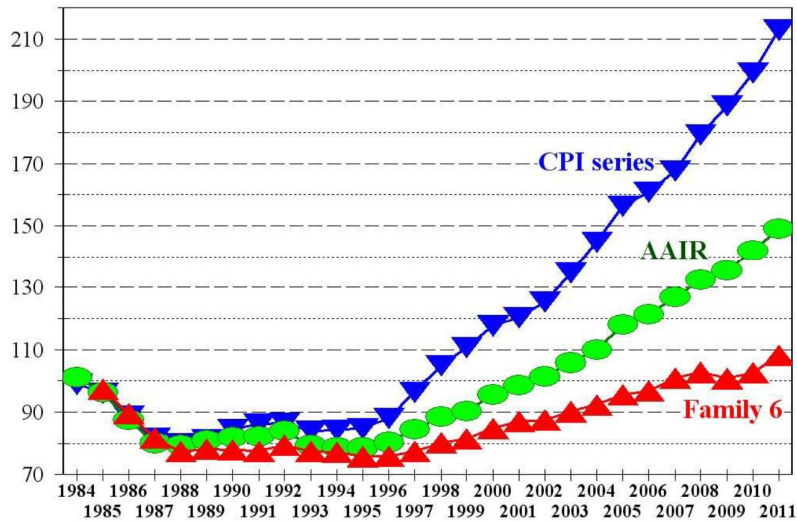
As economies of scale are critical in the automotive industry all manufacturers have tended to limit the number of locations any one model is produced and that model is then cross-shipped to markets where there is demand. This approach initially benefits the manufacturer through reducing costs and ultimately benefits the consumer by improving affordability and increasing product choice.

Australia is a small player with less than 1.5 per cent of the global build sold in this market. Consequently, Australia's ability to influence global design and investment is limited and as individual states are even a smaller proportion of the market and their ability to influence multi-national companies is correspondingly very limited.

It has become much easier to afford a new car since the mid-1990s, as earnings growth has exceeded the movements in motor vehicles prices. Figure A.1 shows the affordability of new passenger cars on three separate indices, CPI motor vehicle index, Australian Automotive Intelligence Report index and an index based on a 'Family 6' car.

³ FCAI, VFACTS National Report, New Vehicle Sales, December 2012.

Figure A.1 - Car Affordability Indexes⁴



Motor vehicles are more technologically advanced today than ever before. While the structural changes in the Australian market, in terms of lower tariffs and more brands, has resulted in significant consumer benefits with improved affordability and choice it has also greatly increased the knowledge base required of repairers. The industry has had to change to compete in this global market place and cannot slow the rate of adoption of these technologies, or limit consumer choice.

The expansion of new and global brands and models into the market has led to the introduction of advanced security, safety and environmental features in motor vehicles. The introduction of these features is in response to increasingly strict environmental regulations and growing demands from consumers for advanced security and safety features.

Vehicle brands face a range of de-facto regulations in the form of safety and environmental star ratings and buyer requirements. They face a range of competitive pressures to continually improve environmental performance and safety standards. For example, more than 40 per cent of passenger vehicle sales are to governments, businesses and/or fleets that frequently require a 5 star ANCAP rating and/or 4 star GVG rating.

⁴ Johns R, 2012, Australian Automotive intelligence 2012 Yearbook.

Vehicles are developed to meet vehicle emission standards with an expectation of fuel quality in a particular market. During the design and durability phases of new model development, the local market fuel parameters need to be specifically considered to ensure the vehicle operates to the expectations of both the owner and manufacturer as well as meeting any regulated CO₂ targets and pollutant emission standards.

Australian Design Rules (ADRs), the regulatory standards for vehicles in Australia, are harmonised with the international UN-ECE Regulations. The ADRs includes the standards and test cycles used to measure CO₂ emissions and air pollutant emissions from vehicles. Harmonisation with the leading international standards provides low barriers to entry for vehicle brands and assists with creating a highly competitive vehicle industry and delivering consumer benefits.

In their recently released Draft Regulatory Impact Analysis: Tier 3 motor Vehicle Emission and Fuel Standards, the US EPA highlights the linkage between fuel quality and vehicle emissions, noting in the opening paragraph that proposed program considers ‘the vehicle and its fuel as an integrated system⁵.’

B1 CO₂ TARGETS

Following the industry’s agreement to the introduction of mandatory CO₂ targets for light vehicles, the Prime Minister announced during the lead up to the 2010 federal election that the starting point for negotiations would be an industry average of 190 gCO₂/km in 2015 and 155 gCO₂/km in 2024. These targets equate to reductions in CO₂ emissions of 14% and 30% by 2015 and 2024 respectively from 2008 levels.

The Australian Government has proposed to mandate CO₂ targets⁶ for light vehicles as part of the Government’s Clean Energy Future Plan:

“In July 2011, the Government announced its Clean Energy Future plan to reduce CO₂ emissions across all sectors of the Australian economy. The Government will achieve this through introducing a carbon price into the Australian economy and through implementing a range of complementary measures.”

In a recent submission⁷ to the Department of Infrastructure and Transport (DoIT), the FCAI noted that as CO₂ emission standards are a complementary measure to the Clean Energy

⁵ United States Environmental Protection Agency, Draft Regulatory Impact Analysis: Tier 3 Motor Vehicle Emission and Fuel Standards, March 2013.

⁶ Australian Government, Department of Infrastructure and Transport, Light vehicle CO₂ emission standards for Australia, Key Issues - Discussion Paper 2011.

⁷ FCAI Submission to the Department of Infrastructure and Transport in response to the Discussion Paper on a new approach to comparing the environmental performance of vehicles on the Green Vehicle Guide.

Future Plan, a whole of Government approach is required to incorporate all associated issues, including fuel quality standards, which have an impact on CO₂ emissions.

B2 AIR POLLUTANT EMISSIONS

The Australian Government has introduced the European (Euro) vehicle emission standards as Australian Design Rule (ADR) 79/03, ADR 79/04 and ADR 79/05. The timetable for implementation of the standards is outlined in Table B2.1 (below).

Table B2.1 Introduction timing of Euro 5 and Euro 6 Emission Standards

Emission Standard		Light petrol, LPG and NG vehicles		Light diesel vehicles	
		New models	All models	New models	All models
Euro 5 (stage 1)	ADR 79/03	1/11/13		1/11/13	
Euro 5 (stage 2)	ADR 79/04		1/11/16		1/11/16
Euro 6	ADR 79/05	1/7/17	1/7/18	1/7/17	1/7/18

The introduction of Euro 5 and Euro 6 are the latest in a series of air pollutant emission standards that have been introduced by the Government. Table B2.2 summarises the pollutant emissions standards that have been introduced since 2003 along with limit values for the measured pollutants.

These are very complex standards, and include a requirement to demonstrate that the vehicle will continue to comply for a prescribed operating life of 160,000km.

The fuel required in the tests to certify a vehicle to the Euro 5 and Euro 6 air pollutant emission standards is 95 RON 10 ppm sulphur petrol. This is a higher standard than the fuel available in the Australian retail fuel market (see Section B3).

Table B2.2 – Summary of Emission Standards⁸

Emission Standard	Introduction timing ⁹	Limit Values (g/km)								
		CO		THC		NOx		THC+NOx		PM
		Petrol	Diesel	Petrol	Diesel	Petrol	Diesel	Petrol	Diesel	Diesel
Euro 2 (ADR 79/00)	2003	2.2	1.0	-	-	-	-	0.5	0.7	0.08
Euro 3 (ADR 79/01)	2005	2.3	0.64	0.20	-	0.15	0.50	-	0.56	0.05
Euro 4 (ADR 79/02)	2008	1.0	0.50	0.10	-	0.08	0.25	-	0.30	0.025
Euro 5 (ADR 79/03)	2013	1.0	0.50	0.10 (0.068)	-	0.06	0.18	-	0.23	0.0045
Euro 6 (ADR 79/05)	2017	1.0	0.50	0.10 (0.068)	-	0.06	0.08	-	0.17	0.0045

B3 FUEL QUALITY STANDARDS

Australia is a relatively small market for most automotive brands, and has a market fuel standard that is of lower quality than the certification fuel for the regulated CO₂ targets and pollutant emission standards.

The Australian Design Rules are harmonised with the UN-ECE Regulations, and more than 80% of vehicles sold in Australia are imported (Attachment A). Consequently, harmonisation

⁸ Extract from “Emission Limits for Light Vehicles (3.5 tonnes GVM) under Un Regulation 83/.. at Euro 2, 3, 4 5 & 6 levels,” www.infrastructure.gov.au [downloaded 5 Nov 2012]

⁹ Introduction timing for ‘new models’ for petrol light vehicles as indicative timing. Full introduction timing is;

Light Petrol, LPG and NG Vehicles;

- Euro 2 adopted in ADR79/00 from 1/1/03 to 1/1/04
- Euro 3 adopted in ADR79/01 from 1/1/05 to 1/1/06
- Euro 4 adopted in ADR79/02 from 1/7/08 to 1/7/10
- Euro 5 adopted in ADR79/03 (Core Euro 5)⁹ from 1/11/13 and ADR79/04 (Full Euro 5) from 1/11/16
- Euro 6 to be adopted in ADR79/05 from 1/7/17 to 1/7/18

Light Diesel Vehicles

- Euro 2 adopted in ADR79/00 from 1/1/02 to 1/1/03
- Euro 3 (never formally adopted)
- Euro 4 adopted in ADR79/019 from 1/1/06 to 1/1/07
- Euro 5 adopted in ADR79/03 (Core Euro 5) from 1/11/13 and ADR79/04 (Full Euro 5) from 1/11/16
- Euro 6 to be adopted in ADR79/05 from 1/7/17 to 1/7/18

of Australian fuel quality standards with the World Wide Fuel Charter¹⁰ (WWFC) and/or European fuel standards is necessary to achieve the improvement in fuel consumption and reduction in pollutant emission outcomes that the Australian Government aims to achieve with CO₂ targets and the introduction of Euro 5 and Euro 6 vehicle emission standards.

The WWFC represents the best collective assessment of fuel quality required for vehicle engines to operate as designed. The data contained in the documents are based on the experience of all major vehicle and engine manufacturers and is intended to promote understanding of the fuel quality needs of motor vehicle technologies. Importantly, the WWFC matches fuel specifications to the needs of engines and emission technologies designed for various major markets.

Table B3.1 – Differences in Petrol Parameters

Parameter	WWFC – Cat 4	EU Fuel Standard	Australian Fuel Standard
Sulphur content	10 ppm (max) all grades	10.0 ppm (from 1 Jan 09)	150 ppm (max) ULP 50 ppm (max) PULP
Olefins	10.0% (max) v/v	18% (max) by volume	18% (max) by volume
Aromatics	35.0% (max) v/v	35.0% (max) v/v	42% pool average over 6 months with a cap of 45%
Research Octane Number		95.0 (min)	91.0 (min) ULP 95.0 (min) PULP
Motor Octane Number	82.5 (min) '91 RON'	85.0 (min) '95 RON'	81.0 (min) ULP 85.0 (min) PULP

As Australia currently has Euro 4 as the minimum regulatory vehicle emission standard and Euro 5 will become the minimum emission standard in 2013, the FCAI considers that Australia is a Category 4 country under the WWFC:

“Markets with further advanced requirements for emission control to enable sophisticated NO_x and particulate matter after-treatment technologies. For example, markets requiring... EURO 4, EURO 5 Heavy Duty, or equivalent emission standards.”

However, the Australian fuel quality standard is of a lower standard than that recommended by the WWFC for Category 4 fuels and also the European fuel standard¹¹.

¹⁰ World Wide Fuel Charter, Fourth Edition, September 2006.

¹¹ Delphi, 2010/2011, Worldwide Emission Standards

The main differences between the current Australian fuel quality standard, the WWFC Category 4 fuel standard and the EU market fuels for petrol and diesel are outlined in Tables B3.1 (above) and B3.2 (following).

Table B3.2 – Differences in Diesel Parameters

Parameter	WWFC – Cat 4	EU Fuel Standard	Australian Fuel Standard
Cetane Index	55.0 (min) (52.0 min when cetane improvers are used)		46 (min)
Cetane Number	55.0 (min)	51 (min)	
Derived Cetane Number (of diesel containing biodiesel)	Meet the relevant WWFC limit.		51.0 (min)
Density	820 kg/m ³ (min)	820 (min) to 845 (max) kg/m ³	820 (min) to 850 (max) kg/m ³
Distillation T95	340°C (max) (or 320°C at T90)	360°C (max)	360°C (max)
Polyaromatic hydrocarbons (PAHs)	2.0% (max) m/m	11% (max) m/m	11% (max) m/m
Flash point	55°C (min)		61.5°C (min)

Tables B3.1 and B3.2 show that the two main areas where Australian fuel quality standards differ from the WWFC Category 4 fuels and also the EU market fuel are:

- Sulphur levels in petrol, and
- Cetane index/number in diesel.

Sulphur in Petrol

Sulphur is a significant contributor to vehicle emissions through reducing the efficiency of catalysts. Reductions in sulphur provide immediate reductions of emissions from catalyst-equipped vehicles on the road. For example, a US study found significant reductions in HC emissions when sulphur is reduced from around 100 ppm to 'low' sulphur fuel (see Figure B3.1 below)¹².

¹² World Wide Fuel Charter, 4th Edn, Technical Background for Harmonised Fuel Recommendations

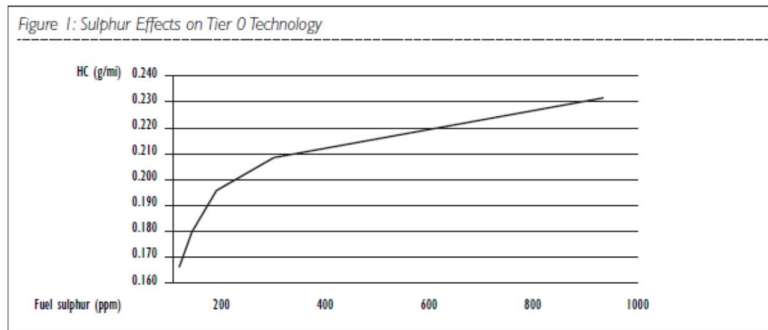


Figure B3.1 - Sulphur Effects on HC Emissions

The importance of sulphur levels in petrol are highlighted by two recent publications;

- Proposed 5th Edition of the World Wide Fuel Charter that includes ‘Category 5: Markets with highly advanced requirements for emission control and fuel efficiency.’ In addition to requiring 10 ppm sulphur petrol for Euro 5/6, Category 5 gasoline requires 10 ppm sulphur for meeting fuel efficiency requirements.
- US EPA Draft Regulatory Impact Analysis: Tier 3 motor Vehicle Emission and Fuel Standards. The US is proposing to move to a test fuel (gasoline) with sulphur levels 8-11 ppm and an in-service fuel (gasoline) standard of 10 ppm sulphur on an annual average basis from 1 January 2017.

Cetane in Diesel Fuel

Cetane is a measure of the compression ignition behaviour of diesel fuel and influences both NOx emissions and fuel consumption. Tests conducted as part of the European Auto-Oil I program¹³ showed:

- Reductions of up to 9% of NOx in heavy duty engines
- An increase in Cetane Number from 50 to 58 resulted in a 26% reduction in both HC and CO emissions in light duty diesel engines
- Increase in cetane (from 50 to 58) also improved fuel consumption at every load level tested.

B4 VEHICLE OPERATION

Reducing the environmental impact of motor vehicles, including reducing CO₂, is a key design input for all manufacturers as part of providing a quality product that meets the expectations of customers.

If appropriate market fuel quality is not available, higher exhaust emissions (both CO₂ and pollutants) will be generated with lower than expected air quality improvements and health outcomes.

Also, vehicle operability and durability issues will be experienced such as:

- Reduced time between regeneration of NOx catalysts leading to increased fuel consumption and reduced catalyst and particulate filter life
- Early activation of malfunction indicator warning lamps (MIL)
- Increased operating and servicing costs.

Impact on fuel consumption (CO₂ targets)

The petrol fuel quality standard is important to achieve the Government's CO₂ emission outcomes through the introduction of new engine and emission technology.

For example, there is a growing inclusion of direct injection gasoline technology to deliver reduced CO₂ emissions (i.e. improved fuel consumption) with the use of lean NOx traps. Sulphur from burnt fuel is stored on the lean NOx trap and high temperature regeneration (running a rich fuel mixture) is required to remove the sulphur. The higher the sulphur level in the fuel, the more frequent regeneration is required, resulting in a higher CO₂ penalty (i.e. increase in fuel consumption), corresponding higher air pollutant emissions and reduced life of the NOx trap.

Early activation of MIL

Both Euro 5 and Euro 6 emission standards introduce additional on-board diagnostic (OBD) requirements. Currently, many brands offer desensitized Euro 5 OBD systems due to the high (i.e. >10 ppm) sulphur levels in Australian petrol. With the introduction of Euro 5 and Euro 6 air pollution emission standards, the full OBD requirements will also be introduced. To successfully operate across their full range, OBD monitors need 10 ppm sulphur petrol¹⁴.

High sulphur petrol can cause loss of catalyst efficiency and increases the level of particulates in direct injection gasoline technology vehicles, resulting in illumination of malfunction indicator lights (MILs) on the vehicle's dashboard. This requires the vehicle to be taken to a service centre to be re-set the MIL.

The negative impact of high sulphur levels in petrol is acknowledged by the United Nations Economic and Social Council, World Forum for Harmonisation of Vehicle Regulations¹⁵:

“Meeting stringent emission regulations, combined with long-life compliance requirements, requires extremely efficient and durable exhaust after-treatment systems. Onboard diagnostic (OBD) systems are increasingly used to ensure that this performance is maintained over the life of the vehicle. The fuel sulphur content will negatively affect the performance of advanced OBD systems.”

¹⁴ World Wide Fuel Charter, 4th Edn, Technical Background for Harmonised Fuel Recommendations

¹⁵ UN-ECE Consolidated Resolution on the Construction of vehicles (R.E.3), 25 January 2012

Increased operating and servicing costs

To meet the increasingly stringent regulatory requirements (e.g. Euro 5 doubles the durability requirement from 80,000 km to 160,000 km, requiring vehicles to continue to meet the full emission standard for 160,000 km) as well as customer expectations, vehicle manufacturers are delivering new technology.

