TRADING STANDARDS

Fuel Quality Monitoring Programme

TEST RESULTS 2024-2025

MINISTRY OF BUSINESS, INNOVATION & EMPLOYMENT
HĪKINA WHAKATUTUKI

Te Kāwanatanga o Aotearoa
New Zealand Government

MINISTRY OF BUSINESS, INNOVATION & EMPLOYMENT
HĪKINA WHAKATUTUKI

Ministry of Business, Innovation and Employment (MBIE)
Hīkina Whakatutuki – Lifting to make successful

MBIE develops and delivers policy, services, advice and regulation to support economic growth and the prosperity and wellbeing of New Zealanders.

More information

Information, examples and answers to your questions about the topics covered here can be found on our website: **www.tradingstandards.govt.nz**

Disclaimer

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Trading Standards
Ministry of Business, Innovation and Employment
15 Stout Street
PO Box 10729
Wellington 6011

Tel: 0508 627 774
Email: tradingstandards@mbie.govt.nz
www.tradingstandards.govt.nz

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Executive Summary

This report provides an overview of the sampling and testing results of the Fuel Quality Monitoring Programme (the Programme) from 1 July 2024 to 30 June 2025.

The Programme is managed by Trading Standards, a division of the Ministry of Business, Innovation and Employment (the Ministry or MBIE), and operates independently of the fuel industry.

The technical findings presented herein are intended for stakeholders and researchers within the fuel industry. This report does not offer policy advice, solutions, or recommendations, nor does it include details of complaints received by Trading Standards or incidents within the fuel industry.

The Programme monitors the quality of petrol, diesel, and marine fuels sold in Aotearoa New Zealand to ensure compliance with the Engine Fuel Specifications Regulations 2011 (The Regulations or EFSR). Since 2022, the Programme has also included marine fuel monitoring in partnership with Maritime New Zealand, supporting New Zealand's obligations under Annex VI of the International Convention for the Prevention of Pollution from Ships (MARPOL).

During the reporting period, 658 fuel samples were collected from across the country:

	Number of Samples
Automotive Retail Sites Sampled	184
Automotive Fuel Routine Samples Tested	419
Automotive Fuel Non-routine Samples Tested	160
Marine Fuel On-board Samples Tested	47
Marine Fuel On-shore Samples Tested	32
Total Fuel Samples Tested	658

Following a comprehensive analysis of all samples and test results, Trading Standards confirms that, overall, automotive fuel sold in New Zealand during the reporting period complied with the specified regulations and met the required quality standards. Marine fuel samples also showed compliance with MARPOL Annex VI sulphur limits.

The Programme plays a key role in protecting consumers, supporting environmental outcomes, and maintaining confidence in New Zealand's fuel supply.

For more information, please contact Trading Standards: Tel: 0508 627 774 or Email: tradingstandards@mbie.govt.nz

Fuel Quality Monitoring Programme

Background

MBIE is the Government's lead business-facing agency. MBIE's purpose is 'to grow New Zealand for all,' which guides its work including Trading Standards' consumer protection role.

Trading Standards, operating as a division within MBIE, holds primary responsibility for ensuring that the quantity of fuel supplied to consumers in New Zealand is measured accurately and the quality of fuel complies with all regulated standards. As the lead regulator, Trading Standards administers the Programme and systematically monitors the quality of automotive and marine fuels across New Zealand, ensuring compliance with the Regulations.[1]

Programme Objectives and Key Activities

The primary objective of the Programme is to verify the quality of fuels available for retail sale to consumers. This is achieved through the collection of samples directly from dispenser nozzles at the point of sale. To detect instances of non-conformance, Trading Standards employs a statistical sampling methodology designed to ensure a high likelihood of detecting non-compliance. Secondly, the Programme incorporates a joint initiative with Maritime NZ on sampling and testing marine fuels supplied domestically and used on board ships.

The relevant regulations specify limits for key properties of premium and regular petrol grades, diesel, biofuels—including biodiesel and ethanol blends—and marine fuels.

In the domain of fuel quality monitoring, key activities encompass the following:

- Conducting routine sampling and targeted projects to assess fuel quality, as well as addressing emerging issues.
- Investigating complaints from consumers and traders and responding to related enquiries.
- Developing and executing projects in response to newly identified issues.
- Providing advice and facilitating the improvement of the best practices within the fuel industry.
- Contributing to the regular review, amendment, and updating of relevant Regulations.

Regulatory Relationships and International Representation

Trading Standards maintains robust and effective relationships with fuel companies, retailers, and relevant stakeholders throughout New Zealand and internationally. The agency represents New Zealand on international standards committees concerned with fuel quality, ensuring alignment with global best practices. Further, collaboration with Maritime New Zealand is undertaken to facilitate the effective regulation of marine fuel standards.

[1] https://www.tradingstandards.govt.nz/assets/documents/compliance-strategy.pdf

International Commitments

On 26 May 2022, New Zealand formally acceded to Annex VI of the International Maritime Organization (IMO) Convention for the Prevention of Pollution from Ships (1973), which subsequently entered into force for New Zealand on 26 August 2022. In accordance with this accession, new marine fuel quality regulations were incorporated into the Engine Fuel Specifications Regulations 2011, effective from August 2022.

Funding of the Programme

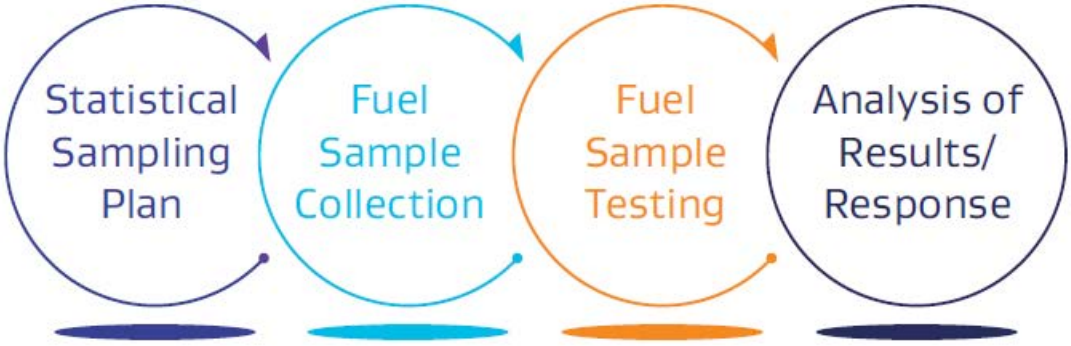
The Programme is funded by the Petroleum or Engine Fuel Monitoring Levy (PEFML), as prescribed under the Energy (Petrol, Engine Fuel, and Gas) Levy Regulations 2017[2]. Notably, the PEFML was recently updated to include marine fuel quality monitoring, reflecting the expanded scope of regulatory oversight following the accession to Annex VI of the IMO MARPOL Convention.

Programme Structure and Methodology

The Programme employs a statistical sampling methodology to achieve a high probability of identifying non-compliance. The EFSR sets specific limits for key fuel properties and components, covering premium and regular petrol grades, diesel, marine fuels, and biofuels such as biodiesel and ethanol.

Marine fuel sampling is now conducted under a regime that mirrors the existing fuel quality monitoring framework for automotive fuels, thereby broadening the Programme's scope to include marine fuels and increasing the volume of samples tested.

The key principles and structure of the Programme remain consistent with previous years. References to legislation relating to engine fuel quality can be found on the Ministry website or in preceding annual reports.[3]



During the reported period, Trading Standards was responsible for overseeing the collection of fuel samples, their testing in an accredited laboratory, and analysing the results. The sampling and analysis methodology adheres to statistical principles to ensure comprehensive monitoring and compliance with regulatory standards.

In cases where non-compliance or abnormalities were detected during testing, further analysis and investigation were conducted by Trading Standards. The main goal of these investigations was to confirm the accuracy of the results and take appropriate action if necessary. Additionally, efforts were also made to understand and address the underlying causes of any non-compliance to prevent future occurrences.

[2] https://www.legislation.govt.nz/regulation/public/2017/0147/latest/whole.html#DLM7296652
[3] https://fuelquality.tradingstandards.govt.nz/about-us/fuel-quality-monitoring-annual-reports/

Seasons in the Regulations

SCHEDULE 1 – PETROL

Summer	1 December - 31 March
Autumn	1 April - 31 May
Winter	1 June - 31 August
Spring	1 September - 30 November

SCHEDULE 2 – DIESEL

Summer	15 October - 14 April
Winter	15 April - 14 October

Sampling

Samples of automotive fuel are primarily collected from dispenser nozzles at retail outlets to assess the quality of fuel supplied to consumers. Marine fuel supplied in New Zealand is sampled both at storage terminals and during bunkering operations.

Maritime NZ arranges sampling of fuel used on board ships arriving in New Zealand.

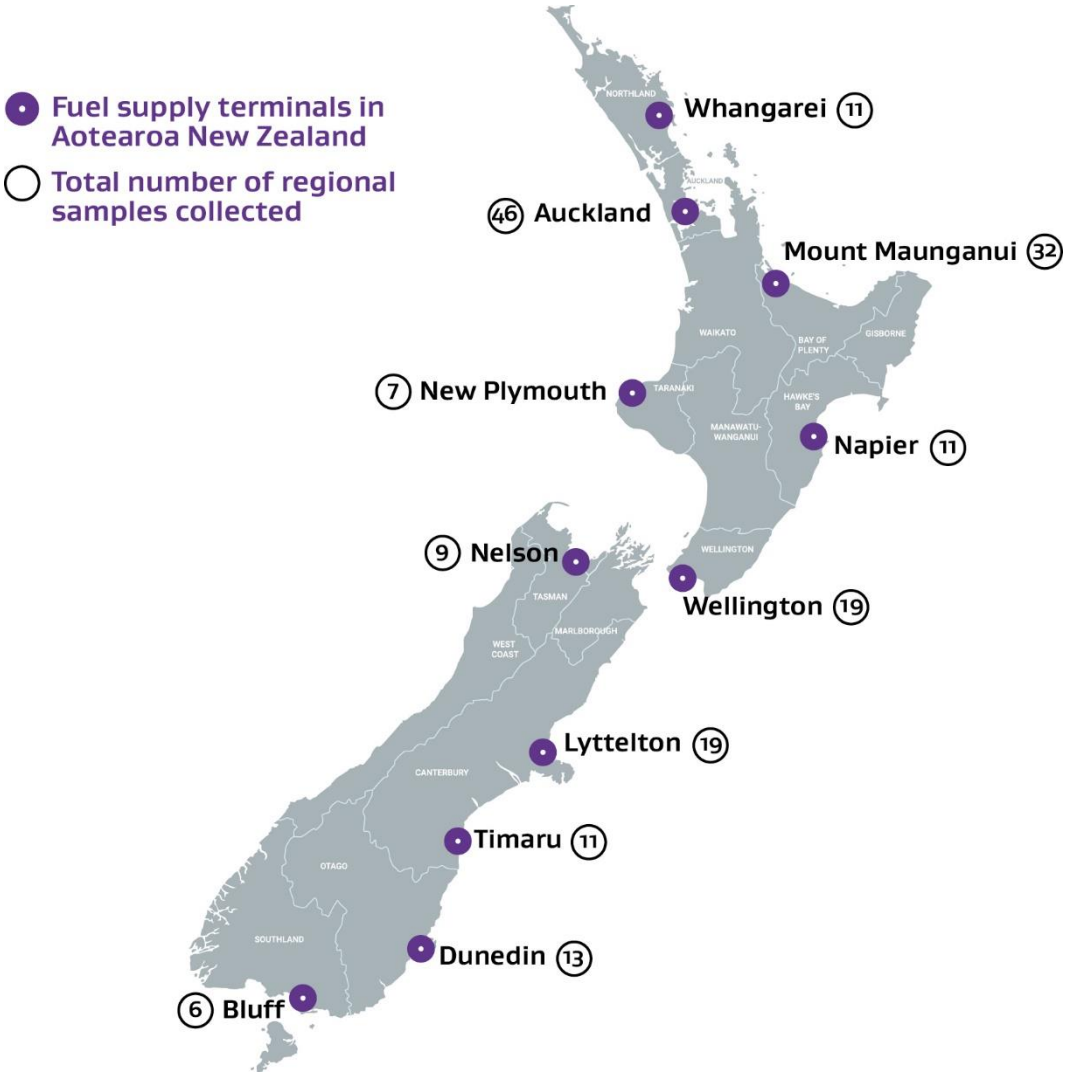
Trading Standards collected samples from 11 regional areas across the country, serviced by specific fuel supply terminals listed in the table below. The collection was based on a statistical model that takes into account the market share of each retail fuel company in regions.

The regional distribution of fuel sample sets collected in 2024-2025:

Terminal / Month	Jul-24	Aug-24	Sep-24	Oct-24	Nov-24	Dec-24	Jan-25	Feb-25	Mar-25	Apr-25	May-25	Jun-25	Total
Whangarei	0	2	0	1	2	1	1	2	0	1	0	1	**11**
Auckland	4	2	2	3	4	2	2	4	7	4	5	7	**46**
Mt Maunganui	3	3	1	3	3	2	3	2	3	2	4	3	**32**
New Plymouth	0	1	1	0	0	0	0	0	1	1	0	3	**7**
Napier	0	0	2	0	0	2	1	0	0	1	2	3	**11**
Wellington	0	2	3	2	1	0	1	1	4	1	2	2	**19**
Nelson	3	0	1	0	1	0	1	0	1	0	1	1	**9**
Lyttelton	3	1	1	2	2	0	2	1	0	3	1	3	**19**
Timaru	0	1	0	2	0	3	1	2	2	0	0	0	**11**
Dunedin	1	2	2	1	0	2	1	0	0	2	0	2	**13**
Bluff	0	0	0	1	1	0	0	0	2	1	0	1	**6**
Total	**14**	**14**	**13**	**15**	**14**	**12**	**13**	**12**	**20**	**16**	**15**	**26**	**184**

A total of 184 sets of samples were collected from various retail sites, with 132 sites sampled as part of routine procedures and the remaining sites sampled for reasons related to complaints or specific projects. These include 419 routine samples, 160 non-routine samples taken in response to complaints and enquiries, projects, and 79 marine fuel samples. There were two ethanol samples collected during the reported period. Ethanol is no longer available for retail sales in New Zealand.

Most of the sample sets from retail sites comprised samples of regular petrol, premium petrol, and diesel samples. There were some sites where premium petrol was not available during the sample collector visits. There were also instances where four samples were collected from a single site, including two samples of premium petrol with RON 95 and RON 98 or higher.



Test Methods

The programme conducted tests in accordance with the methods prescribed in the Regulations and the results are reported based on their relevant specification limits.

ISO Standard 4259[4] provides testing tolerances that allow for results to fall slightly beyond the specified limits but still within the acceptable levels, which is the tolerance limit. The tolerance limits are set out according to the precision statements established for the relevant test methods.

Additional tests not yet specified in the Regulations, such as silver strip corrosion in petrol, and microbial content and appearance for diesel, were added to the routine list. The latter was added to assess the level and nature of the potential presence of water and other contaminants that can be visually assessed.

Monitoring diesel for microbial content and appearance was emphasized due to potential risks to diesel engines. The presence of microbial content in fuel is a highly contentious topic, as discussed in the Microbial Content section of the report.

[4] BS EN ISO 4259-2:2017 Petroleum and related products - Precision of measurement methods and results. Part 2: Interpretation and application of precision data in relation to methods of test

Wet Stock Management

Trading Standards also monitors wet stock management practices at service station forecourts, including the maintenance of underground storage tanks and measures to prevent fuel contamination. These practices support the overall quality and integrity of fuel supplied to consumers.

Environmental Impact- Reducing Emissions and Pollution

The Programme plays a critical role in safeguarding New Zealand's environment by ensuring that fuels supplied for automotive and marine use meet regulatory standards. Through systematic sampling and testing, the Programme ensures compliance with fuel quality and supports emissions regulations, contributing to improved air quality.

- **Automotive Fuels:** By enforcing limits on sulphur content and other key fuel properties, the Programme supports the reduction of vehicle emissions, contributing to improved air quality across urban and rural regions. The adoption of cleaner fuels and biofuel blends further reduces the environmental footprint of transport in New Zealand.
- **Marine Fuels:** In partnership with Maritime NZ, the Programme monitors marine fuel quality to ensure compliance with Annex VI of MARPOL convention. This international commitment has led to the implementation of low-sulphur marine fuels, reducing sulphur oxide emissions from ships in accordance with international regulatory standards.

When the new sulphur limit of 0.50% m/m was implemented in 2020, sulphur dioxides (SO_2) emissions from shipping dropped sharply. According to the Community Emissions Data Systems (CEDS), emissions were reduced from over 10 million tonnes per year in 2019 to lower than 3 million tonnes a year later. The new sulphur limit was expected to reduce overall SO_2 emissions from ships by 77%, equivalent to an annual decrease of about 8.5 million tonnes of SOx globally.[5]

Conclusion

Trading Standards has verified the quality of fuel and concluded that the fuels supplied in 2024/25 were of good quality and complied with standards specified in the Regulations.

Based on the data from the previous years, the probability of supplying non-compliant fuel from the terminals remains relatively low. Otherwise, it would be necessary for the monitoring system to identify and address specific high-risk locations, potential sources of non-compliance, or any exceptional conditions that might increase the likelihood of fuel falling outside the required specifications.

Consistent with previous reports, the origins of the sampled fuels remain confidential to protect commercially sensitive information.

[5] https://www.imo.org/en/mediacentre/hottopics/pages/sulphur-2020.aspx

Petrol

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

Octane rating, or grade, quantifies a gasoline fuel's resistance to auto-ignition under engine operating conditions. Auto-ignition can result in abnormal combustion phenomena such as engine knock, which may cause significant engine damage if persistent. The octane rating is a critical parameter influencing engine performance, fuel efficiency, emissions, and is a key consideration in engine design. Accordingly, it is imperative that fuel with the octane rating specified by the vehicle manufacturer is used to ensure optimal engine operation, efficiency, and compliance with emission standards[6].

For regulatory purposes, the RON is determined in accordance with ASTM D2699[7], while the MON is determined in accordance with ASTM D2700[8]. These standardized test methods are referenced in international and national fuel quality regulations and are essential for certifying fuel properties.

Here and below: The abbreviation 'EFSR' stands for the specification limit prescribed in the Regulations.