When a vehicle operates on a lower specification fuel, there is a significantly higher servicing requirement that is directly attributable to the high sulphur levels in the petrol. This is a hidden cost to consumers that could average hundreds of dollars per year. The other downside is that manufacturers/importers won't introduce the latest (usually more fuel efficient) engine technology because of incompatibility with Australian fuel.

Also, some FCAI member companies are marketing diesel engine passenger cars that are European specification vehicles. Again there is the risk of reduced performance due to the lower quality market fuel (cetane in diesel in this case).

The potential for degraded performance, operability and durability of some vehicle technologies due to low quality market fuel could lead to reputational damage if the vehicle does not operate as expected. To protect against such damage, some brands may choose instead to restrict from Australia the introduction of new technologies that require higher fuel standards.



Fuel Quality Monitoring Programme

Test Results 2010–11

MEASUREMENT AND
PRODUCT SAFETY SERVICE



**Ministry of Business,
Innovation & Employment**

New Zealand Government

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Executive Summary

The Fuel Quality Monitoring Programme (**the Programme**) has had a successful year and continued to assess the quality of retail fuel in New Zealand and to monitor compliance with the specifications set out in the Engine Fuel Specifications Regulations 2008 (**the Regulations**).

Primarily, the Programme has been established to monitor the quality of the fuel sold by fuel retail companies nationwide. It employs a statistically-based sampling scheme to ensure that an acceptable likelihood of detecting non-compliance is maintained.

The Regulations specify limits on a number of properties for premium and regular petrol grades, diesel and biofuels such as biodiesel and ethanol.

The main focus of the Programme is to sample and test the quality of fuels as they are sold to consumers, i.e. sampling is done from dispenser nozzles at the point of sale. Since 2009, the Programme has expanded to include more sampling and testing of biofuels. The emerging market for biofuel during the time period covered in this report, was being subsidised by government support and a focus of this testing was to give feedback to the fuel producers to improve their production processes before this fuel entered the fuel supply chain.

On the whole, it was found that the large majority of fuel sold in New Zealand was of good quality and compliant with specifications

prescribed in the Regulations. In some instances samples were initially found to be outside specifications but on subsequent investigation and analysis of the results they were found to be within established tolerance limits.

This summary report sets out the results of the Programme run from 1 July 2010 to 30 June 2011. During this period retail fuel samples were collected and tested from 104 of the approximately 1,200 petrol stations in New Zealand. Biofuel samples were also collected and tested from production plants of biofuel producers.

One non-compliant sample detected during the period of this report related to premium petrol where the research octane number on investigation was found to be 94.4 relative to a minimum limit of 95.0.

Another instance of minor non-compliance related to a sample of premium petrol blended with ethanol where the dry vapour pressure on investigation was found to be on the tolerance limit of 73.4 kPa relative to a maximum limit of 72 kPa.

This report details these non-compliant results and summarises the results of routine sampling during the period covered.

For further explanation or to comment on the reported results please contact the Ministry:

Tel: 0508 627 774 or

Email: fuelquality@mca.govt.nz



Introduction

This report sets out the results of the Programme from 1 July 2010 to 30 June 2011.

During this period the FQM Programme was administered and maintained by the Measurement and Product Safety Service (**MAPSS**), an operational unit within the Ministry of Consumer Affairs, which was part of the wider Ministry of Economic Development. In July 2012 MAPSS became part of the Ministry of Business, Innovation and Employment.

The key principles for the Programme were the same as in the two previous years. References to legislation related to engine fuel quality may be found on the Ministry web site¹ or in the similar reports for the previous years.

Collection of fuel samples during this period was carried out by SGS New Zealand Ltd under the direction of MAPSS. The collected samples were then tested by Independent Petroleum Laboratory Ltd and the results subsequently analysed by MAPSS.

Any non-compliance or abnormalities identified through testing were subject to analysis and follow-up investigation by MAPSS. The focus of any investigation is to confirm the validity of the results, identify any potential issues and implement an appropriate and timely response if required. Attention is also given to ensuring the underlying cause of any non-compliance is understood and remedied to prevent recurrence.

The samples were collected from 11 designated regional areas nationwide serviced by specific fuel supply terminals. The samples were taken from various petrol stations according to a plan based on a statistical model which takes into account each retail fuel company's market share in that area.

In total, 104 sample sets were collected from retail sites and each set included samples of regular and premium grade petrol and a sample of diesel.

This year, the number of 'sample sets' collected were relatively lower than the previous two years. To some extent this reflects the fact that tests on additional properties, e.g. flash point of diesel, were added to the routine list of tests. More resources were also allocated to small projects focused on specific issues and testing biofuels.

An additional test on appearance according to ASTM Standard D4176², which is not specified in the Regulations, was added to the routine list of diesel properties tested to enhance MAPSS confidence that water in bulk and/or other contamination, if present, would be identified and categorised.

As a result of collaborative work between MAPSS, the industry and retailers the rate of suspected non-compliances has decreased this year compared to the previous one.

¹ <http://www.consumeraffairs.govt.nz/for-business/by-business-type/for-fuel-industry/acts-and-regulations>

² ASTM Standard D4176 – 04(2009) *Standard Test Method for Free Water and Particulate Contamination in Distillate Fuels (Visual Inspection Procedures)*.

The seasonal and regional distribution of ‘sample sets’ collected is shown in the table below:

Terminal/Month	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Total
Whangarei	1	1	0	1	0	0	1	1	0	0	0	0	5
Auckland	3	4	3	3	3	1	3	3	2	1	1	3	30
Mt Maunganui	2	0	3	2	3	2	0	2	1	0	2	2	19
New Plymouth	0	2	0	0	0	0	0	0	0	1	1	0	4
Napier	1	0	0	0	0	1	1	0	0	0	1	0	4
Wellington	2	0	0	1	1	0	3	0	2	0	2	1	12
Nelson	0	1	1	0	0	0	0	0	0	2	0	0	4
Lyttleton	2	2	1	0	1	3	0	0	1	0	0	1	11
Timaru	0	1	0	1	0	0	0	1	1	0	1	0	5
Dunedin	1	1	0	0	0	1	0	1	1	1	0	0	6
Bluff	0	0	0	0	0	0	0	0	0	3	0	1	4
Total	12	12	8	8	8	8	8	8	8	8	8	8	104

The results of subsequent testing and analysis of these ‘sample sets’ have been reported in accordance to their relevant specification limits set out in the Regulations. Testing tolerance limits were derived according to the ISO Standard 4259³ as described in previous annual test result reports.

The non-retail market of biofuels is emerging in New Zealand and the Programme has identified a number of areas for improvement of the quality of biodiesel and ethanol blended petrol. This information has been provided directly to the relevant industry stakeholders.

In this report, the anonymity of the source of the samples is maintained due to the commercial sensitivity of this information.

This report is the third one since the Regulations came into force on 1 July 2008 and follows the report issued by the Ministry for the year 2009-10.

On the whole, the Programme has confirmed that throughout the year the retail fuel supplied in New Zealand was of good quality, fit for purpose and compliant with the performance and quality specifications prescribed in the Regulations.

Engine Fuel Specifications Regulations 2011 came into force on 1 December 2011 and changed some of the fuel specifications. These changes are outside the period covered by this report.

³ ISO 4259:2006 *Petroleum products – Determination and application of precision data in relation to methods of test.*



Petrol

Research Octane Number (RON) and Motor Octane Number (MON)

RON 91

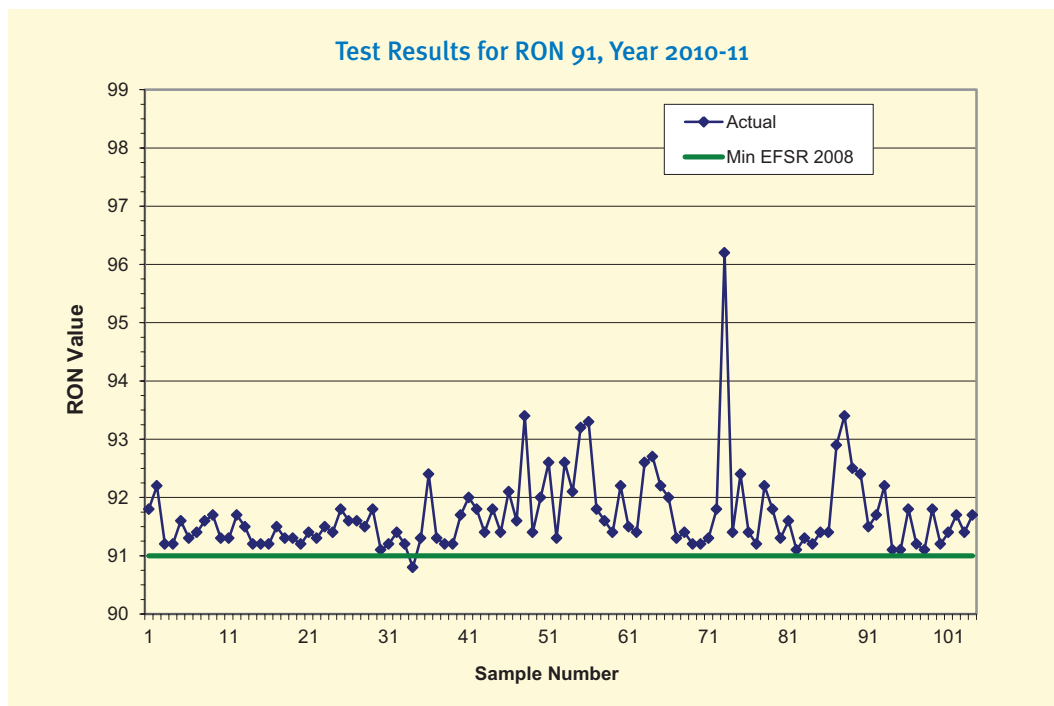
In total, 104 samples of regular petrol were collected and tested. Fig. 1a and 1b below show the testing results for RON and MON respectively.

All samples except one were found to be above the minimum specification limit of 91.0 for RON.

Sample 34 with testing results for RON of 90.8, was found to be below the specification limit but within the testing tolerance limit of 90.6. Since the deviation from the prescribed limit was not significant the sample, according to the established policy, was treated as compliant. The respective figure for MON was compliant: 82.8.

Fig. 1a

Here and below: the legend 'EFSR 2008' means the specification limit prescribed in the Regulations; each result is independent from others although they are connected in the graphs for convenience to follow.



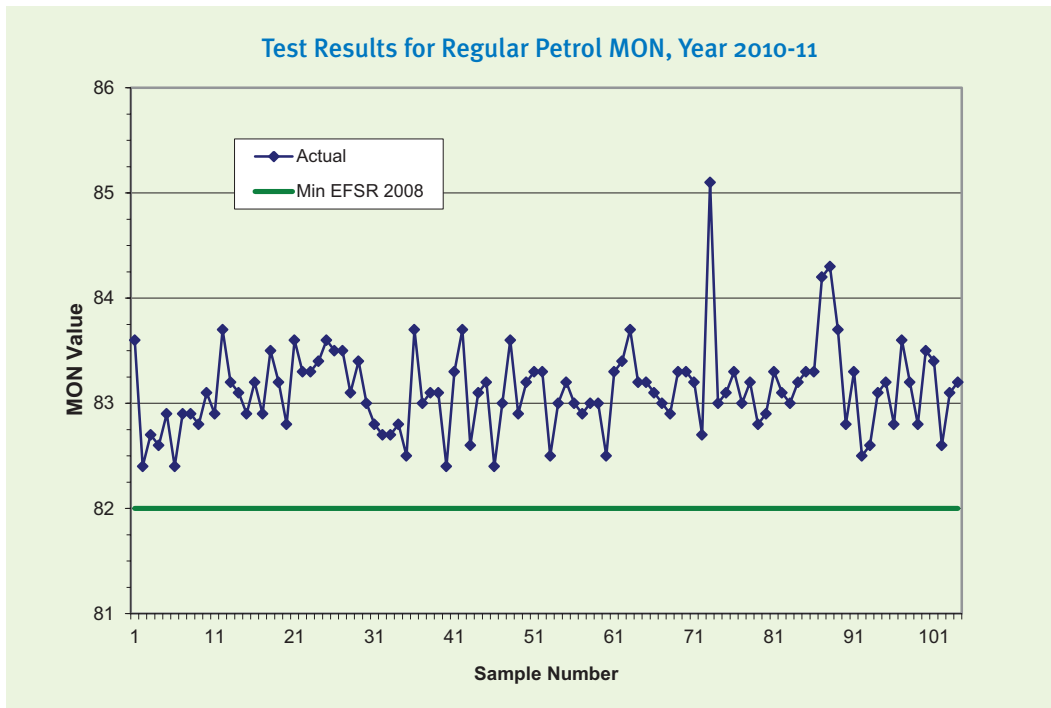


Sample 73 was found to be high on RON and MON with results, respectively, of 96.2 and 85.1. Although the presence of ethanol should have enhanced both RON and MON, it is believed that this was the result of a misdelivery of RON 95 petrol into a storage

tank for RON 91. No deterioration of the product quality is expected after blending high octane petrol into petrol with a lower octane.

All samples were found to be above the minimum specification limit of 82.0 for MON.

Fig. 1b



RON 95

In total, 86 samples of premium grade petrol with RON 95, were collected and tested. Fig. 2a and 2b below show the testing results for RON and MON respectively.

Six samples were found to be on the minimum specification limit of 95.0 for RON.

Sample 69 was found to be below the specification limit with testing results for RON of 94.4 and below the testing tolerance limit of 94.6. When repeated twice by a different operator the test returned the figures of 94.4 and, again, 94.4 which means the average was 94.4 and the repeatability condition satisfied, with $r = 0.2$ O.N. for the two repeated tests. The reproducibility condition, $R = 0.7$ O.N., was also satisfied for the initial test compared to the average of the repeated two. Since the average of the repeated two was also found to be below the tolerance limit, the result was treated as non-compliant.

An investigation was conducted in collaboration with the fuel retail company

involved and possible causes for the lower RON were considered. Through comparison of product properties at other sites where the same product was delivered at approximately the same period of time, as well as through data on product delivery reconciliation at the site in question, it was concluded that the most likely cause of the low RON was an unsolicited discharge of a modest amount of diesel into the storage tank for premium petrol.

There were no complaints at the time of the suspect sample collection in the region. Another sample at the same site taken by the retailer three weeks later returned a result for RON of 95.5.

All samples except one were found to have MON on or above the minimum specification limit of 85.0 for premium petrol. The exception was Sample 52 with MON of 84.9 which is well within the test tolerance limit i.e. above 84.6. The relevant figure for RON was well above the minimum limit.

Fig. 2a

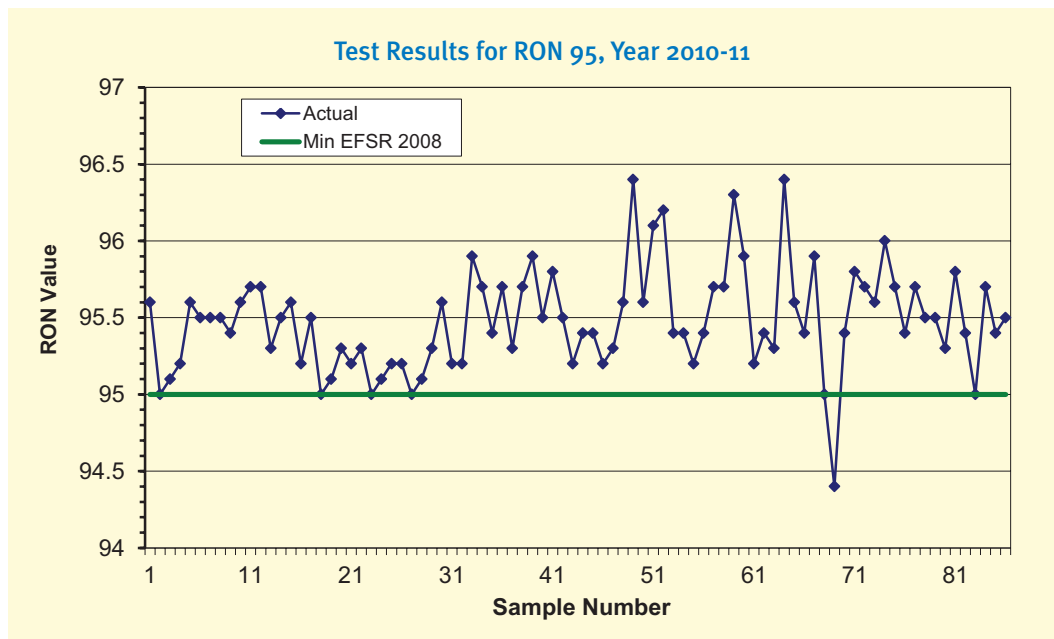
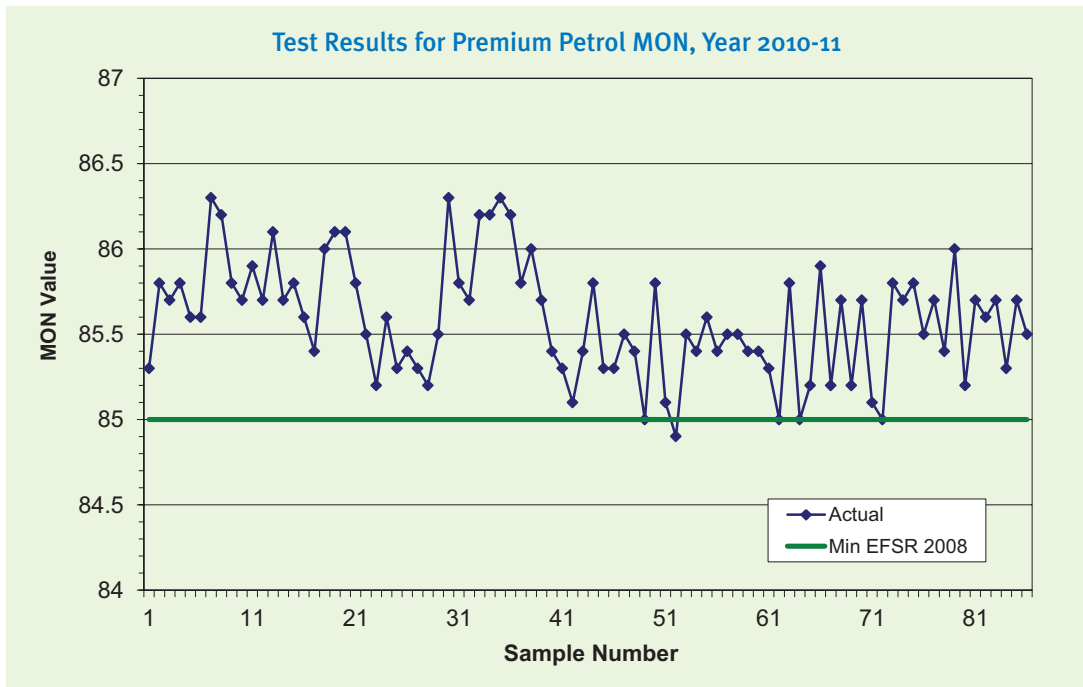




Fig. 2b



RON 98

No minimum value is specified in the Regulations for premium petrol with RON 98. In this circumstance an “advertised minimum” is referred to in Fig. 3a which is enforceable under the provisions of the Fair Trading Act 1986 in relation to misdescription. Under this approach it is also deemed that the actual figures of RON must not be lower than 95.

For premium petrol with RON 98, a minimum limit for MON is neither specified in the Regulations nor advertised. In the absence of a specified minimum limit for MON the limit for premium petrol has been used as a benchmark.

In total, 18 samples of petrol with RON 98 were collected and tested. Fig. 3a and 3b below show the testing results for RON and MON respectively.

All samples with the advertised RON of 98 were found to be above the advertised minimum limit.

All samples were found to have MON above the specification limit of 85 for premium petrol.

Fig. 3a

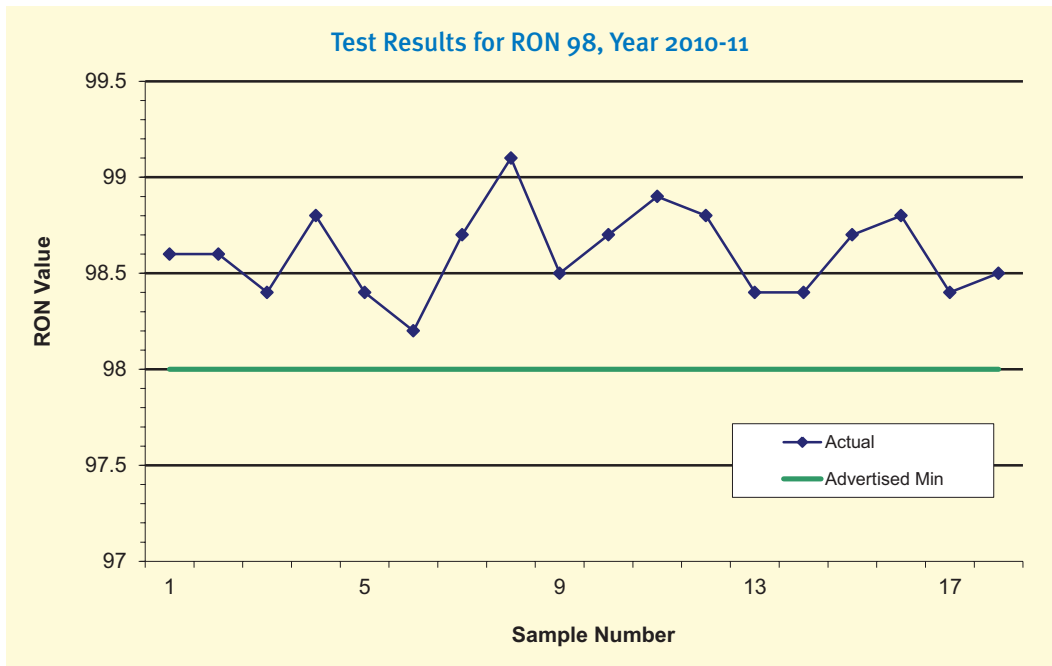
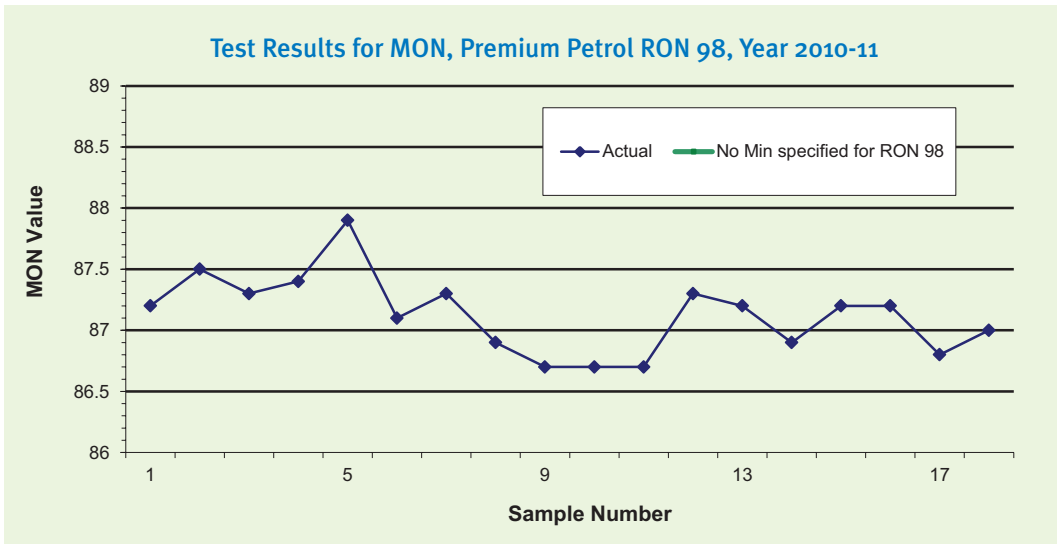


Fig. 3b





Evaporation Percentage

There are three categories for evaporation percentage limits in the Regulations: E70, E100 and E150. These categories are analysed below separately for regular petrol (RON 91) and for premium petrol (RON 95 incl. that with RON 98).

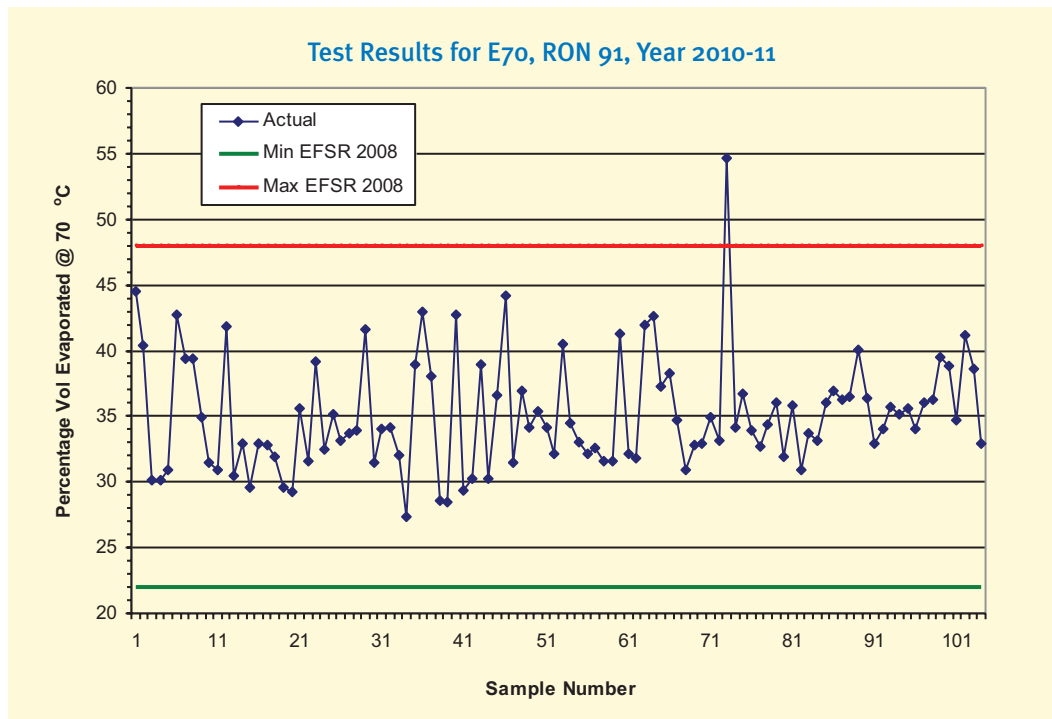
54.7%. According to the Regulations (Footnote 1 in Schedule 1), the E70 maximum is increased by 1% per 1% volume ethanol in the blend therefore when the ethanol content was found to be 9.68% (i.e. approximately 10%), the prescribed limit was calculated as 58% and the result was within this limit.

RON 91

Percentage Volume Evaporated @ 70°C

Sample 73 was found to be within the maximum specification limit established for ethanol blends with the testing result of

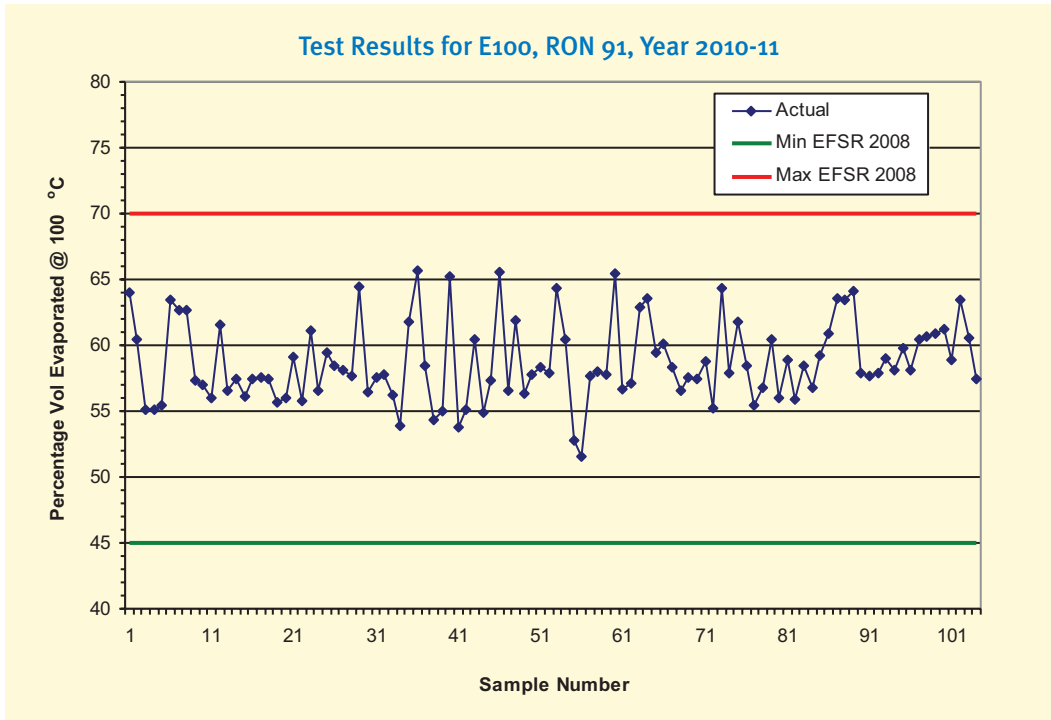
Fig. 4a



Percentage Volume Evaporated @ 100°C

All samples were found to be well within the specification limits from 45% to 70%.

Fig. 4b



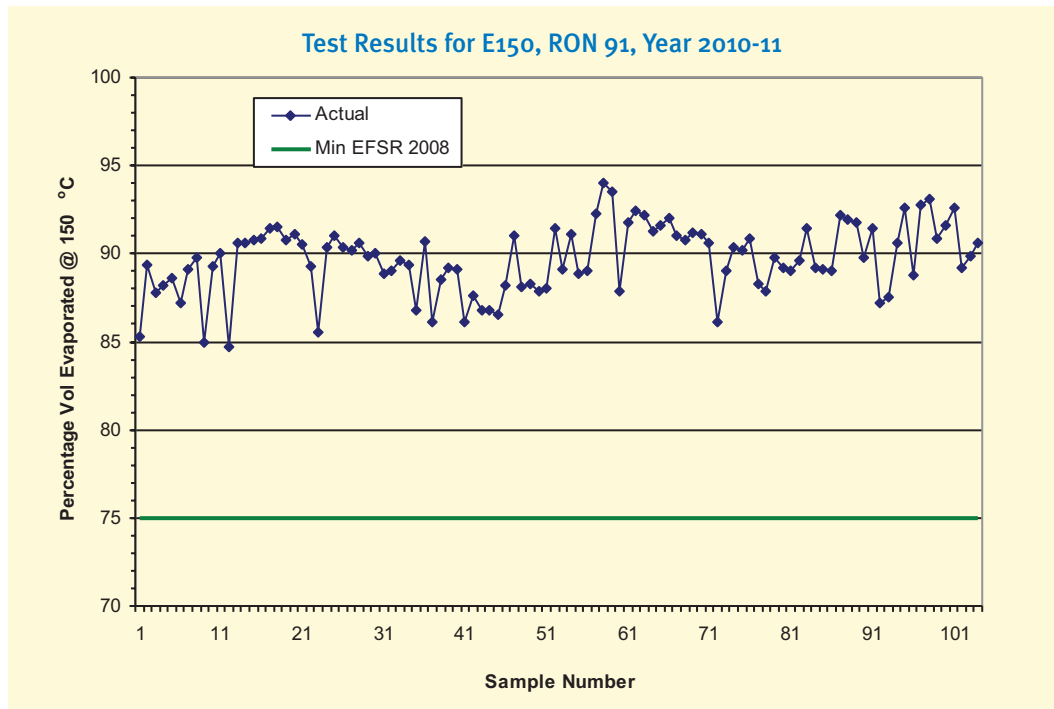


Percentage Volume Evaporated @ 150°C

All samples were found to be above the minimum specification limit of 75%.

No maximum is prescribed by the Regulations for this parameter.

Fig. 4c



RON 95

Percentage Volume Evaporated @ 70°C

The majority of results were found to be within the specification limits of 22% to 48% with the exception of a number of ethanol blends. According to the Regulations (Footnote 1 in Schedule 1), the maximum percentage of volume evaporation at 70°C (E70) is increased by 1% per each 1% volume ethanol in the blend.

All results for samples with ethanol, are set out in a Table below. They were all found to be within the prescribed limits for ethanol blends.

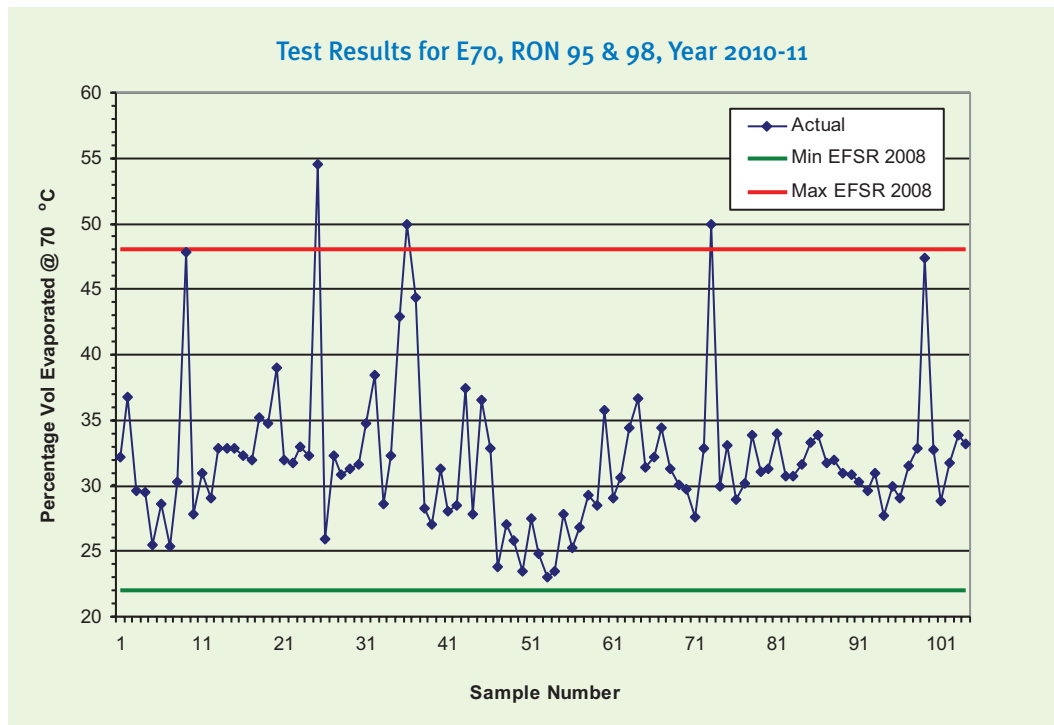
Table 1

Sample	Ethanol Content % Vol	Limit for Ethanol Blend % Vol	Percentage Volume Evaporated @°C
9	9.32	57	47.8
25	9.42	57	54.5
36	9.09	57	50.0
73	9.34	57	50.0
99	9.46	57	47.4

Sample 25 was found to have the largest figure for E70 at the ethanol content of 9.42% i.e. approximately 9%, which corresponds to the requirement for ethanol blends and a maximum limit of evaporation of 57%. The result in this case of 54.5% was within this limit.

A few samples in a range from 47 to 56 were found to be most close to the minimum limit of 22% with actual figures down to 23.0%. These results did correlate with a similar variation in the same range for E70 but have no correlation in the range for E150. The samples were pure premium petrol not ethanol blends.