Here and below: each individual result is independent from others although they are connected in the graphs for the ease of interpretation.

[6] *Worldwide Fuel Charter*, Gasoline and Diesel 6th Ed., 2019, p.14.
[7] ASTM D2699–24a *Standard Test Method for Research Octane Number of Spark-Ignition Engine Fuel.* Here and further in footnotes, the test method's version is shown that was current in the period of testing.
[8] ASTM D2700-24a *Standard Test Method for Motor Octane Number of Spark-Ignition Engine Fuel*

RON 91

A total of 162 samples of regular petrol were tested for RON, and all results met or exceeded the minimum specification limit of 91. Similarly, 162 samples of regular petrol were tested for MON, with all results above the minimum specification limit of 81.

Fig. 1a and Fig. 1b below show the testing results for RON and MON respectively.

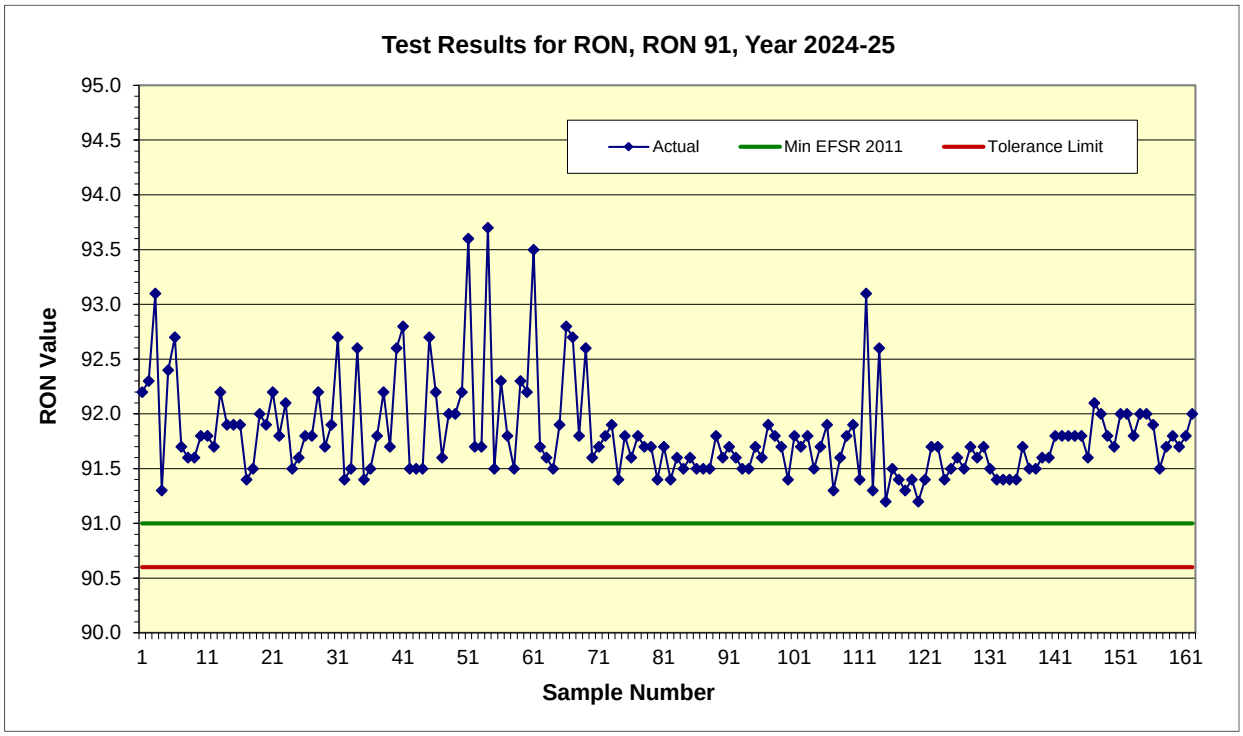


Fig.1a

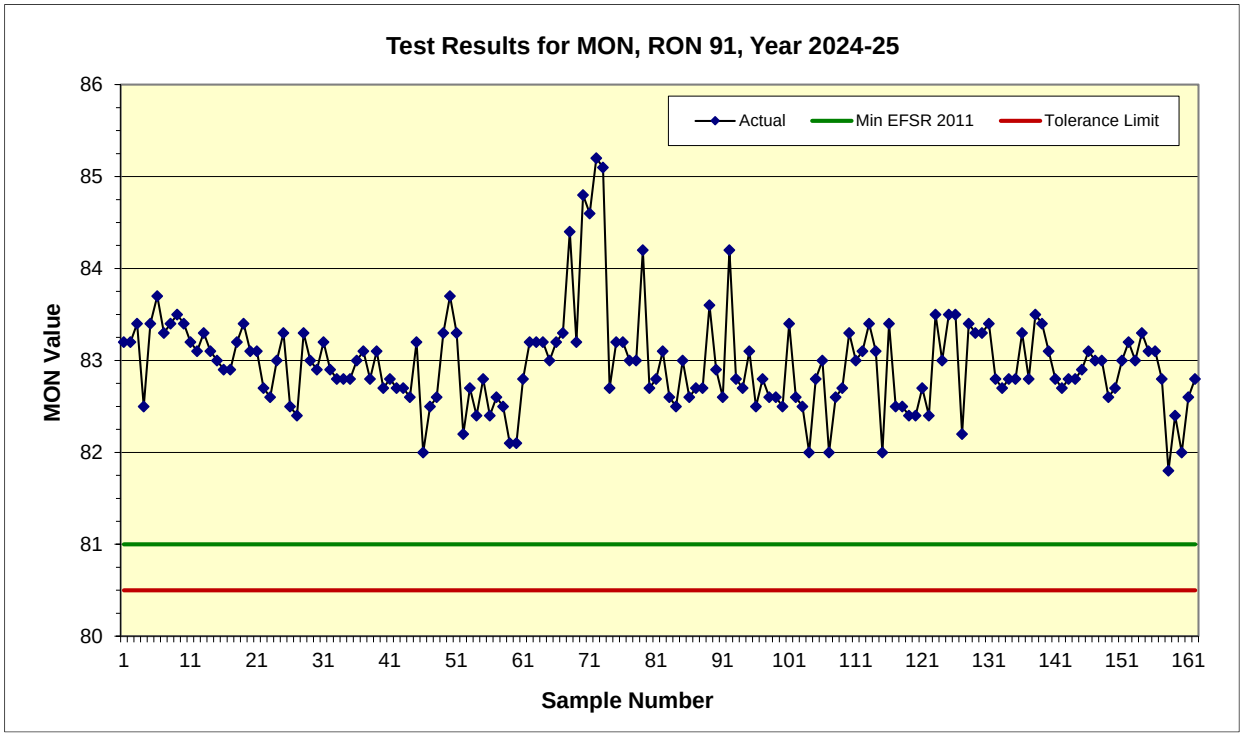


Fig.1b

RON 95

A total of 136 samples of premium grade petrol were tested for RON 95, with all results meeting or exceeding the minimum specification limit of 95. Additionally, 132 samples of premium petrol with RON 95 were tested for MON, and all results met the minimum specification limit of 85.

Fig. 2a and Fig. 2b below show the testing results for RON and MON respectively.

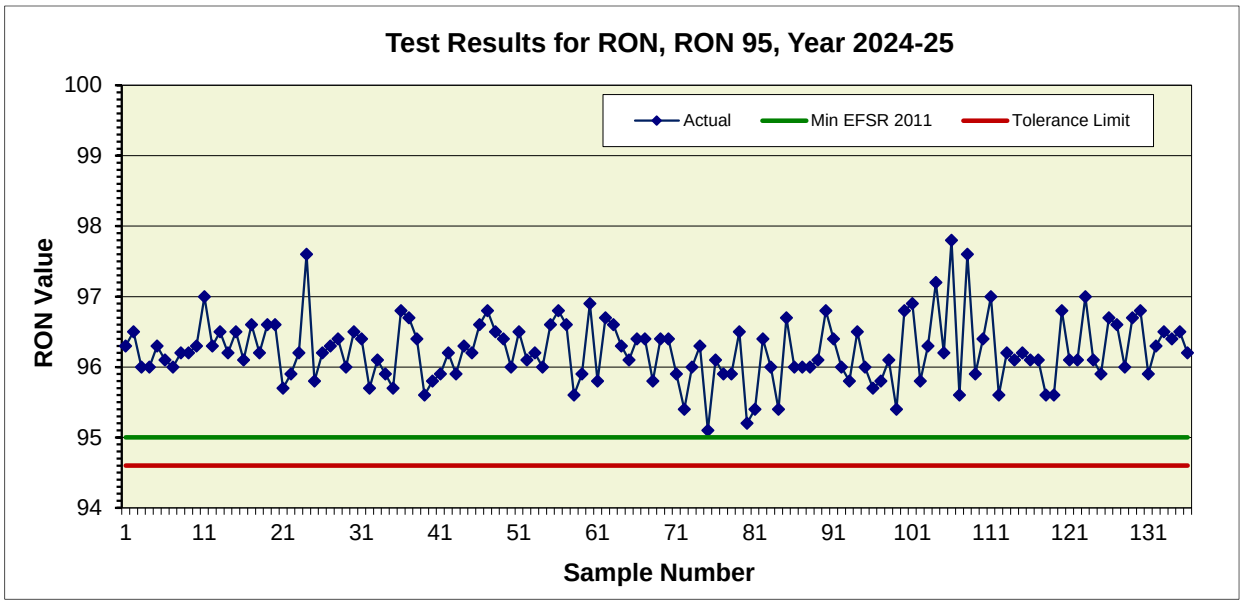


Fig. 2a

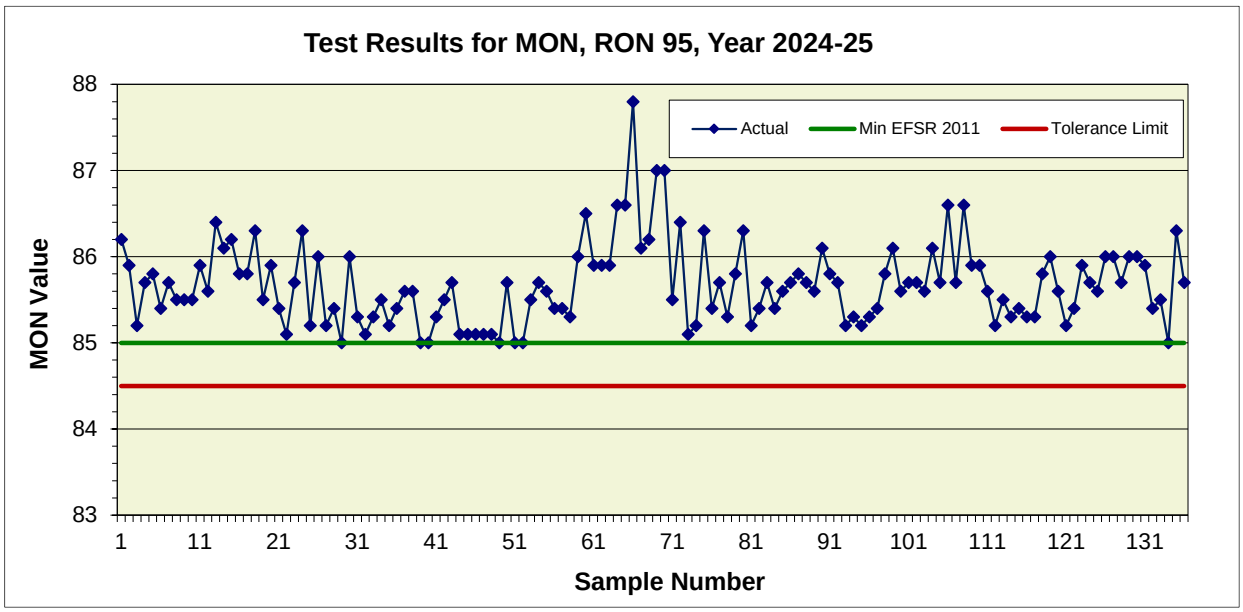


Fig. 2b

RON 98 & above

No specific minimum value for RON is prescribed in the Regulations for premium petrol sold in the retail market with an advertised RON above 95. These fuels are promoted as exceeding regulated

limits. For example, petrol advertised as "RON 98" must comply with Section 11 of the Regulations when tested according to the methods specified in Schedule 1.

Under the Fair Trading Act 1986, the advertised RON value is enforceable in cases of misrepresentation. Therefore, it is inferred that the actual RON must be at least equal to the advertised value.

There is no specified minimum limit for MON in the Regulations or in the advertising of premium petrol with an advertised RON of 98 or higher. As a result, the minimum MON limit for premium petrol is used as a benchmark.

During the reporting period, 41 samples of petrol with an advertised RON of 98 and higher were collected and tested. All samples met or exceeded the advertised RON value. For MON, 41 samples of premium petrol with RON above 95 were tested, and all results were above the specification limit of 85.

Fig. 3a and Fig. 3b below show the testing results for RON and MON respectively. Only the tolerance limit for RON 98 is shown in the graph for RON.

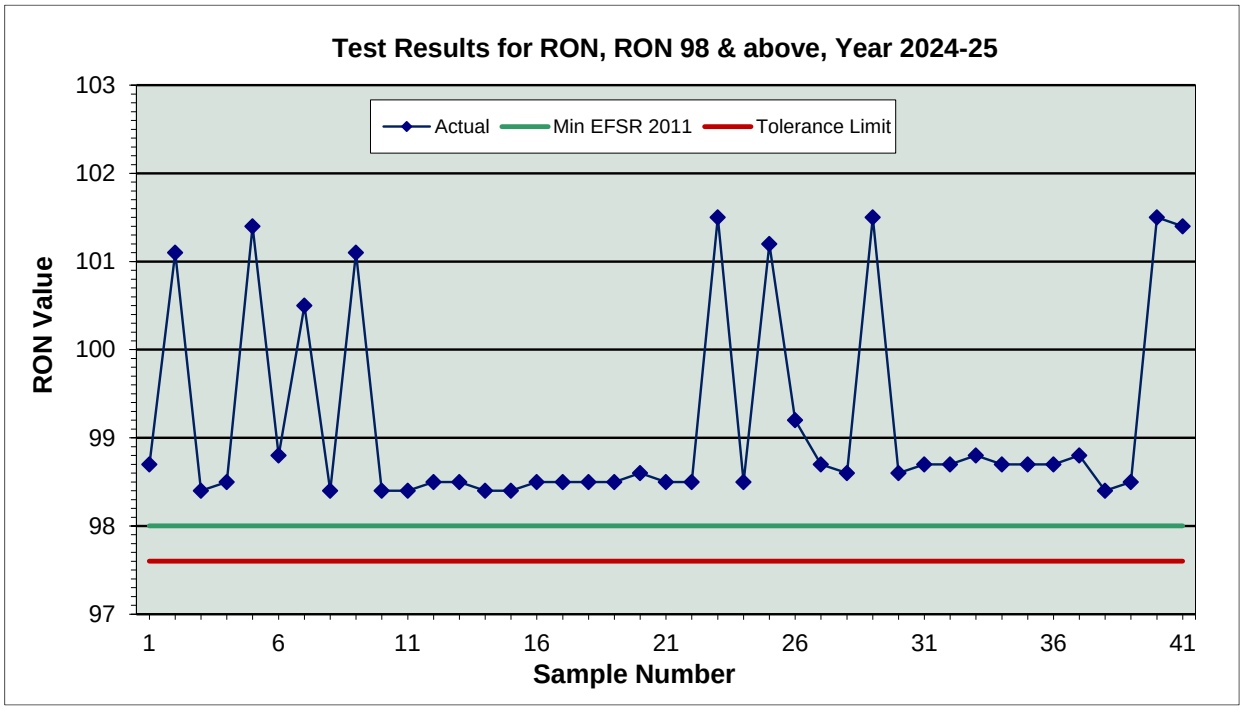


Fig. 3a

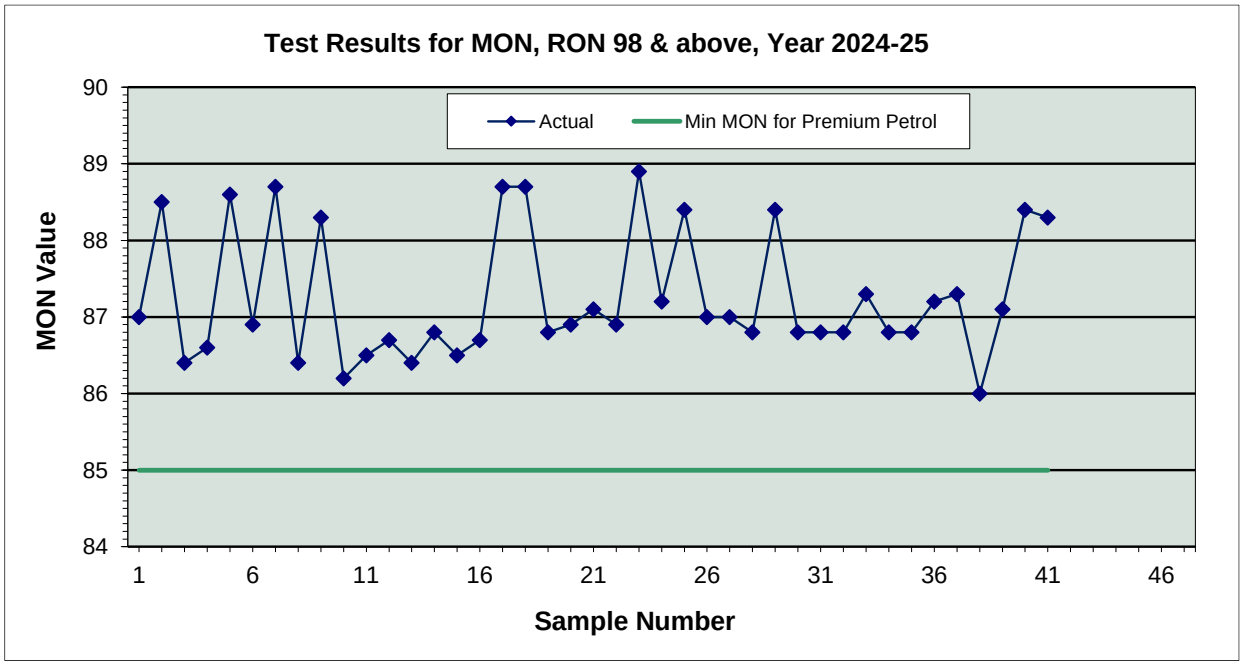


Fig. 3b

Evaporation Percentage

The test method ASTM D86[9] is prescribed in the Regulations for determining the volume percentage of petrol evaporated at three fixed temperatures: 70°C, 100°C, and 150°C. Thus, three categories for evaporation percentage limits, designated as E70, E100, and E150. These parameters are analysed separately for regular petrol (RON 91) and for premium petrol (RON 95, RON 98, and above), in accordance with the requirements set out in Schedule 1 of the Regulations.