Fig. 5a



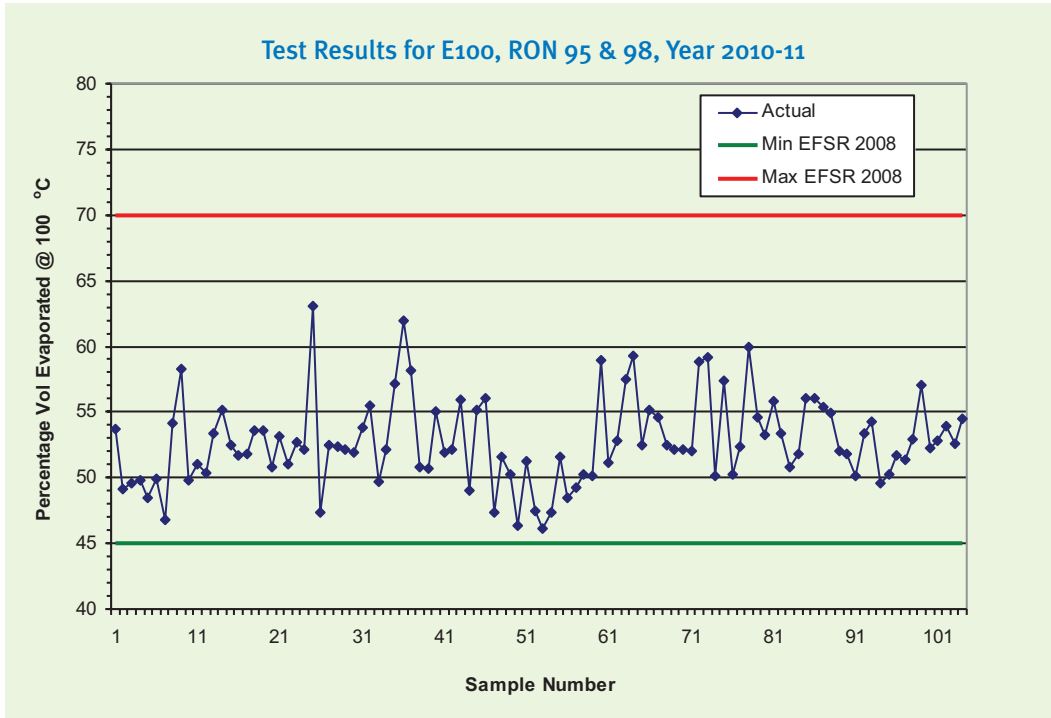


Percentage Volume Evaporated @ 100°C

All samples were found to be within the specification limits from 45% to 70%.

The largest figure for E100 of 63.1% which was found for Sample 25, corresponds to that for E70.

Fig. 5b

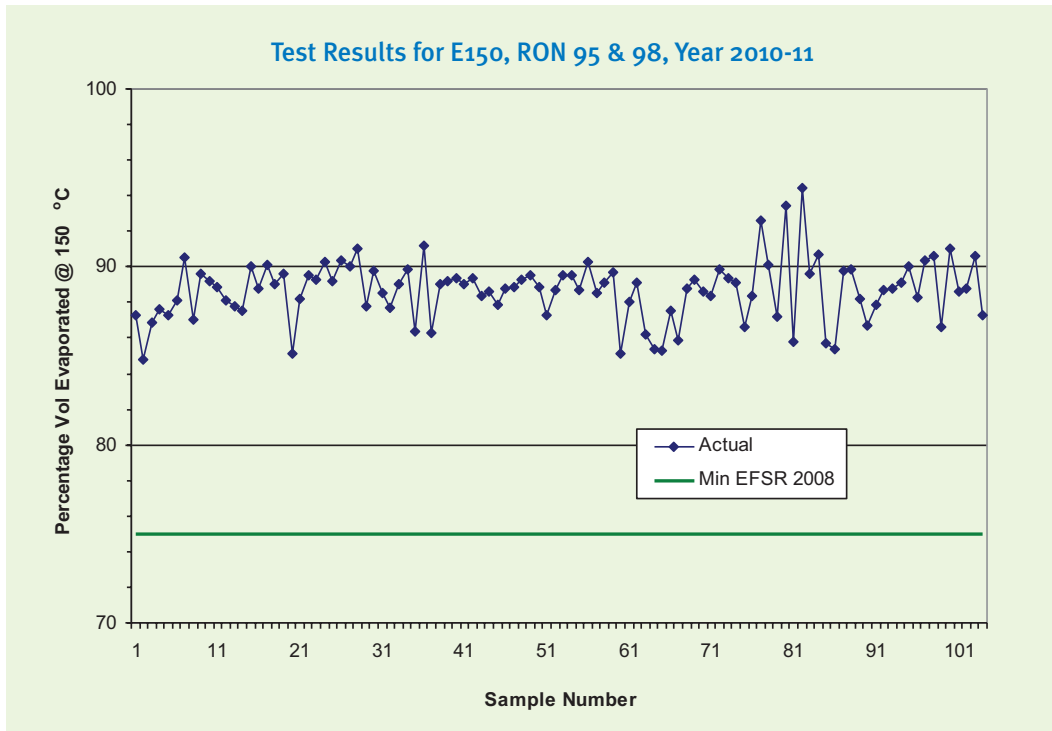


Percentage Volume Evaporated @ 150°C

All samples were found to be above the minimum specification limit of 75%.

No maximum is prescribed by the Regulations for this parameter. All samples were found to be well above 80% (Fig. 5c).

Fig. 5c



Final Boiling Point

All samples were found to be within the specification maximum limits for both regular and premium grades (Fig.6).

nor the next largest result of 205.6°C which was found for sample 72, corresponded to any special variation in other parameters.

The largest figure for final boiling point of 206.0°C was found for Sample 78. Neither this



Fig. 6a

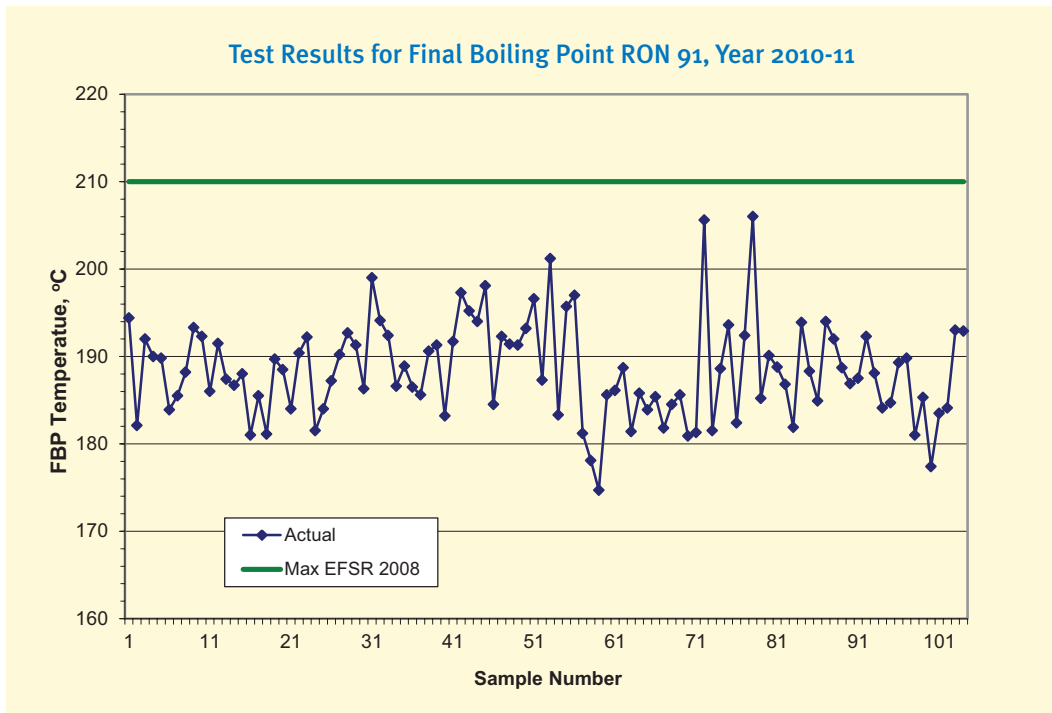
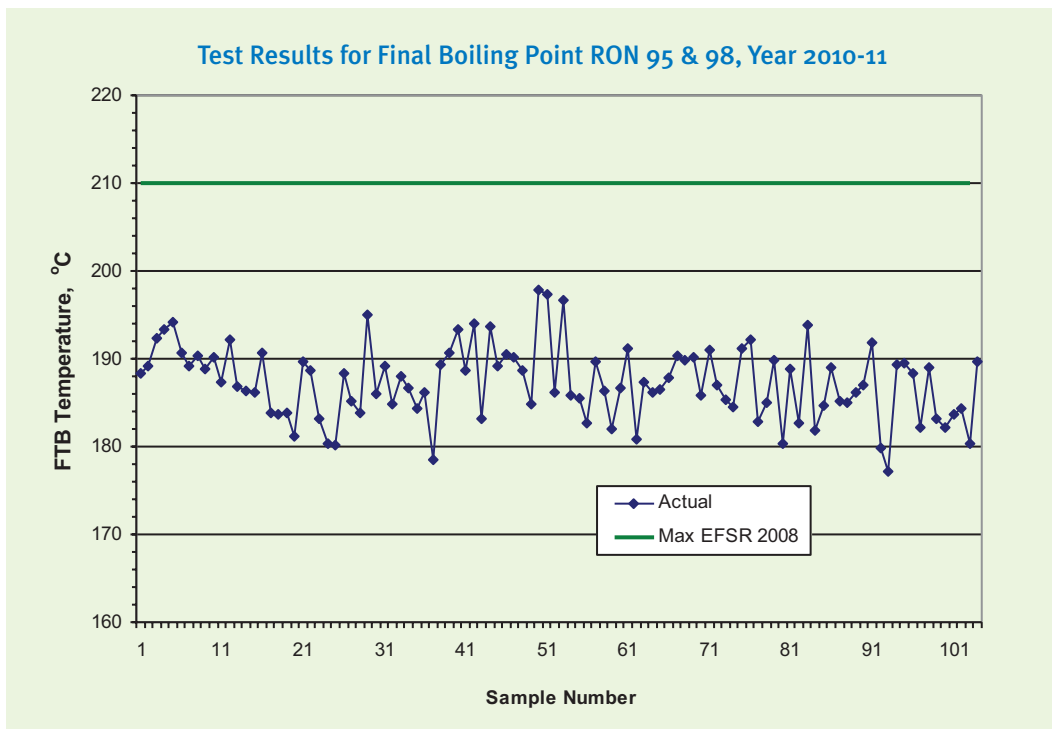


Fig. 6b



Residue

All samples were found to be well within the limits for both regular and premium grades (Fig. 7).

Fig. 7a

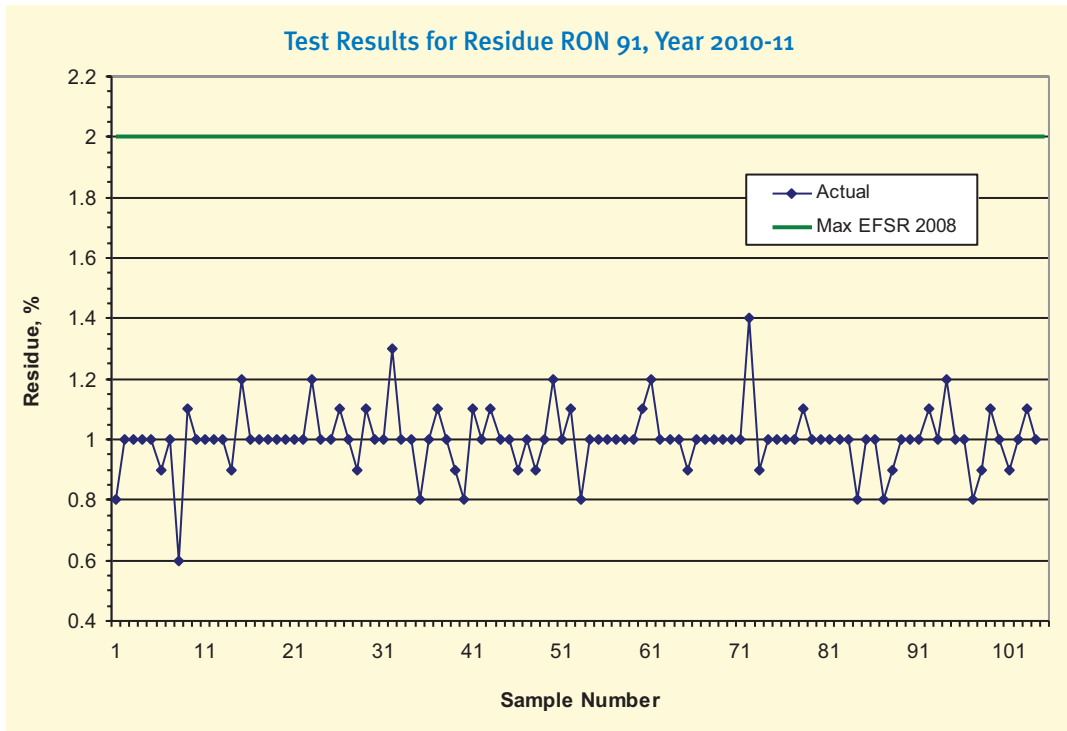
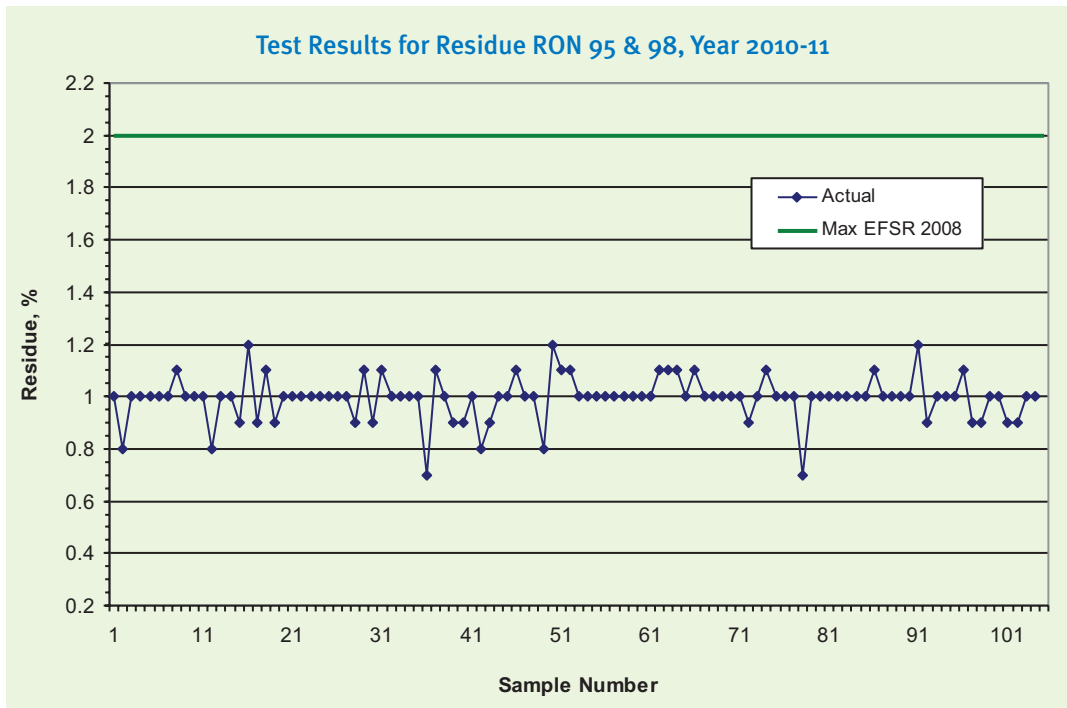


Fig. 7b





Dry Vapour Pressure Equivalent

All samples tested for Dry Vapour Pressure Equivalent (DVPE) were found to be above the prescribed minimum limit of 45 kPa.

The cumulative results for the maximum limit are presented below in a simplified way by combining the lowest prescribed maximum limits for all seasons in one graph. Generally, if results were below the lowest maximum limit established for an area then they definitely complied with the Regulations in all other areas.

For the period of summer in Schedule 1 (season definitions in Regulation 5, the Regulations) from 1 December to 31 March inclusive, the lowest maximum limit of pressure 65 kPa is prescribed for Auckland and Northland. This is shown on the Fig. 8 by a square dip.

The top line before and after the dip, is the next lowest maximum, 80 kPa, which is prescribed for the rest of North Island, for the autumn and spring periods.

The maximum limits prescribed for winter in all three designated regions are equal to or above 90 kPa and not shown in the graph.

Each sample within the relevant season which appeared to be above the lowest 'maximum limit' line was individually analysed.

RON 91

In various periods except summer season, only three samples were initially found to be above the lowest maximum at the time.

Of those three, Sample 25 was initially found to be 81.3 kPa which is above the specification limit of 80 kPa for the rest of North Island during the spring season. On investigation, Sample 25 was found to be under the tolerance limit of 81.4 kPa and should be treated as compliant; further it was found to contain oxygenates but ethanol content was below 1% therefore Footnote 3, Schedule 1 of the Regulations does not apply.

Samples 99 and 100, collected in winter, were found to be within their regional specification limits. In particular, Sample 99 with a figure of 86.4 kPa was found to be below the limit of 90 kPa for the rest of North Island. Respectively, Sample 100 with a figure of 81.2 kPa was well below the maximum limit of 95 kPa for South Island.

Further, there were a number of samples found to be above the lowest maximum in the summer period.

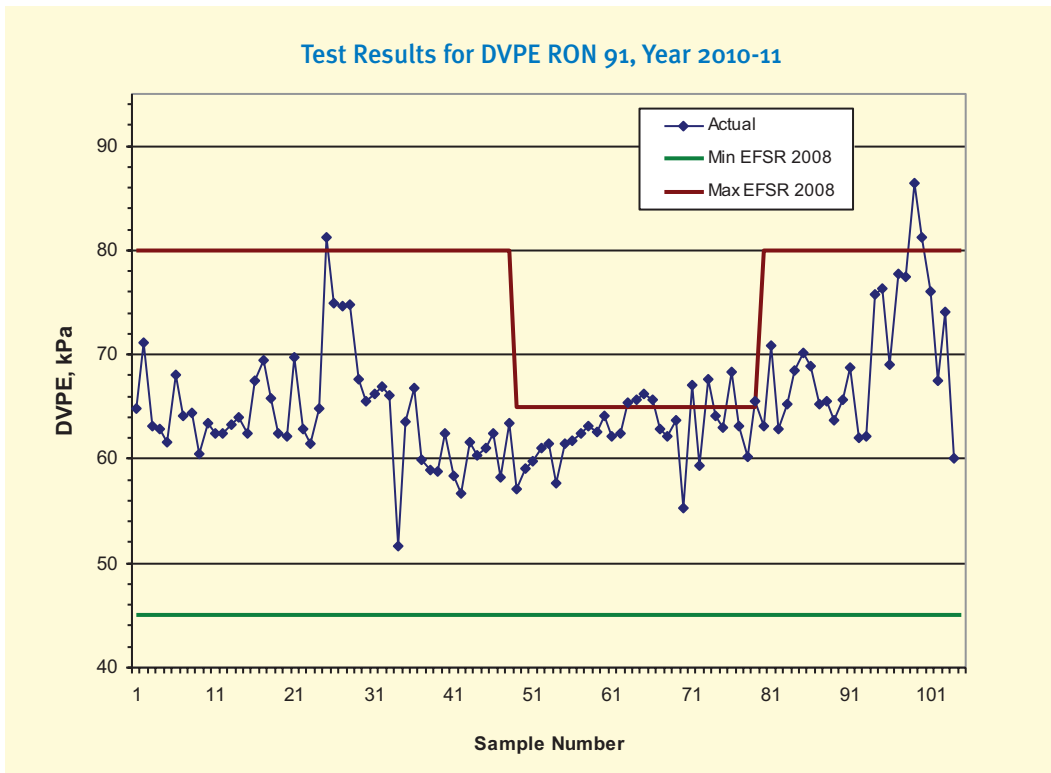
Samples: 63 and 64, which were found to be, respectively, 65.4 and 65.7 kPa, both were from the rest of North Island and within the maximum limit of 70 kPa for summer.