RON 91

Percentage Volume Evaporated at 70°C

For petrol not containing ethanol, the minimum specification limit for E70 is 22%, with a reduced minimum of 20% permitted during the summer season, as outlined in Footnote 1 of Schedule 1 of the Regulations. The maximum specification limit for E70 is 48%, while the corresponding minimum tolerance limits are 20.5% (18.5% in summer) and the maximum tolerance limit is 49.2%.

All 162 samples tested were found to be within the prescribed specification limits, exceeding the minimum requirement of 22% across all seasons, including the summer period when the lower limit of 20% applies (see Fig. 4a).

[9] ASTM D86-23ae *Standard Test Method for Distillation of Petroleum Products at Atmospheric Pressure*

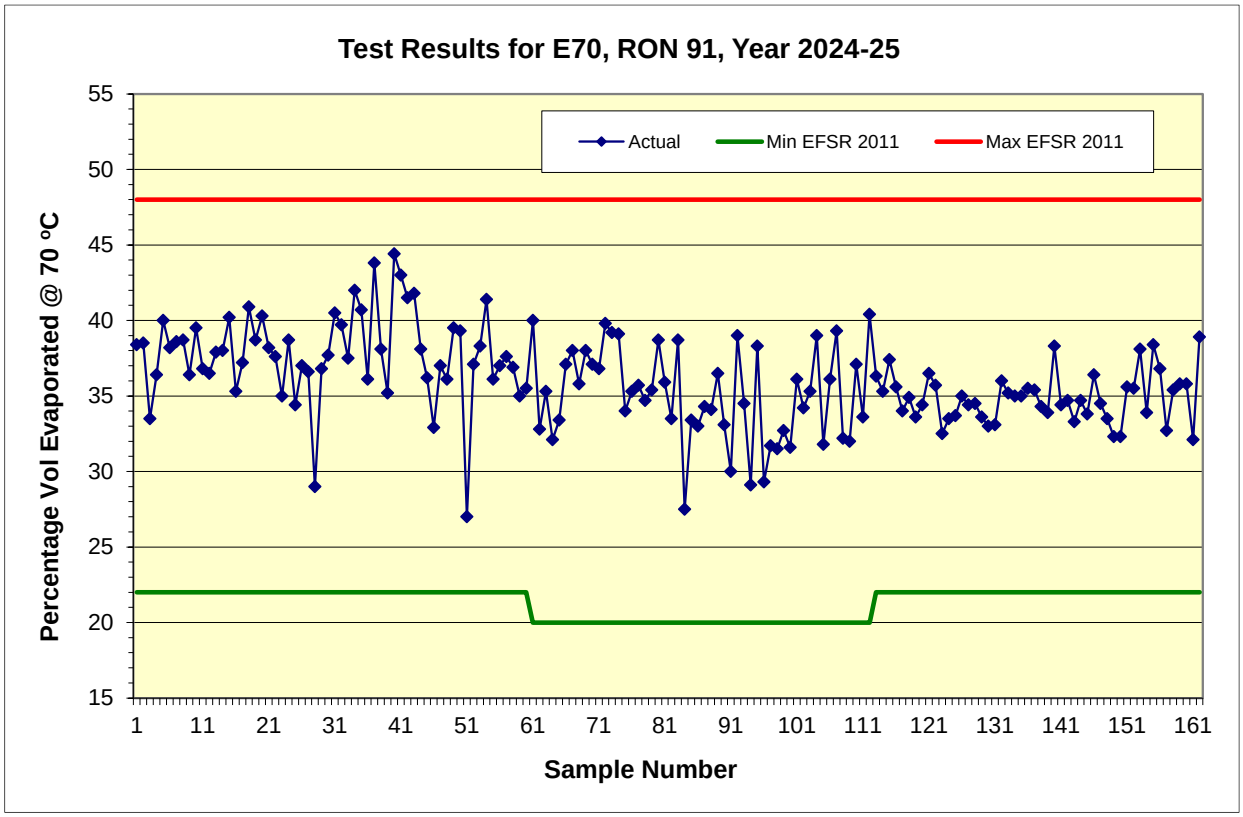


Fig.4a

Percentage Volume Evaporated at 100°C

All 162 samples were found to be within the specification limits from 45% to 70%.

The minimum tolerance limit is 43.8% and maximum tolerance limit is 70.9% (not shown in Fig. 4b).

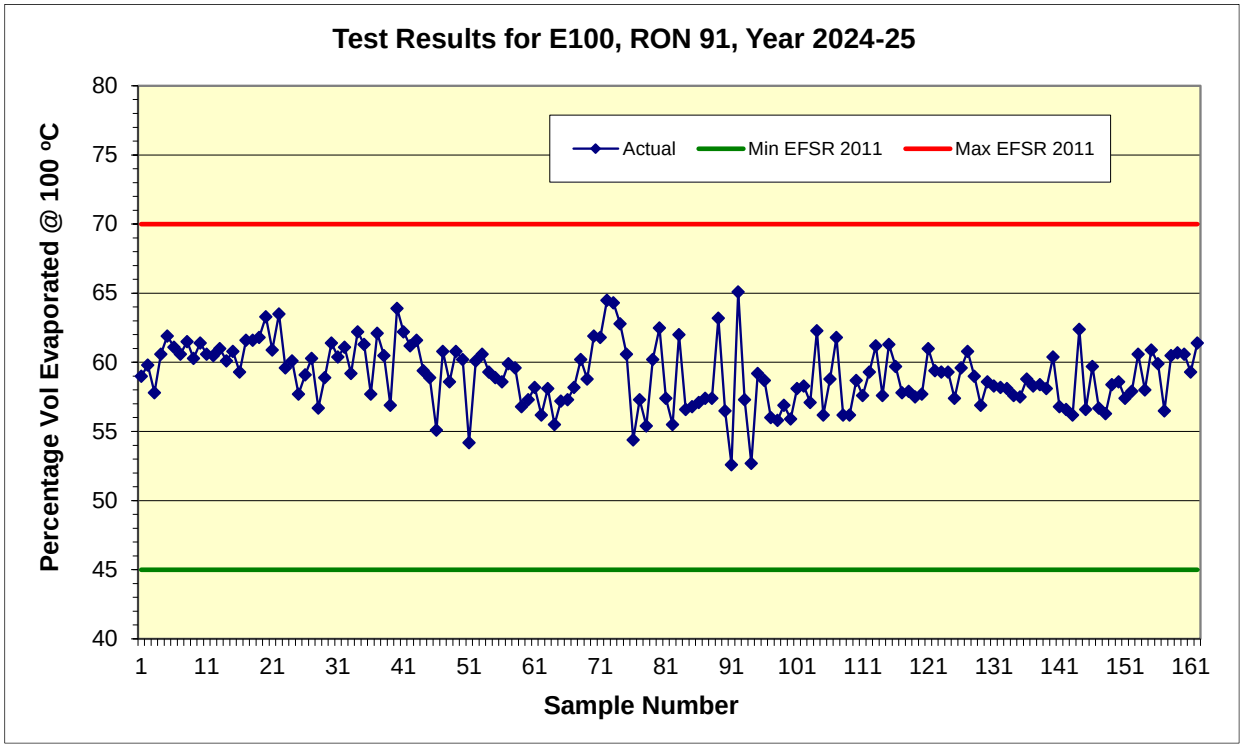


Fig. 4b

Percentage Volume Evaporated at 150°C

All 162 samples were found to be above the minimum specification limit of 75%. The minimum tolerance limit is 74.1% (see Fig. 4c). No maximum limit is prescribed by the Regulations for this property.

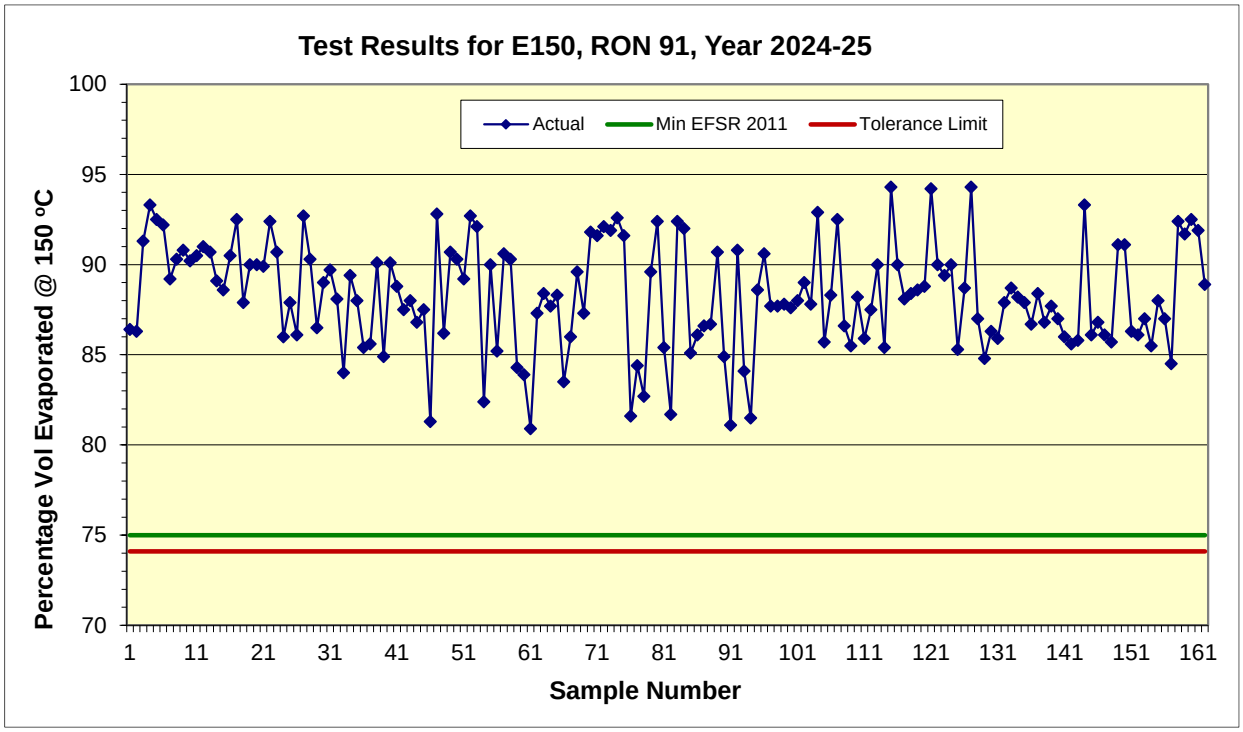


Fig. 4c

RON 95

Percentage Volume Evaporated at 70°C

For premium petrol not containing ethanol, as in case of regular petrol, the minimum specification limit is 22% (a minimum of 20% E70 permitted for the summer season – see Footnote 1 in Schedule 1, the Regulations) and maximum specification limit is 48% while the minimum tolerance limit is 20.5% (18.5 % in summer) and maximum tolerance limit is 49.2%.

All 136 samples were found to be within the prescribed specification limits with the minimum limit of 22% at all seasons including the summer period when the specified minimum limit for E70 is permitted to be 20% (see Fig. 5a).

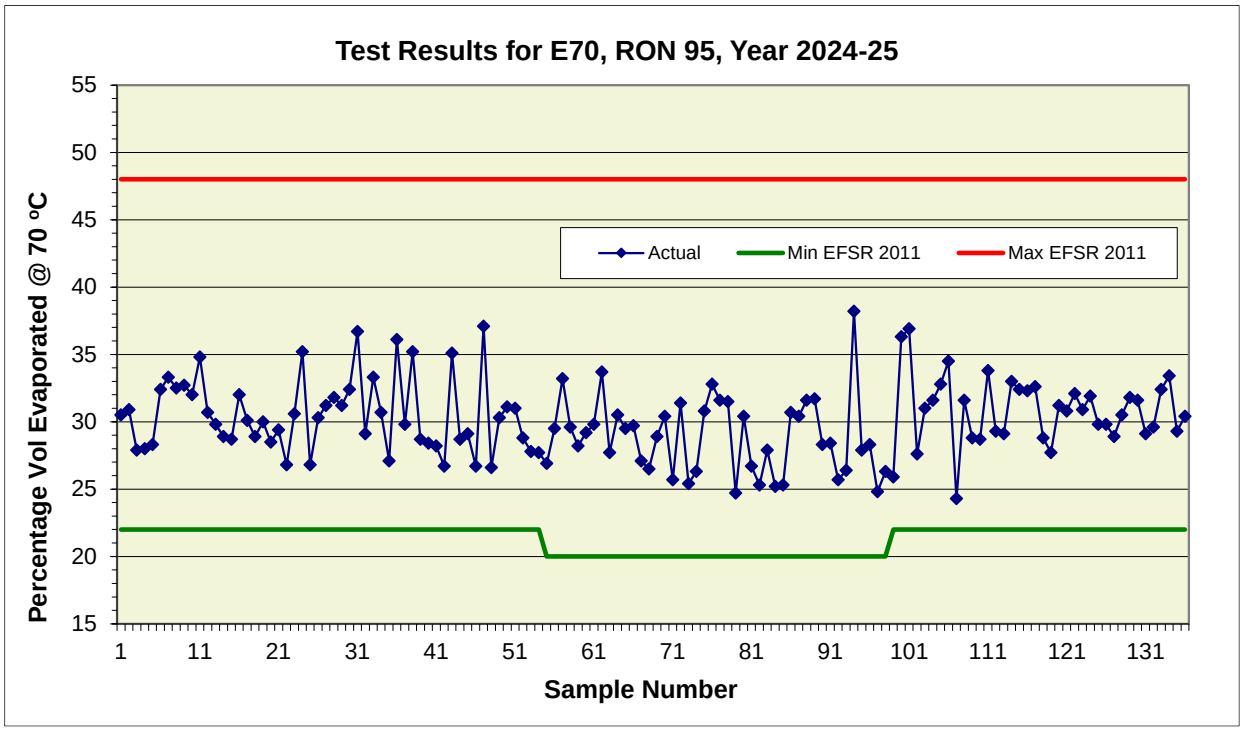


Fig. 5a

Percentage Volume Evaporated at 100°C

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

As in case of regular petrol, the tolerance limits are 43.8 % and 70.9 % respectively (not shown in Fig 5b).

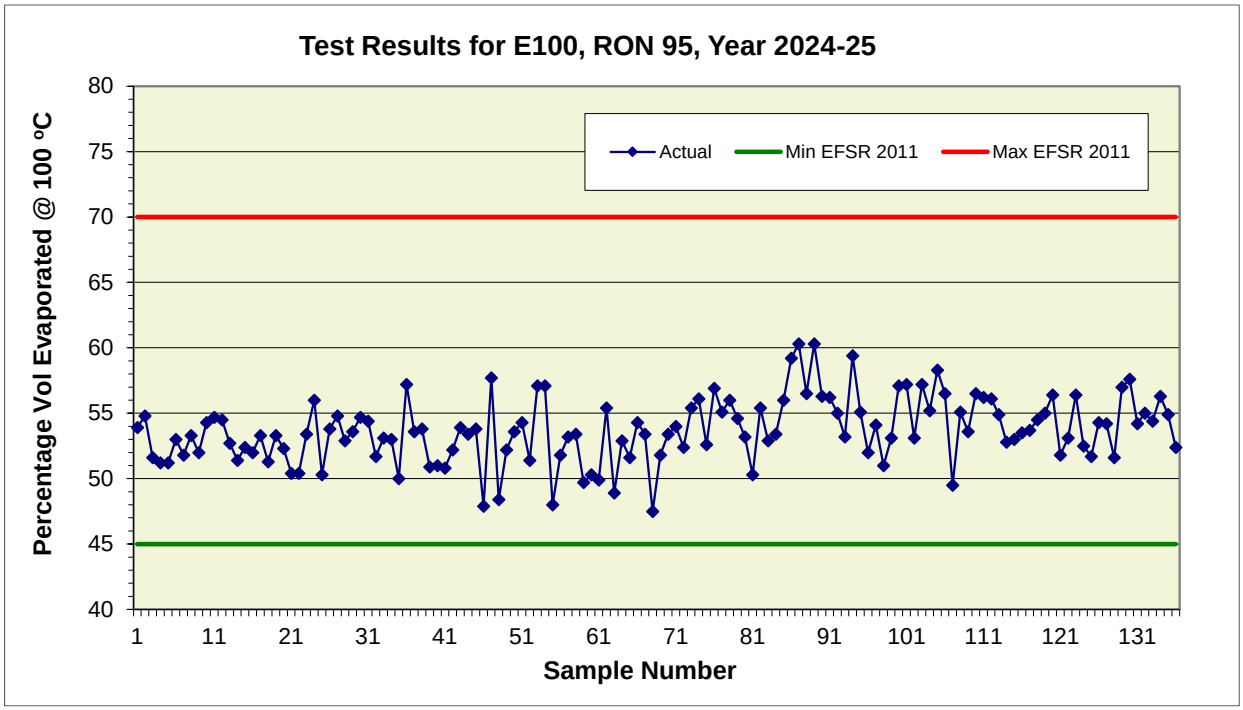


Fig. 5b

Percentage Volume Evaporated at 150°C

All samples were found to be above the minimum specification limit of 75% (Fig. 5c). As in case of regular petrol, the minimum tolerance limit is 74.1%. No maximum is prescribed by the Regulations for this parameter.