Samples: 65, 66, 71, and 76, which were found to be in a range from 65.7 to 68.3 kPa, were from South Island and well within the maximum limit of 75 kPa for summer.

Finally, Sample 73 was found to contain ethanol, 9.68% (see also section on E70 above). Therefore, according to a condition in

the Regulations (Footnote 3, Schedule 1) the maximum limit for this sample is 72 kPa in the Auckland and Northland region, summer season. Sample 73 was found to be 67.7 kPa i.e. within the maximum limit for ethanol blend in the region.

Fig. 8a





RON 95

There were only six samples that were initially found to be above the lowest maximum at the time.

Samples 25 and 73 were ethanol blends (see Table 1 above).

Respectively, Sample 25 was found to be 80.9 kPa i.e. well within the maximum limit of 87 kPa for ethanol blends in the rest of North Island, spring season.

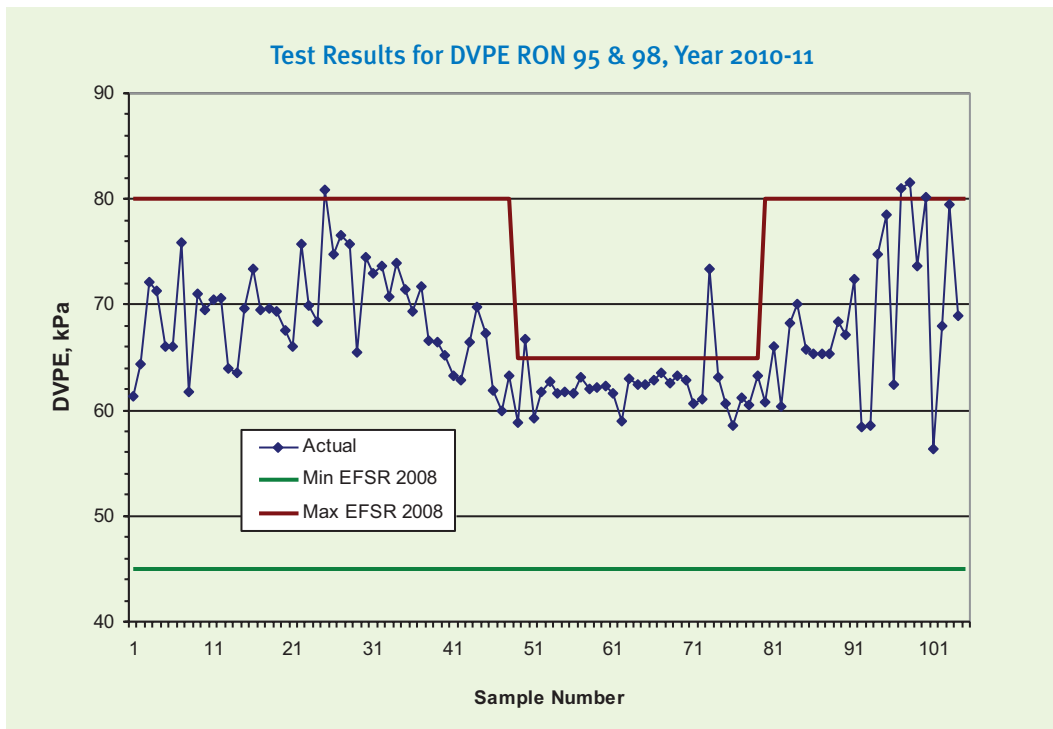
Sample 73 was found to be 73.4 kPa, collected in the Auckland and Northland region, during summer season. Therefore, according to a condition in the Regulations (Footnote 3,

Schedule 1) the maximum limit for this sample is 72 kPa. Since the actual result was found to be right on the tolerance limit of 73.4 kPa it was treated as marginally non-compliant.

Samples 50, collected in South Island, summer season, was found to be 66.7 kPa, which is well within the regional maximum limit of 75 kPa.

Samples: 97, 98, and 100, which were found to be in a range from 80.2 to 81.6 kPa, were all well below their respective maximum limits for winter, 90 kPa for North Island and 95 kPa for South Island.

Fig. 8b



Flexible Volatility Index

The Flexible Volatility Index (FVI) is a derived parameter which is calculated from the measured value of DVPE (see above) and the value of E70, as

$$FVI = DVPE + (0.7 \times E70)$$

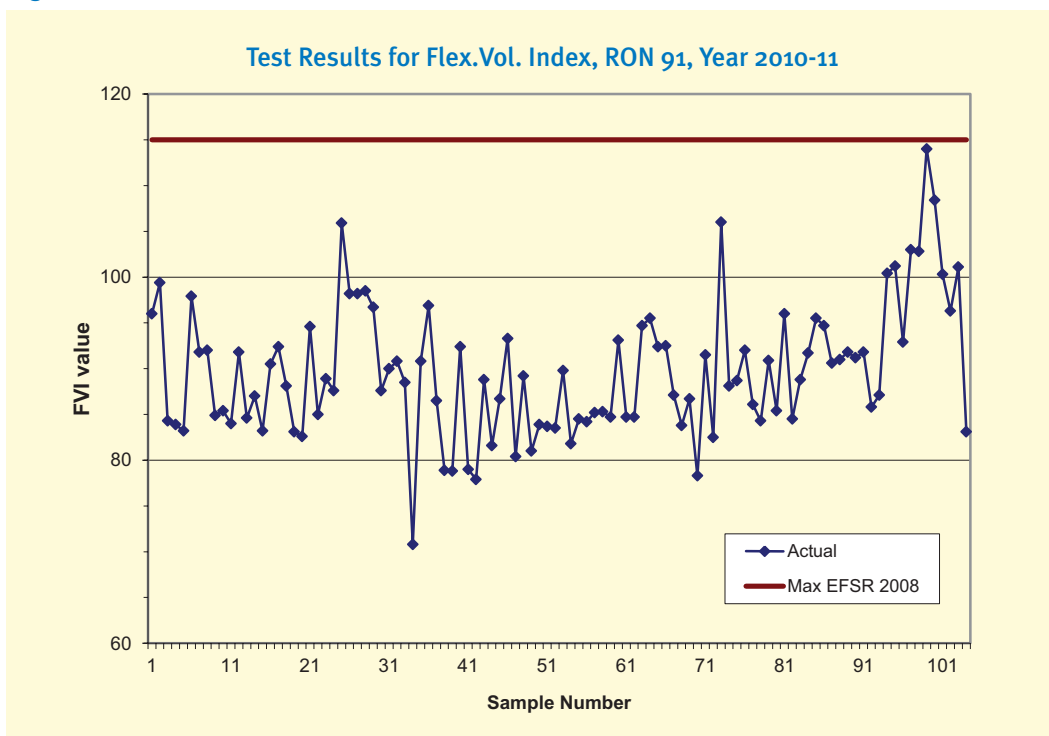
FVI serves as an indicator of the fuel's hot running performance (the tendency for vapour lock). No definition of the FVI value is given in the related ASTM Standards prescribed in the Regulations (D86 and D5191) and no reproducibility value is identified. As a result of this the FVI serves only as a helpful indicator but cannot be used in a strict compliance analysis.

RON 91

All samples were found to be within the prescribed maximum limit.

Only Sample 99 was found to be the closest to the specified limit with the result of 114.0.

Fig. 8c



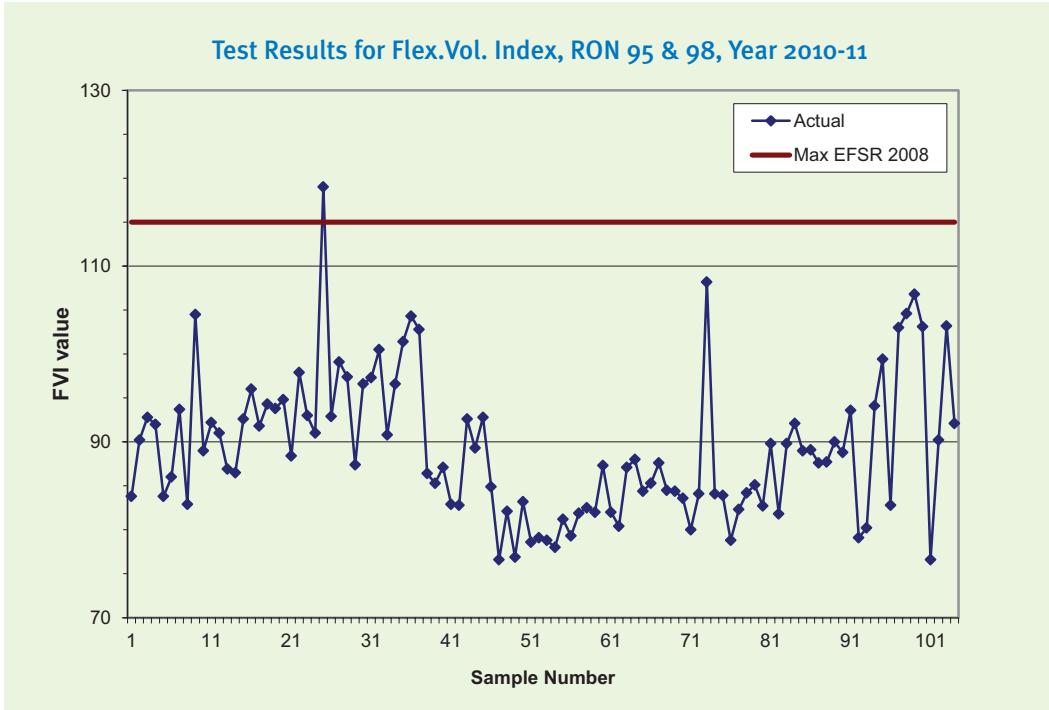


RON 95

Sample 25 was found to be within the specified limit of 120.0 for premium grade petrol blended with ethanol (in this case, 9.42% blend) for spring (Footnote 2,

Schedule 1 of the Regulations), with the testing result of 119.0. The enhanced figure of FVI correlates with the enhanced figures for E70 (Fig.5a) and DVPE (Fig. 8b).

Fig. 8d



Sulphur

Results are set out in a logarithmic scale since there were several results found to be below the test method threshold of 5 mg/kg but the actual figures were not determined.

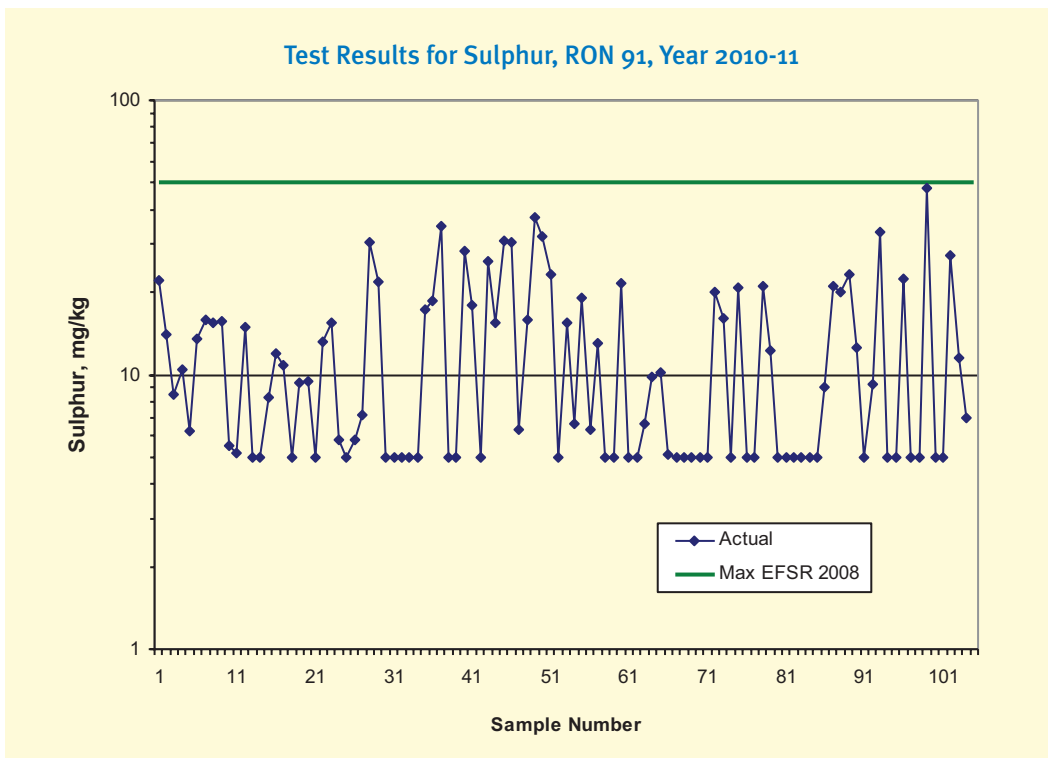
Accordingly, the lowest line of testing results is 5 mg/kg where the actual figures were found to be on or below this indicative level at the maximum limit of 50 mg/kg.

RON 91

All samples for regular petrol were found to be within the prescribed maximum limit.

The majority of the results were between 5 and 40 mg/kg. Only Sample 99 was found to exceed 40 mg/kg with the actual figure 47.9 mg/kg.

Fig. 9a



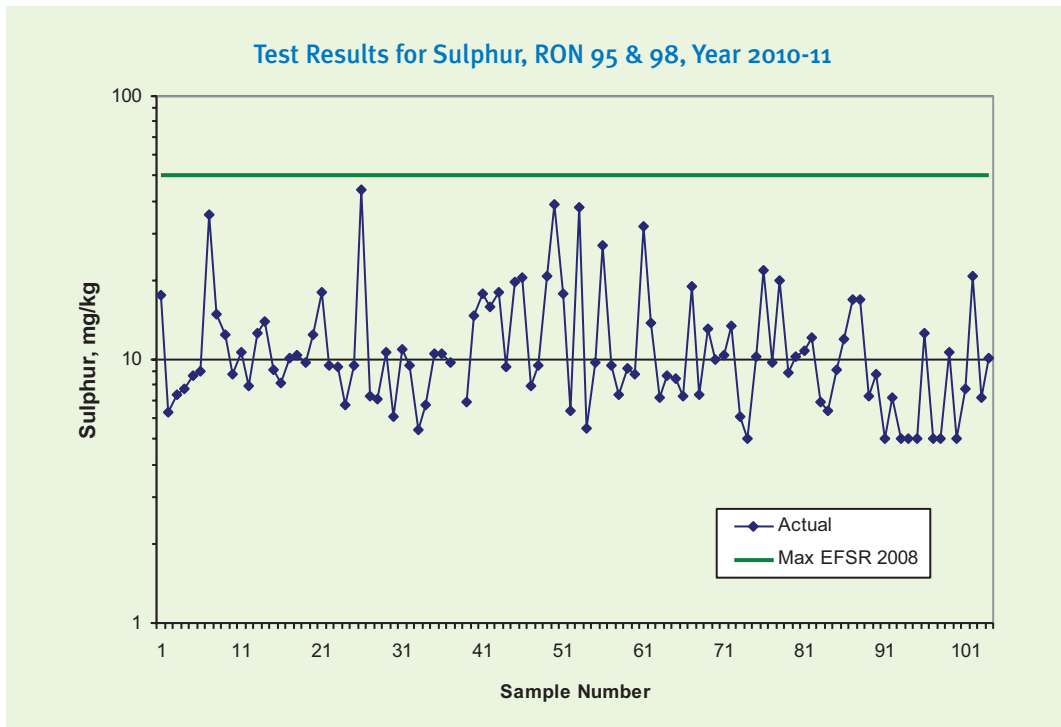


RON 95

All results for premium petrol were found to be within the prescribed maximum limit.

Only Sample 26 was found to exceed 40 mg/kg, with the testing result of 44.1 mg/kg.

Fig. 9b

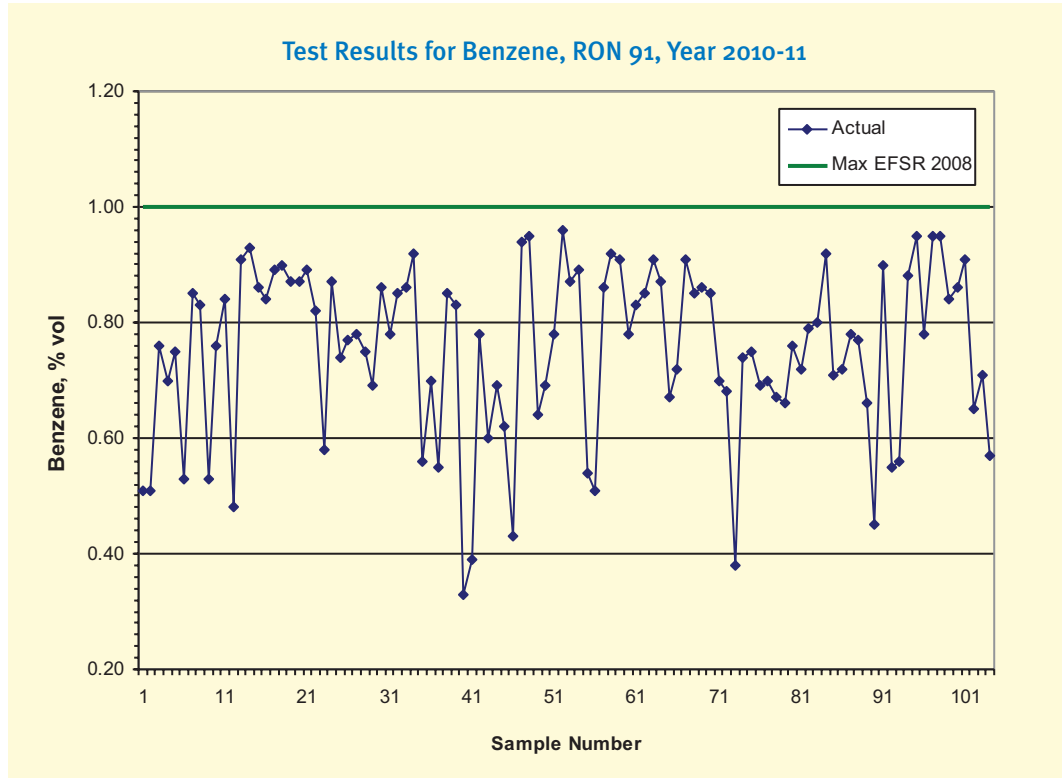


Benzene and Total Aromatics

All samples were found to be within the prescribed maximum limits, for both benzene

(maximum 1% vol) and total aromatic compounds (45% vol maximum cap).

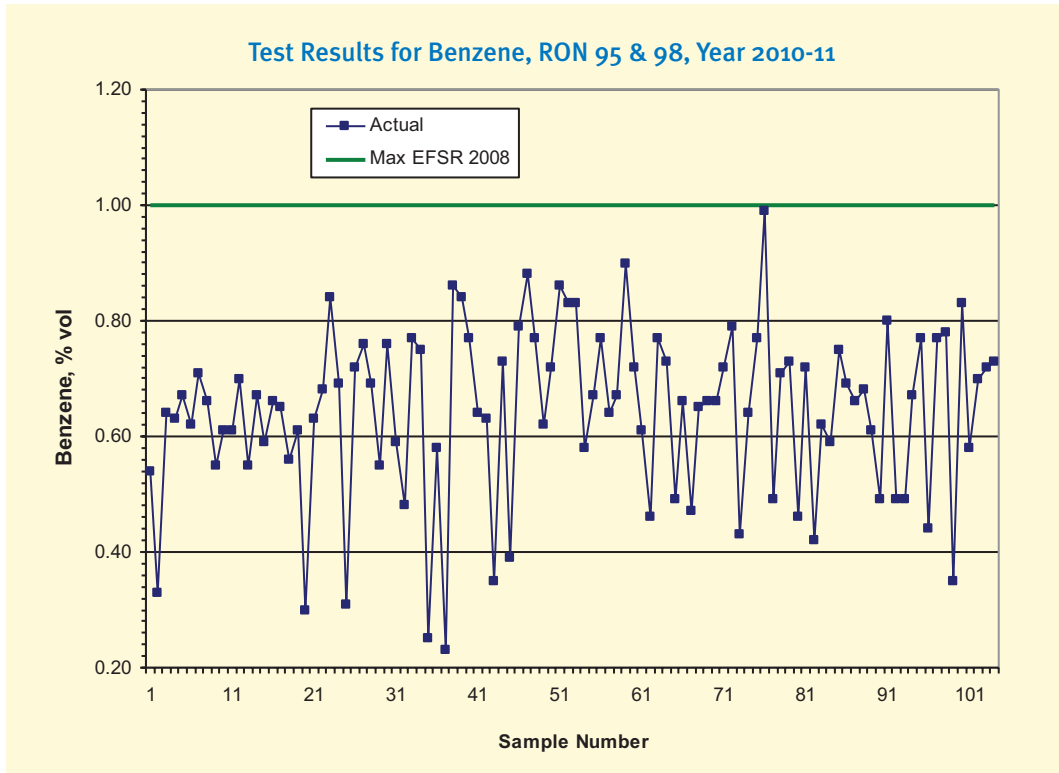
Fig. 10a





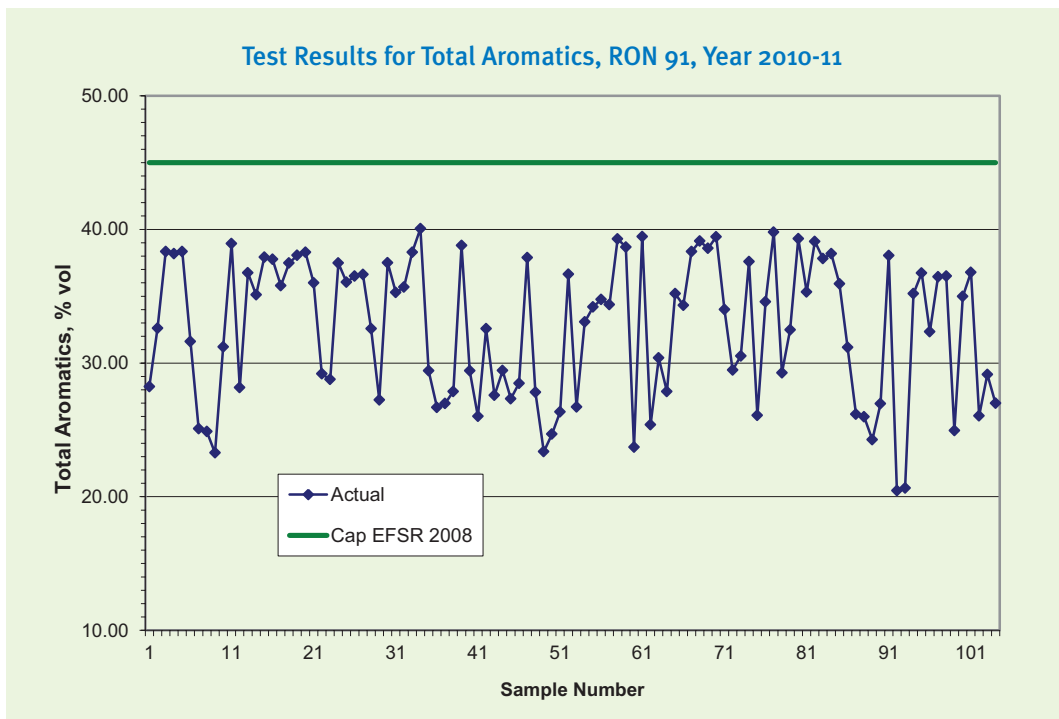
For premium petrol, the majority of the results on benzene were below 0.90%. Only Sample 76 was found to exceed this with the actual figure of 0.99% (Fig. 10b).

Fig. 10b



For RON 91, all results on total aromatics were found to be below 40% (Fig. 10c).

Fig. 10c



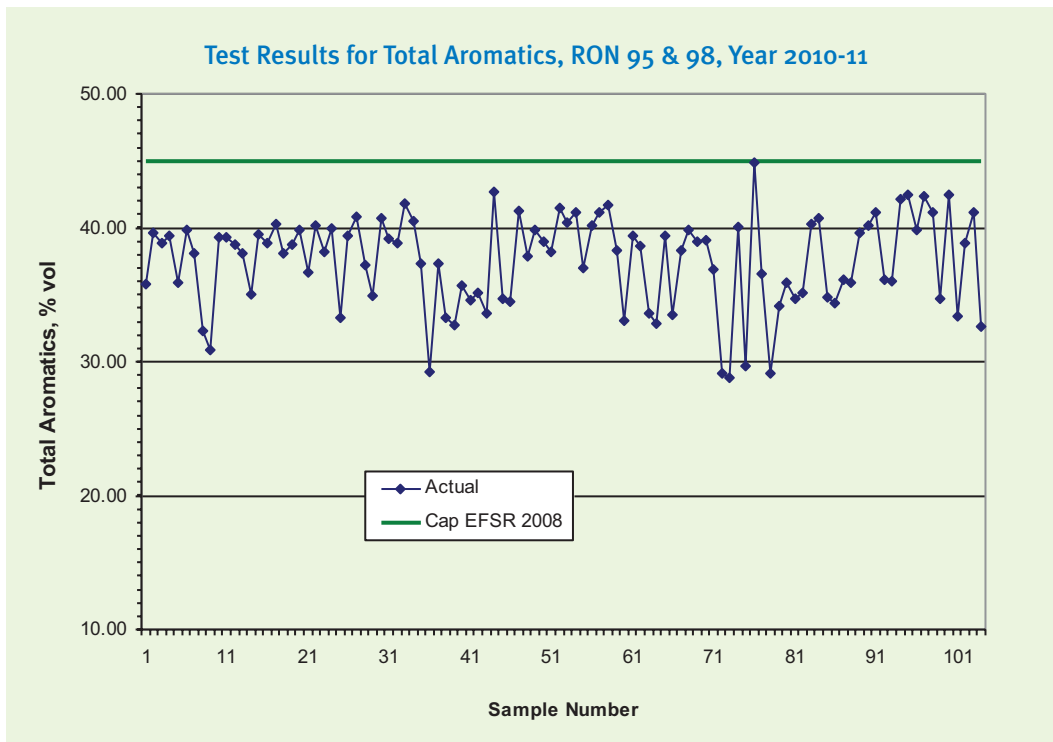
For premium petrol, the largest result on total aromatics was found to be 44.87% for Sample 76 (Fig. 10d). This relatively high figure for total aromatics correlates with that for benzene which for Sample 76 was found to be 0.99% (Fig. 10b). Still, both parameters were within the prescribed limits and no investigation was required.

According to Regulation 19 of the Regulations, actual amounts of petrol which were produced

or imported, must be accounted, to calculate 'pool average' figures for the total aromatic compounds for each calendar month.

Data on 'pool average' were collected from all five fuel retail companies and from The New Zealand Refining Company Ltd. The actual results were found to be within the required limits. Due to the commercial sensitivity of the calculation process, the actual results were not included in this report.

Fig. 10d



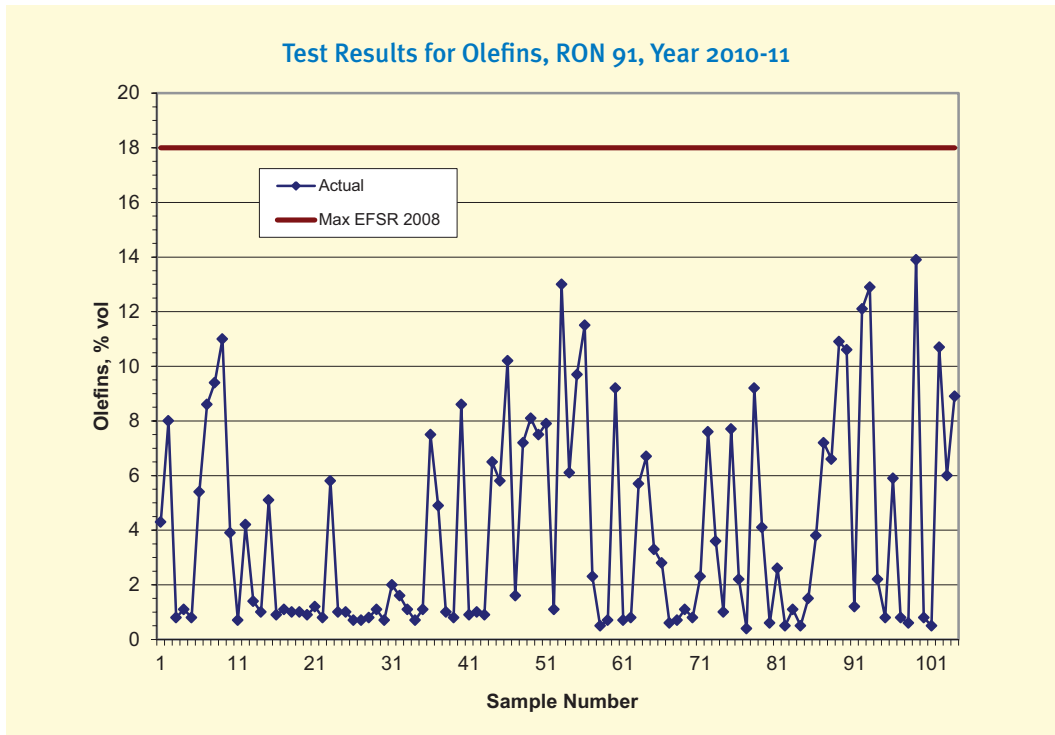


Olefins

All samples were found to be within the prescribed maximum limit of 18% vol.

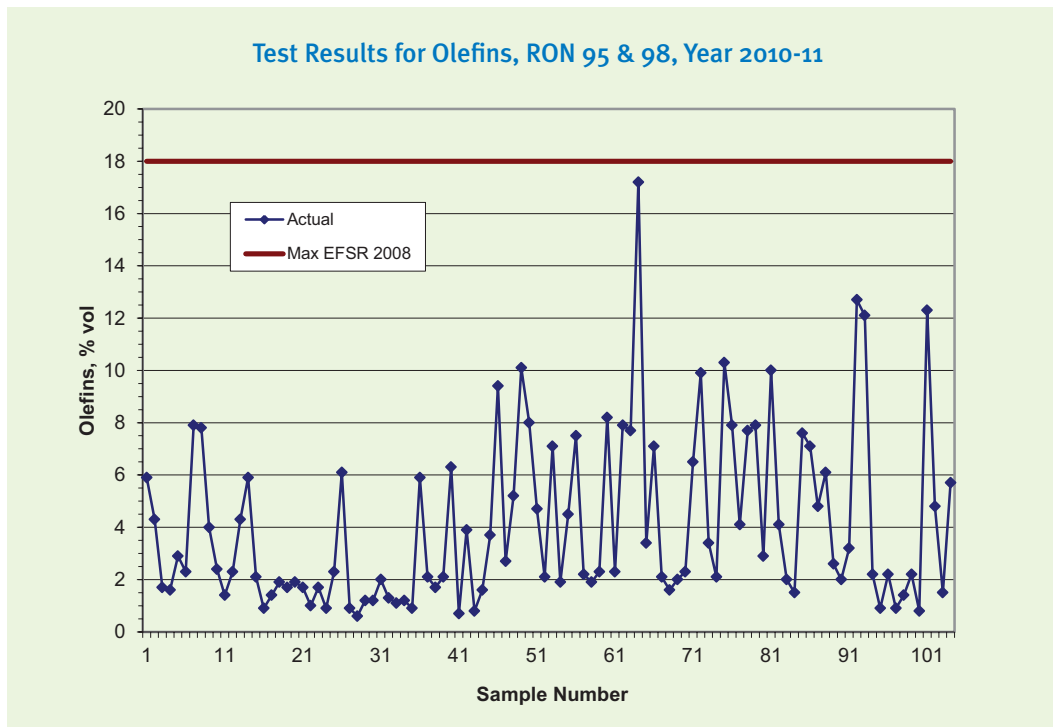
For RON 91, all results were found to be below 14% (Fig. 11a).

Fig. 11a



For premium petrol, the largest result was found to be 17.2% for Sample 64 (Fig. 11b).

Fig. 11b



Other Specification Parameter Testing

Testing and analysis was also conducted on other parameters and properties prescribed in the Regulations. This included testing for the content of: lead, manganese and phosphorus, through an initial identification of their presence on the threshold of resolution by each relevant method. These tests' results

have not been included in this report as they were usually found to be below this threshold and well within the specification limits.

The ethanol content in petrol blends was also tested, as it is shown above, and found to be within the required 10%.

Summary for Petrol Test Results

The number of suspected non-compliance cases was low and there were no repeated cases of non-compliance identified.

One non-compliant sample detected during the period of this report, related to a premium petrol sample where the research octane number on investigation was initially found to be 94.5 relative to a minimum limit of 95.0 and the tolerance limit of 94.6. When repeated, twice, the test confirmed the first finding and after analysis, the average figure was found to be 94.4 and outside testing tolerance limits according to the ISO Standard 4259:2006 after subsequent investigation. The product was regarded as non-compliant and follow-up action was undertaken with the relevant fuel retail company. Another instance

of minor non-compliance related to a sample of premium petrol blended with ethanol which on investigation was found to be on the tolerance limit of 73.4 kPa relative to a maximum limit of 72 kPa.

Only in three other instances the results were initially found beyond the prescribed limits and on subsequent investigation they were found to be within the tolerance limits. These instances include one case on research octane number, one case on motor octane number and one case on dry vapour pressure in regular petrol.

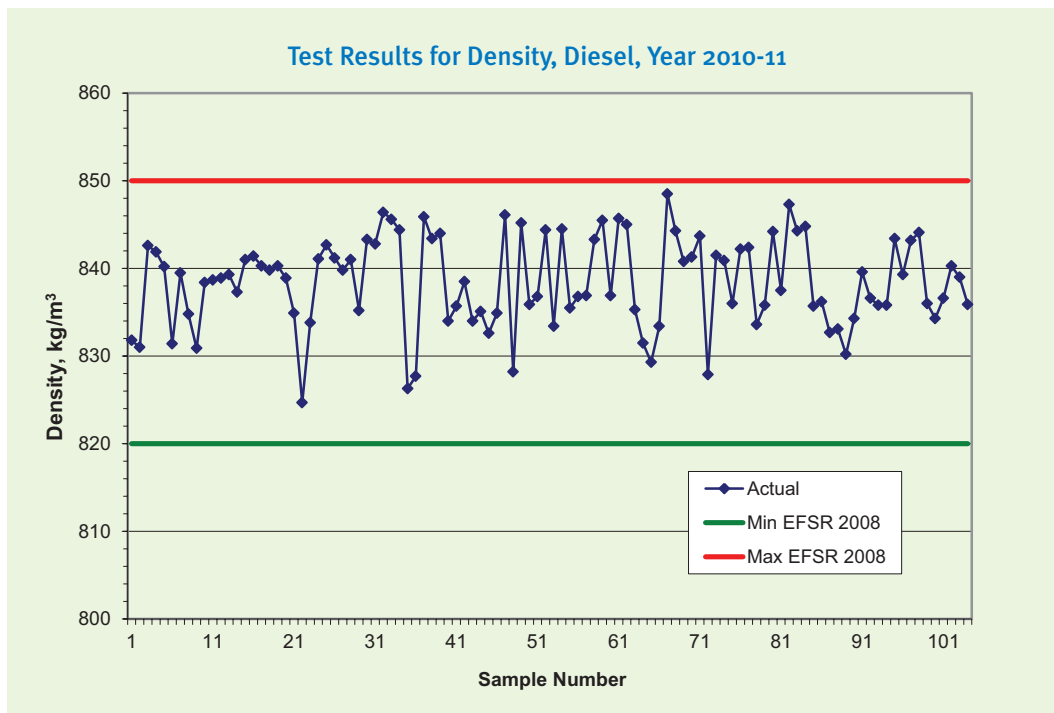
Engine Fuel Specifications Regulations came into force on 1 December 2011 and changed some of the fuel specifications. These changes are outside the period covered by this report.