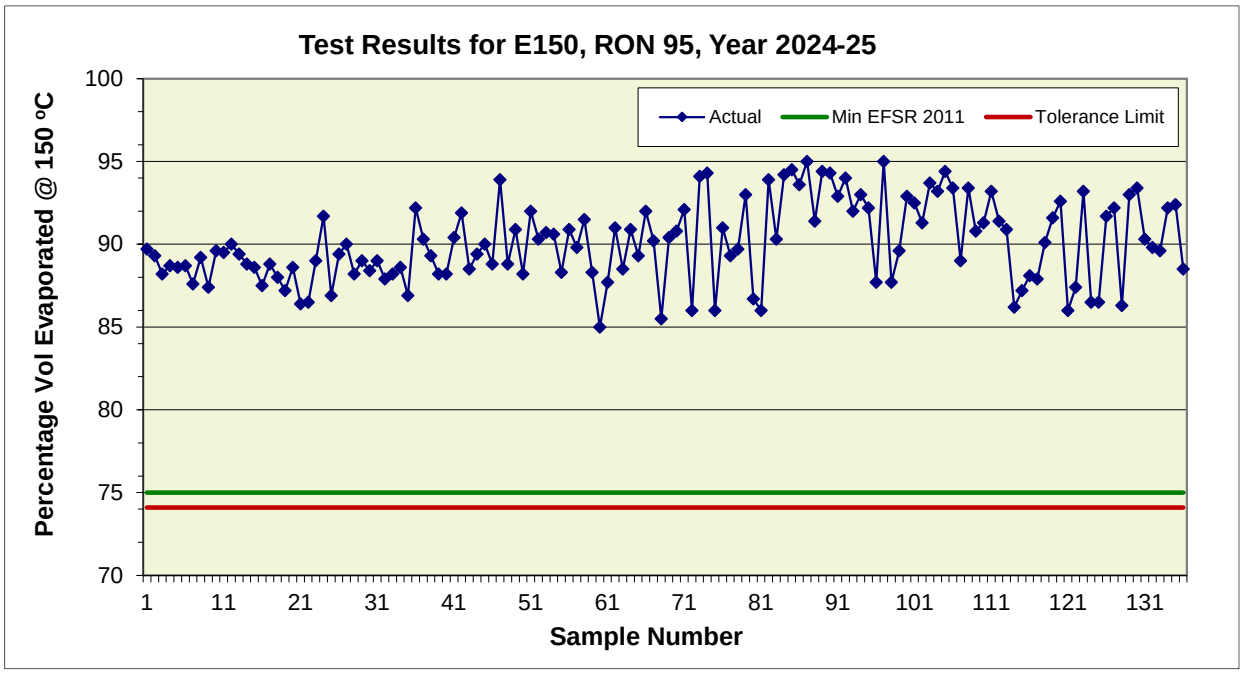


Fig. 5c

RON 98 & above

Percentage Volume Evaporated at 70°C

For premium petrol not containing ethanol, as in case of regular petrol, the minimum specification limit is 22% (a minimum of 20% E70 permitted for the summer season – see Footnote 1 in Schedule 1, the Regulations) and maximum specification limit is 48% while the minimum tolerance limit is 20.5% (18.5% in summer) and the maximum tolerance limit is 49.2%. All results were found within the specified maximum and minimum limits (Fig 6a).

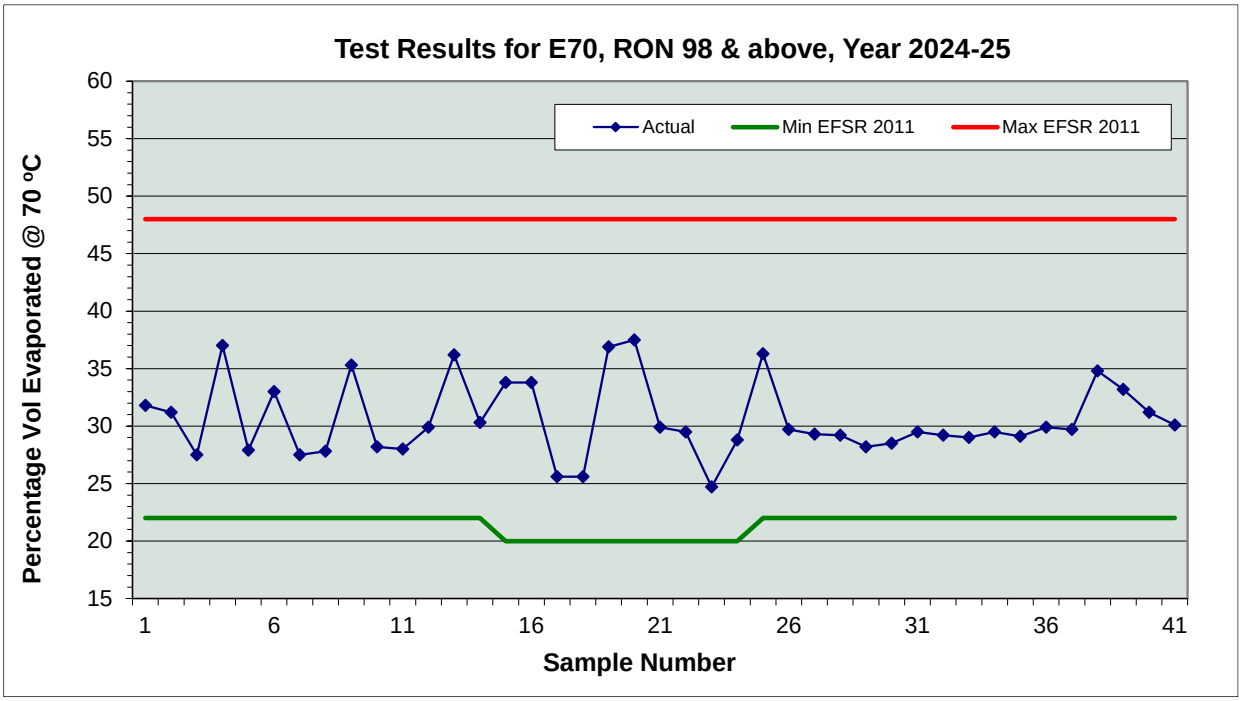


Fig. 6a

Percentage Volume Evaporated at 100°C

All samples were found to be within the specification limits from the minimum of 45% to the maximum of 70% (Fig 6b).

As in case of regular petrol, the tolerance limits are 43.8% and 70.9% respectively (not shown in Fig 6b).

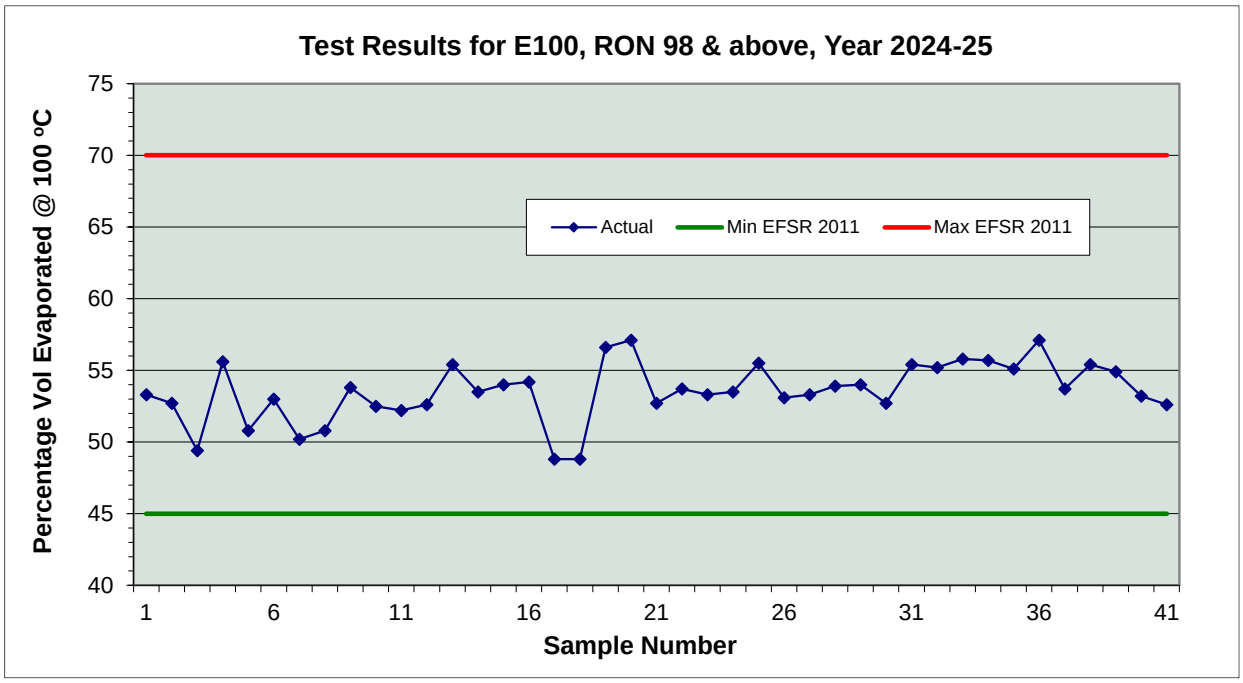


Fig. 6b

Percentage Volume Evaporated at 150°C

All samples were found to be above the minimum specification limit of 75% (Fig. 6c).

As in case of regular petrol, the minimum tolerance limit is 74.1%. No maximum is prescribed by the Regulations for this parameter.