Diesel

Density

Fig. 12



All results were found to be within the specification limits which are 820 kg/m³ and, respectively, 850 kg/m³.



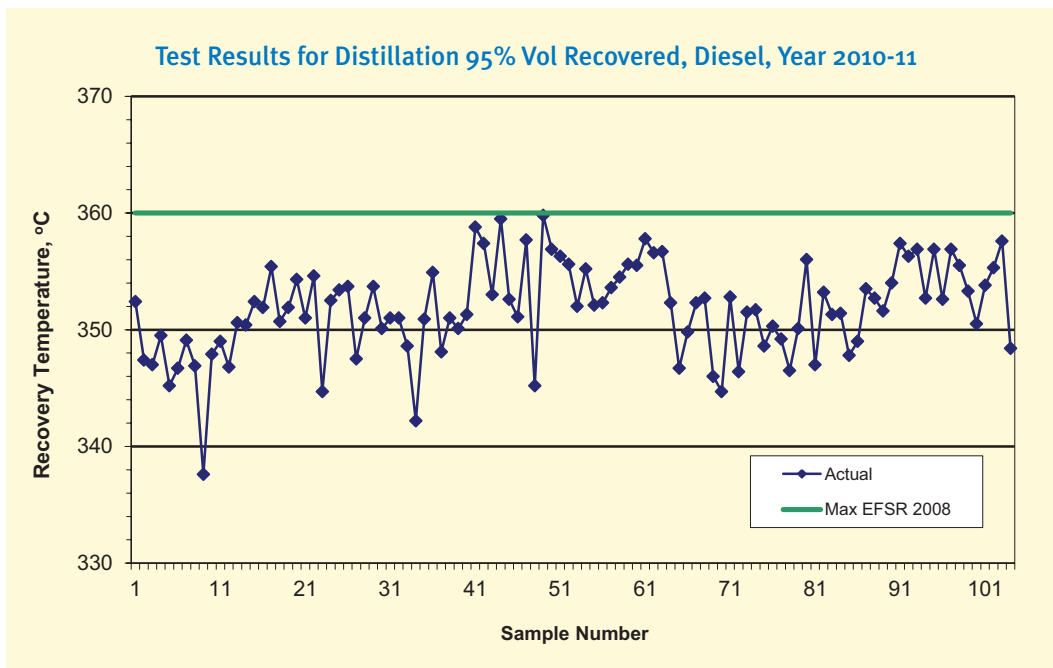
Distillation

All samples were found to be below the specification maximum limit of 360°C for distillation at 95% volume recovered (T₉₅).

Samples 44 and 49 were found to be the closest to the limit with the actual results of 359.5°C and 359.8°C, respectively.

Although a test for the final boiling point is not specified by the Regulations, this parameter was routinely tested as part of the testing process for distillation as per ASTM Standard D86⁴ and found to be within an acceptable range, with the maximum result of 366.3°C.

Fig. 13



⁴ ASTM D86 – 11b Standard Test Method for Distillation of Petroleum Products at Atmospheric Pressure.

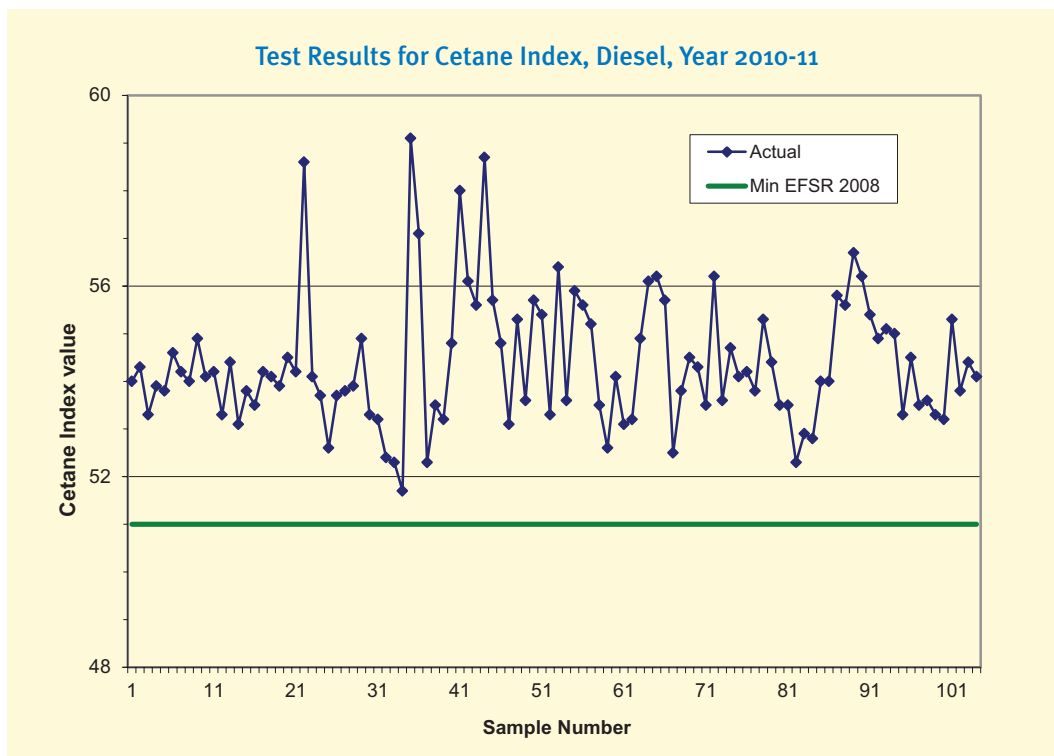
Cetane Index

The cetane index, according to ASTM Standard D976⁵ prescribed in the Regulations, is not tested for but calculated from values of the density and the mid-boiling temperature points. The calculated cetane index is a tool for estimating cetane number where a test engine is not available for determining the property.

All samples except two were found to be above the minimum limit of 51 (Fig.14).

It has been suggested that another Standard, ASTM Standard D4737⁶, which defines the cetane index calculation through another set of parameters compared to ASTM D976, better represents diesel fuels currently in the market place and for this reason it had been suggested by the Ministry as an alternative. It should be in place from December 2011 which is beyond the period covered by this report.

Fig. 14



⁵ ASTM D976 – 06(2011) *Standard Test Method for Calculated Cetane Index of Distillate Fuels.*

⁶ ASTM D4737 – 10 *Standard Test Method for Calculated Cetane Index by Four Variable Equation.*



Water

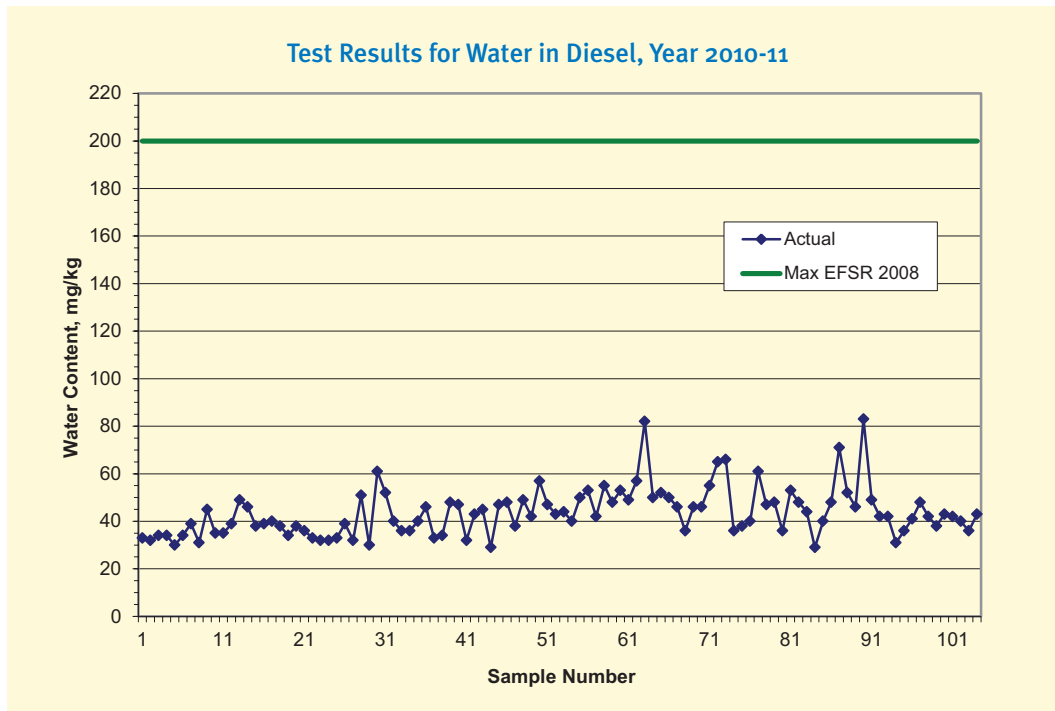
The test for water content means water held in solution. Note: This is not a test for free water content.

Water is soluble to some extent in hydrocarbons. The amount of water that is held in solution will be dependent on the temperature and the composition of the hydrocarbon. At typical ambient temperatures in New Zealand the expected concentration of water dissolved in diesel, is around 30 to

40 mg/kg. Water held in solution in amounts not exceeding that prescribed in the Regulations, should not cause any vehicle operability issues.

The water content in all the tested samples was found to be within the specification limit of 200 mg/kg, with actual testing results not exceeding 80 mg/kg except two: Samples 63 and 90 with the results of 82 mg/kg and 83 mg/kg, respectively.

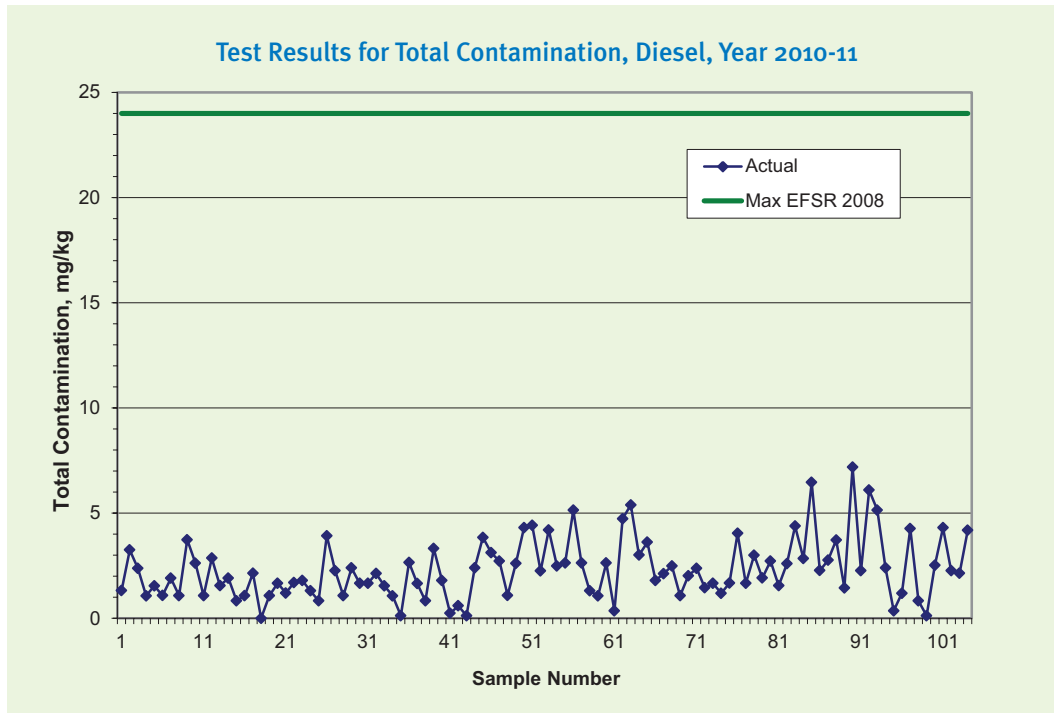
Fig. 15



Total Contamination

All samples were found to be well below the maximum limit of 24 mg/kg specified in the Regulations (Fig. 16).

Fig. 16





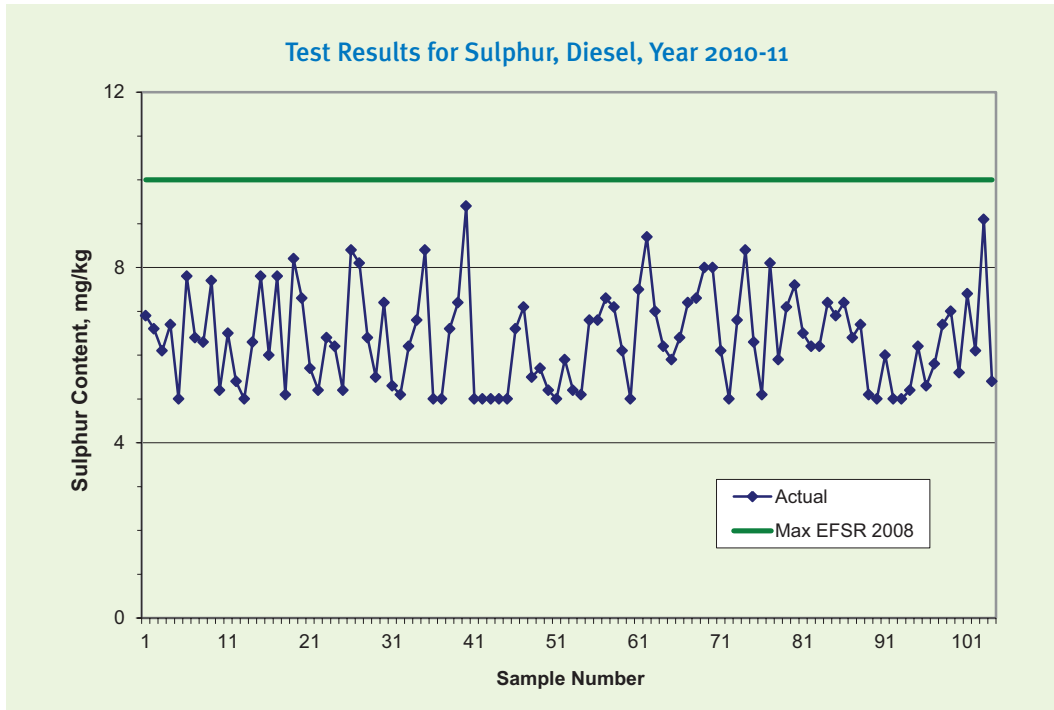
Sulphur

As in the case with petrol (Fig. 9), the lowest line of testing results is 5 mg/kg where the actual figures were found to be on or below this indicative level at the maximum limit of 10 mg/kg.

All samples were found to be below the maximum limit of 10 mg/kg specified in the Regulations (Fig. 17).

Sample 40 was found to be closest to the limit with the actual figure of 9.4 mg/kg.

Fig. 17



Cloud Point

The cumulative results for the cloud point are presented below by combining the lowest prescribed maximum limits for each season in one graph (Fig.18). Generally, if results were below the lowest maximum limit established for an area they definitely complied with the Regulations in all other areas.

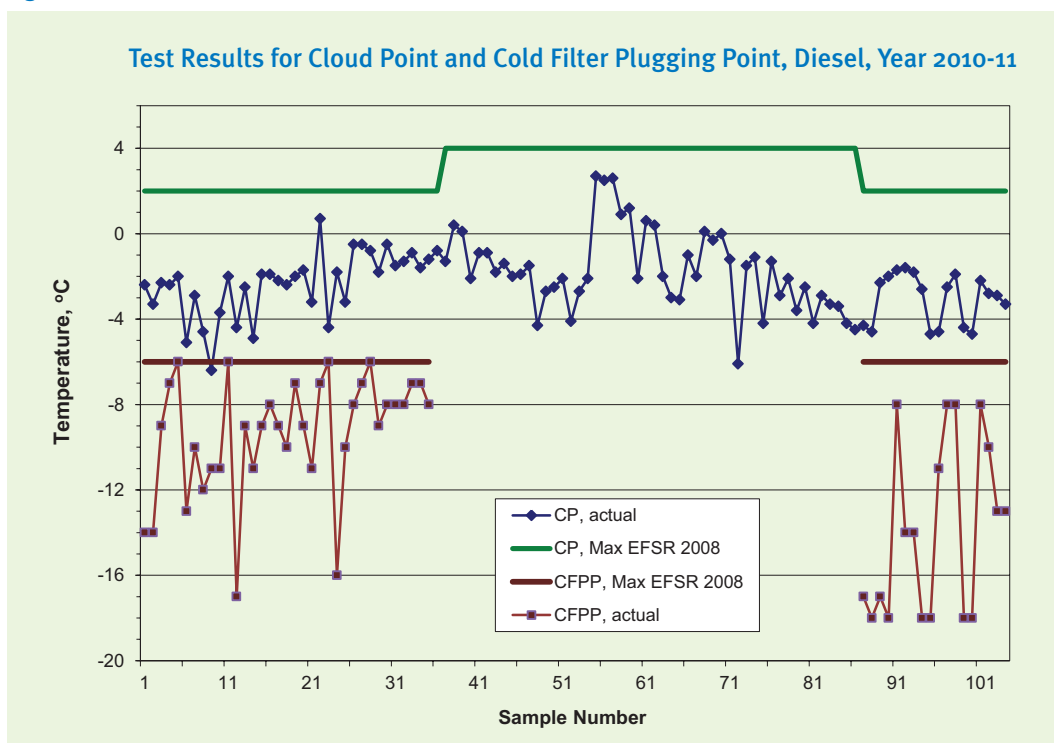
For the period of summer in Schedule 2 (season definitions in Section 5, the Regulations) from 15 October to 14 April inclusive, the lowest maximum limit of cloud point +4°C is prescribed for all New Zealand excluding Auckland and Northland.

The bottom line before and after the pedestal, is the next lowest maximum, +2°C, which is prescribed for all New Zealand in winter, from 15 April to 14 October inclusive.

The maximum limit prescribed for summer in Auckland and Northland, is +6°C and not shown in the graph.

All samples within the relevant seasons appeared to be below the lowest maximum limit. Samples 55 to 57 returned three highest testing results for summer in the range from +2.5 to +2.7°C at the maximum limit of +4°C. They were from two different brands and from the same region, the rest of North Island.

Fig. 18





Cold Filter Plugging Point

The test results for Cold Filter Plugging Point (CFPP) are set out on the same graph as that for cloud point (Fig.18). This gives an advantage to see the data 'at glance' and compare the two sets where necessary.

CFPP is defined only for the winter season with maximum limit of -6°C .

All samples were found to be within the maximum limit of specified in the Regulations for the winter season with four results on the limit.

Four samples collected in a period from mid-July to mid-September from three different brands, reached the maximum limit. None of them did correlate with any specific variation in results for the cloud point.

Two first samples reaching the maximum limit (Fig. 18, bottom graph), were one from

Northland and another from Auckland. Their relatively high value would not be as critical in their region as in the South Island because low temperatures below zero degrees in the Northland and Auckland region, are rare.

The two other samples were from the South Island, one from the down southern area and another from the upper northern area. The former had a relatively low result of -4.4°C for the cloud point which was well within the prescribed maximum of $+2^{\circ}\text{C}$ while the latter had the cloud point of -0.8°C which was relatively closer to the maximum limit. All other parameters did not indicate any concern for both samples.

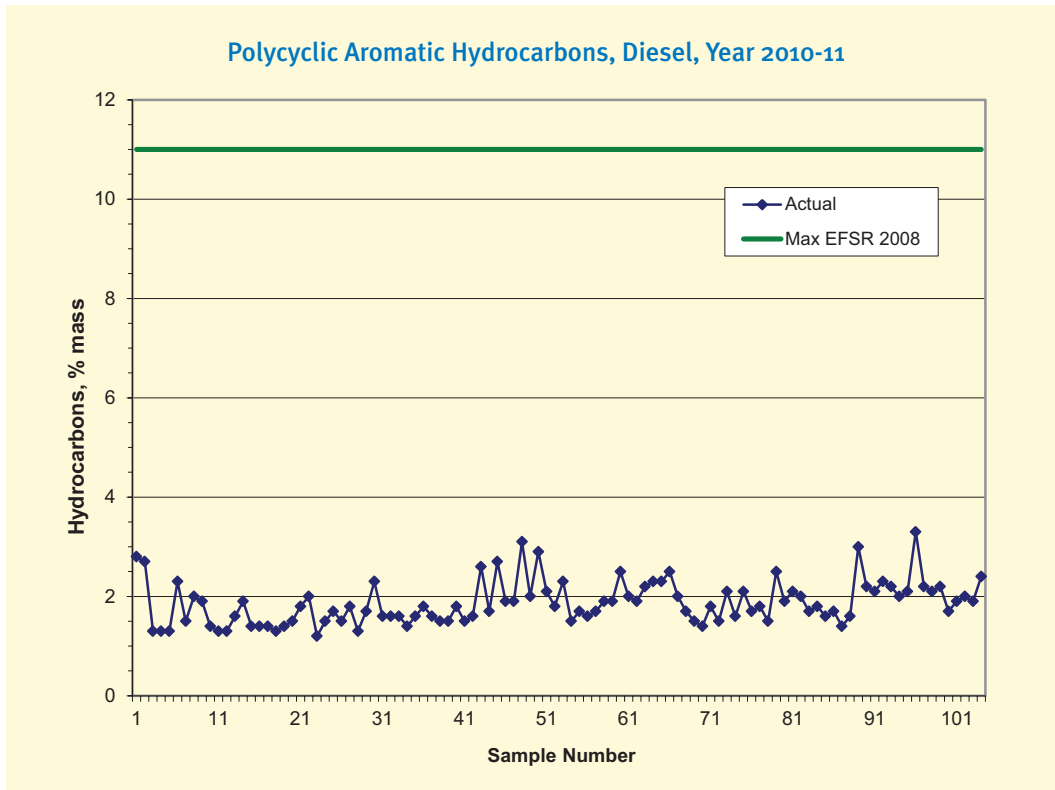
In turn, the lowest CFPP results found for six samples in a range from -17°C to -18°C , did not correlate to any specific variation in results for cloud point either.

Hydrocarbons

In the Regulations, only one limit is prescribed: 11% mass maximum for the polycyclic aromatic hydrocarbons.

All samples were found to be well below the maximum limit specified in the Regulations. The actual testing results were found to be below 4%.

Fig. 19





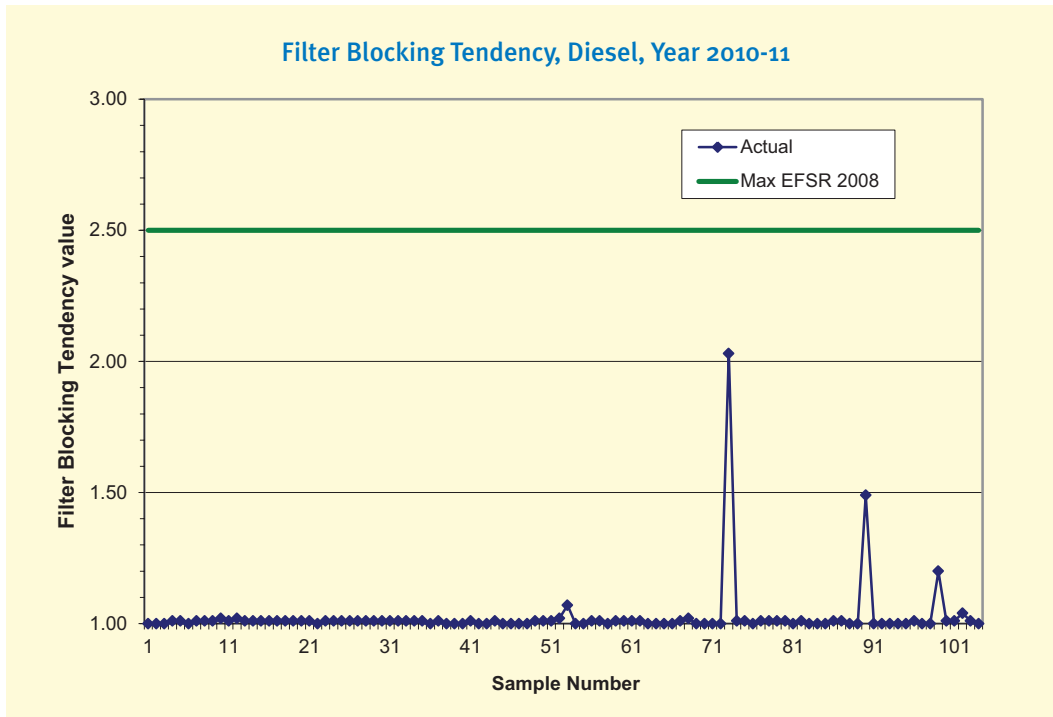
Filter Blocking Tendency

All samples were found to be within the specified maximum limit of 2.5 for filter blocking tendency. The vast majority of actual figures were in the range from 1.00 to 1.05 which means practically perfect filtering.

At the same time, Samples 73 and 90 were found to be comparatively high with the testing results, respectively, of 2.03 and 1.49.

Since the results were within the required limit, and the actual appearance was ‘Clear and Bright’ with the total contamination well within the prescribed limits, the retesting was not done. However, since Sample 73 was standing largely out from the usual pattern, it was analysed further and discussed with the company involved. Possible causes were considered and practical conclusions made.

Fig. 20

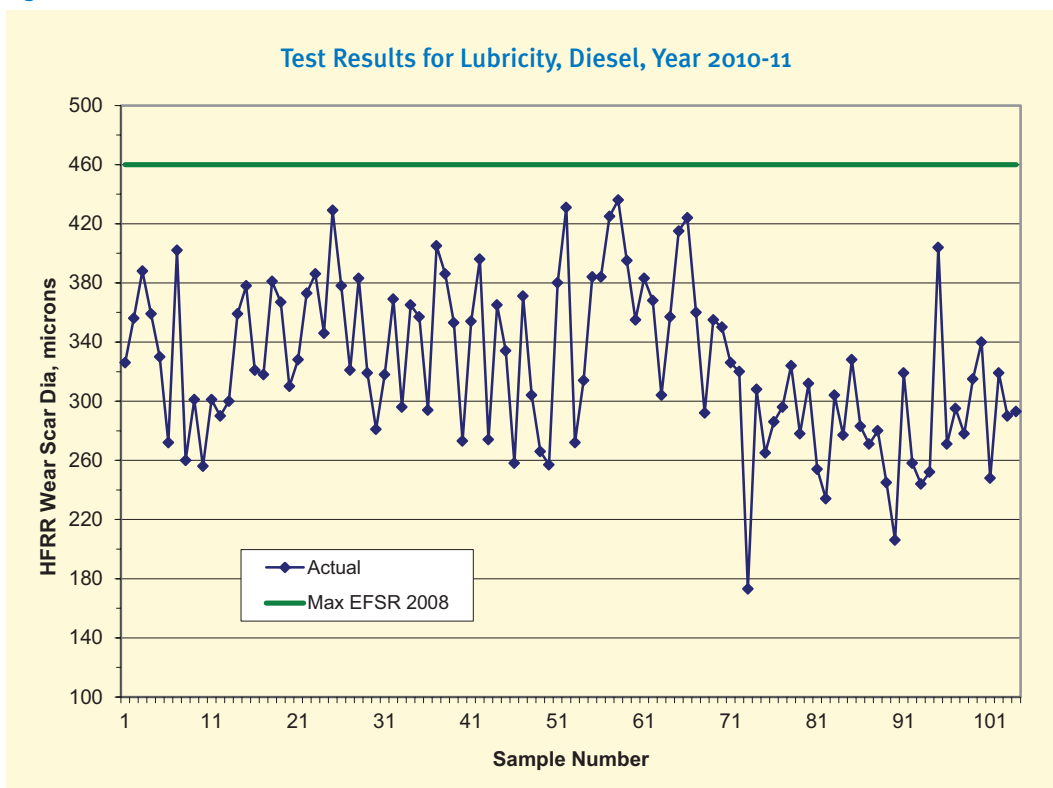


Lubricity

All samples were found to be below the specification maximum limit for the lubricity identified as a diameter of the wear scar produced on an oscillating ball from contact with a stationary plate immersed in the fluid. The diameter is usually measured in microns: the specification maximum limit is 460 μm .

Finally, the reason for the excessive figures of the wear scar diameter in MAPSS samples in the year 2009-10, remains unknown. There were no complaints received from customers in the region at the time. MAPSS continues to look into the matter and consult with fuel supply companies.

Fig. 21



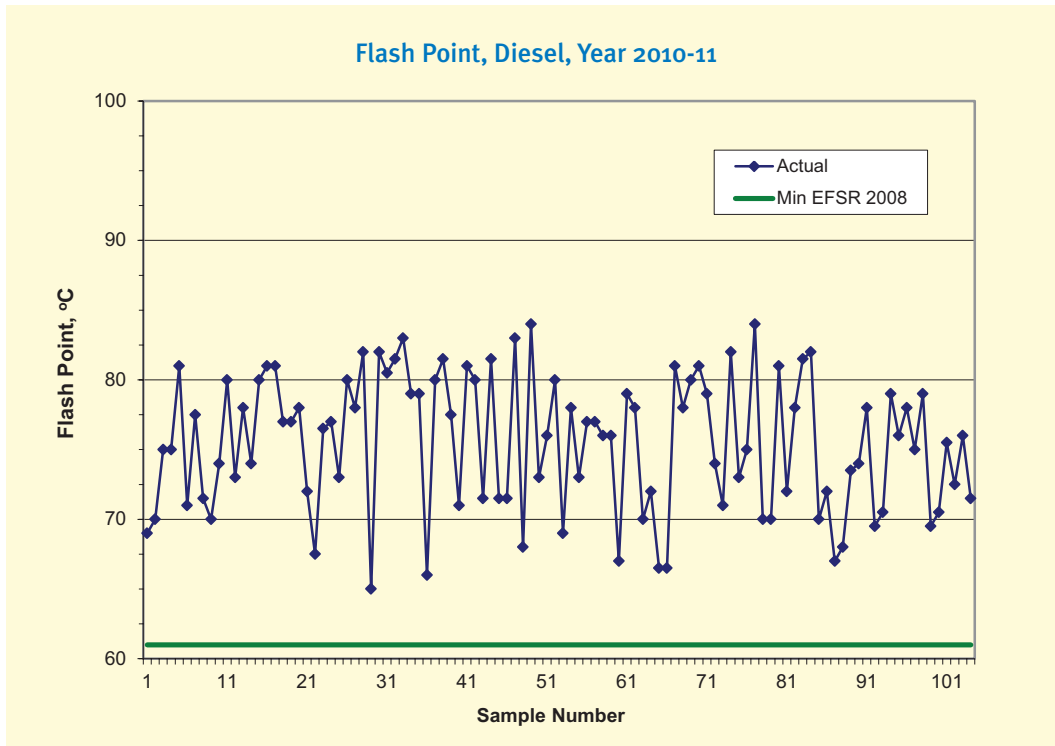


Flash Point

All samples were found to be well above the specified minimum limit of 61°C for flash point of diesel. The vast majority of the test results were in the range above 70°C with the minimum result of 65°C for Sample 29.

This parameter had not been monitored by the Ministry for some period of time due to the evidence from the industry. The flash point test has been added to the set of regular tests this year for the sake of completeness.

Fig. 22



Summary for Diesel Test Results

All test results for diesel were found to be within the limits specified in the Regulations.

No tests were required to be repeated since the properties were initially found to be within prescribed specifications.

Two properties such as flash point and appearance were added into routine list of test this year. The latter is not listed in the Regulations so a method according to the ASTM Standard D4176⁷, was included to enhance the confidence that water in bulk and/or other contamination, if present, are categorised.

⁷ ASTM D4176 – 04(2009) *Standard Test Method for Free Water and Particulate Contamination in Distillate Fuels (Visual Inspection Procedures)*.



Biofuels

Summary on Testing

The specifications for properties of biofuels are still largely under review by the international standardisation committees (CEN and ASTM technical committees in particular). MAPSS is monitoring and contributing to this work to ensure New Zealand has sufficient technical knowledge in this area and our unique perspectives and issues are represented internationally.

This part of the report briefly summarises the initial testing programme on various biofuels sold by non-retail sale. Due to the commercial sensitivity of the data, the actual results were not included in this report.

In the year 2010-11, the Ministry continued sampling and testing biofuels, including two blends of biodiesel, B100 (pure biodiesel) and B20 (20% blend with mineral diesel). Biodiesel B100 was tested according to the requirements of Schedule 3 in the Regulations while the blend B20 was tested according to Regulation 17 of the Regulations. The ethanol produced for blending with petrol in E10 blends (10% ethanol blend with mineral petrol), was not tested this year due to the fact that a special project on ethanol blended petrol is planned for the year 2011-12 and targeted ethanol testing would be part of this project.

A limited number of biodiesel producers claimed the government biodiesel subsidy in the year 2010-11 so the focus of the testing programme was on products from these

producers. In total, 18 samples of biodiesel collected at the production plants and/or at non-retail refuelling sites, were tested. These included 7 samples of B100 and 11 samples of B20.

Biodiesel B5

This blend was tested 6 times throughout the year from samples collected at retail sites. The product falls into the category of diesel by definition in the Regulations, with FAME content up to 5%. Since there was only one retail company in the market selling B5 blend the actual test results were discussed only with the retailer involved. All samples were found compliant except one instance where the FAME content was found to be above the prescribed limit and slightly above the tolerance limit of 5.2%.

Biodiesel B100

The variety of New Zealand feedstock lead to some anomalies in the results of FAME (Fatty Acid Methyl Esters) content as identified by the Standard EN 14103:2003⁸. As a result the Ministry has approved a modified method for correct calculation of the FAME content while the standard had remained under review by the CEN (European Committee for Standardisation) until May 2011. Majority of the samples were found to be within specification regarding the FAME content provided it was measured by the modified method. A few samples were found to

⁸ EN 14103:2003 *Fat and oil derivatives. Fatty acid methyl esters (FAME). Determination of ester and linolenic acid methyl ester contents.*



be below the minimum limit but within the tolerance limit.

In a few instances, tests on total contamination returned marginally elevated results which were addressed by the producers and improvements in product filtering were identified and implemented.

In one instance, the water content was found to be above the maximum limit of 500 mg/kg and, after repeating the tests, the average result was found to be 675 mg/kg at the tolerance limit of 590 mg/kg. However, with a suggestion that the biodiesel should be blended with mineral diesel, the final figures for water content in blends appeared well within the permissible limits.

Various glycerides were sometimes found to be slightly above the maximum limit but often within the tolerance limits.

On the whole the overall quality of the B100 blends was found to be significantly improved this year when the results compared with the previous year data.

None of the fuel identified with potential issues entered the retail supply chain.

Biodiesel B20

This blend was often considered to be a final product supplied to customers therefore the properties listed in Regulation 17 of the Regulations were tested along with a few additional properties such as the filter blocking tendency which MAPSS considers essential when the product is expected to be 'fit for purpose'.

The FAME content was usually found to be within the expected range of up to 19.3%.

In the majority of samples, the filter blocking tendency was found to be below the maximum limit of 2.5. In one instance, a sample was initially found to be 2.52 but failed the repeatability criteria when was repeated. When the test was repeated three times by another

operator, the actual results were found to be 2.36, 2.52 and 2.52 and the average of 2.47 with the repeatability condition satisfied. The result was accepted as compliant but remedial action was recommended by MAPSS and undertaken by the producer.

In another instance, a group of closely related samples were initially found to be in excess of 4.00 on filter blocking tendency in a batch directed for non-retail application. A series of tests revealed a complex pattern of dependence of suspect B20 properties on the B100 ingredient in the blend and in some samples the filter blocking tendency in B20 was found to be extremely high and difficult to accurately quantify, i.e. above 16.00. The situation was investigated with the producer and within 24 hours of the first results being received, a series of remedial actions were urgently applied.

Further, the biodiesel in a storage tank was found to be suspected of non-compliance after tests were completed on the samples of resultant biodiesel B100 and B20 blends. When biodiesel in the storage tank was found to be also non-compliant in subsequent testing the producer emptied the tank and announced their readiness to reimburse the costs of those non-retail users who would be required to clean their engines after possible contamination from this storage tank.

All findings on suspected non-compliance, however marginal, were discussed with the relevant producers in detail and adjustments to the production processes identified and implemented. On the whole, the overall quality of the B20 blend was found to be significantly improved this year when the results are compared with the previous year's data with the one exceptional instance described above.

In conclusion, it must be noted that none of the non-compliant fuels sampled entered the fuel retail supply chain and they were subject to remedial action by the producers before subsequent release or disposal.