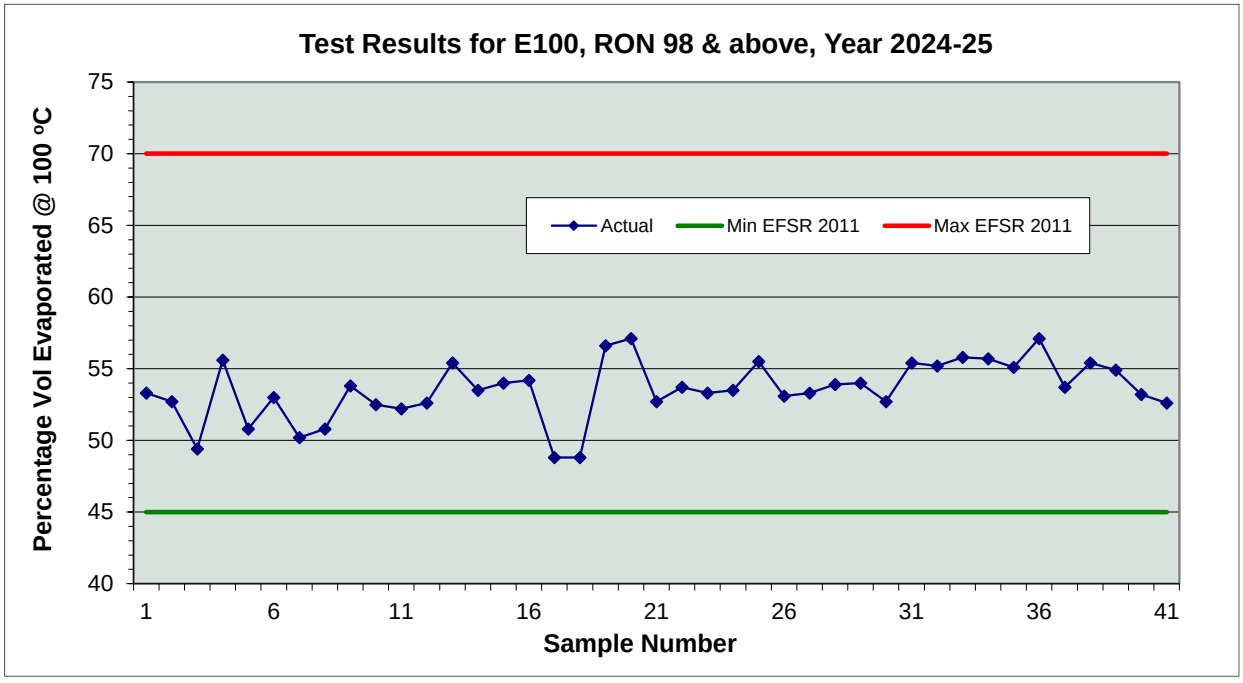


Fig. 6c

Final Boiling Point (FBP)

The test method ASTM D86 is prescribed in the Regulations for distillation end point (or 'final boiling point') in petrol.

All samples were found to be within the specification maximum limit of 210°C for both regular and premium grades (Fig.7). The maximum tolerance limit is 214°C.

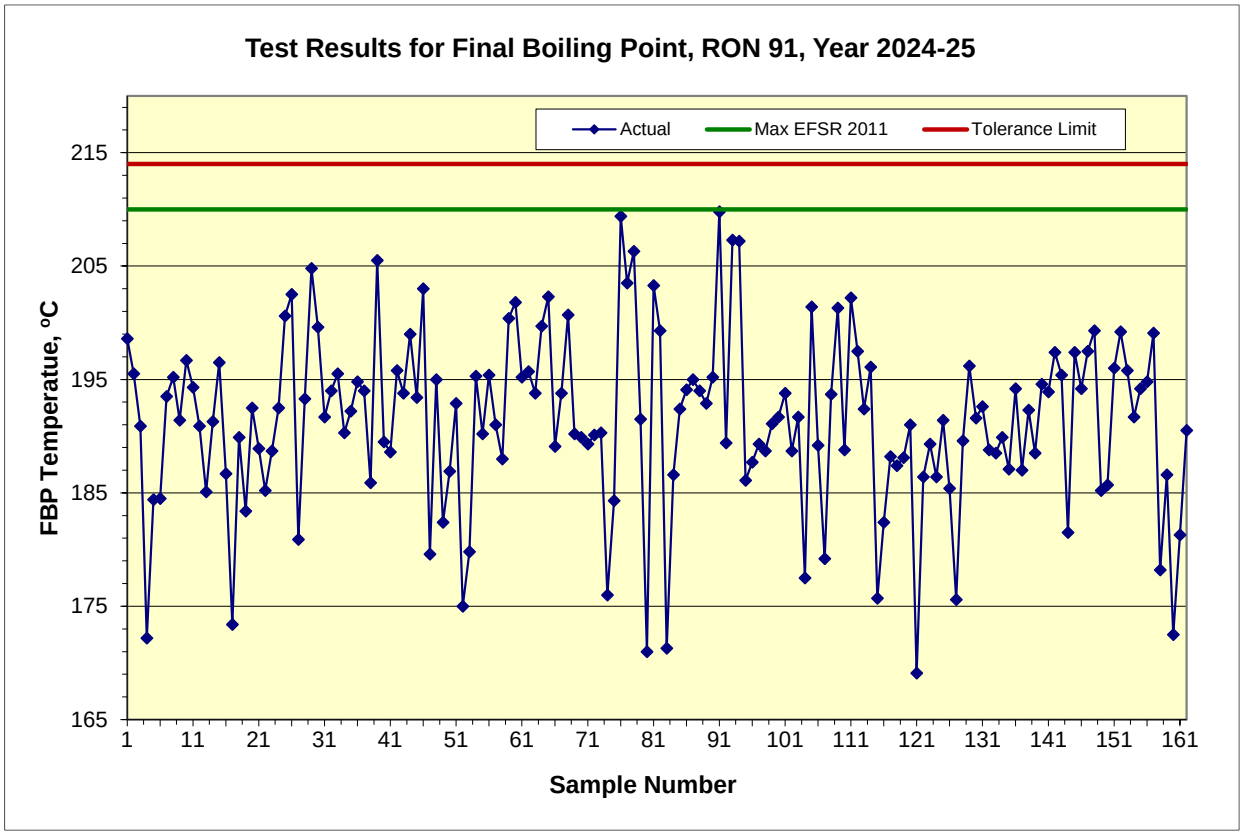


Fig. 7a

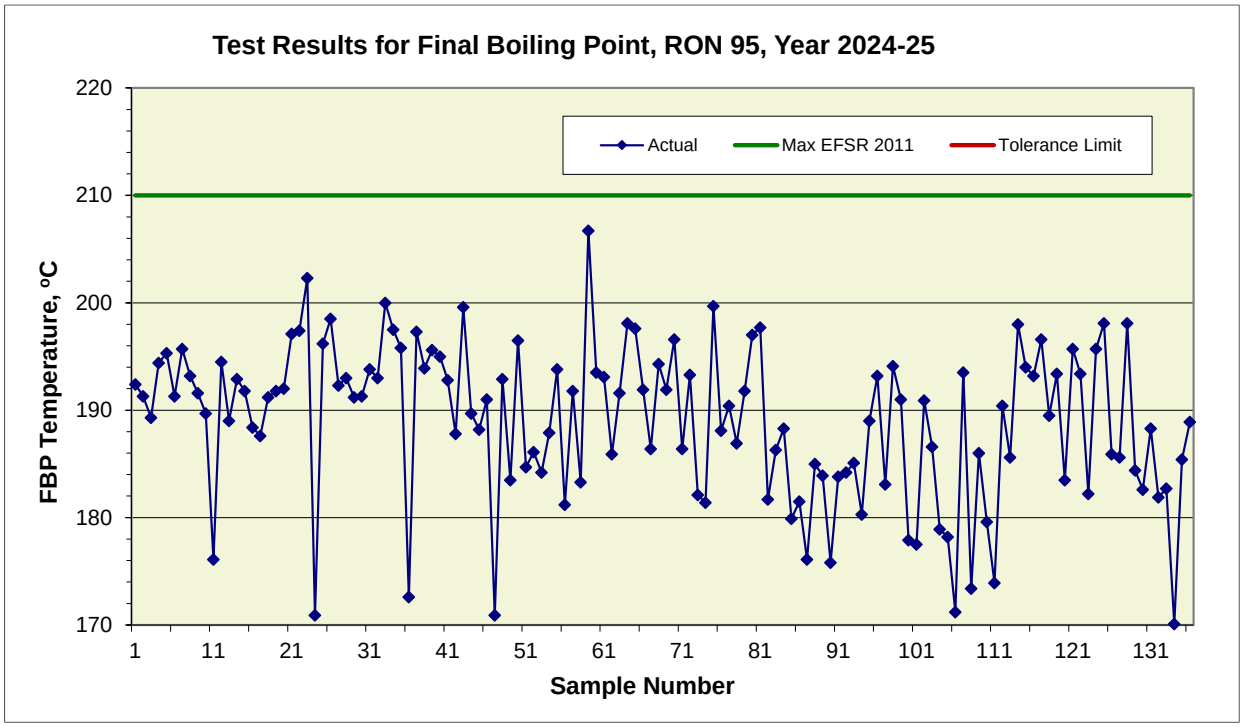

Test Results for Final Boiling Point, RON 95, Year 2024-25
Actual
Max EFSR 2011
Tolerance Limit
FBP Temperature, °C
220
210
200
190
180
170
1
11
21
31
41
51
61
71
81
91
101
111
121
131
Sample Number

Fig. 7b

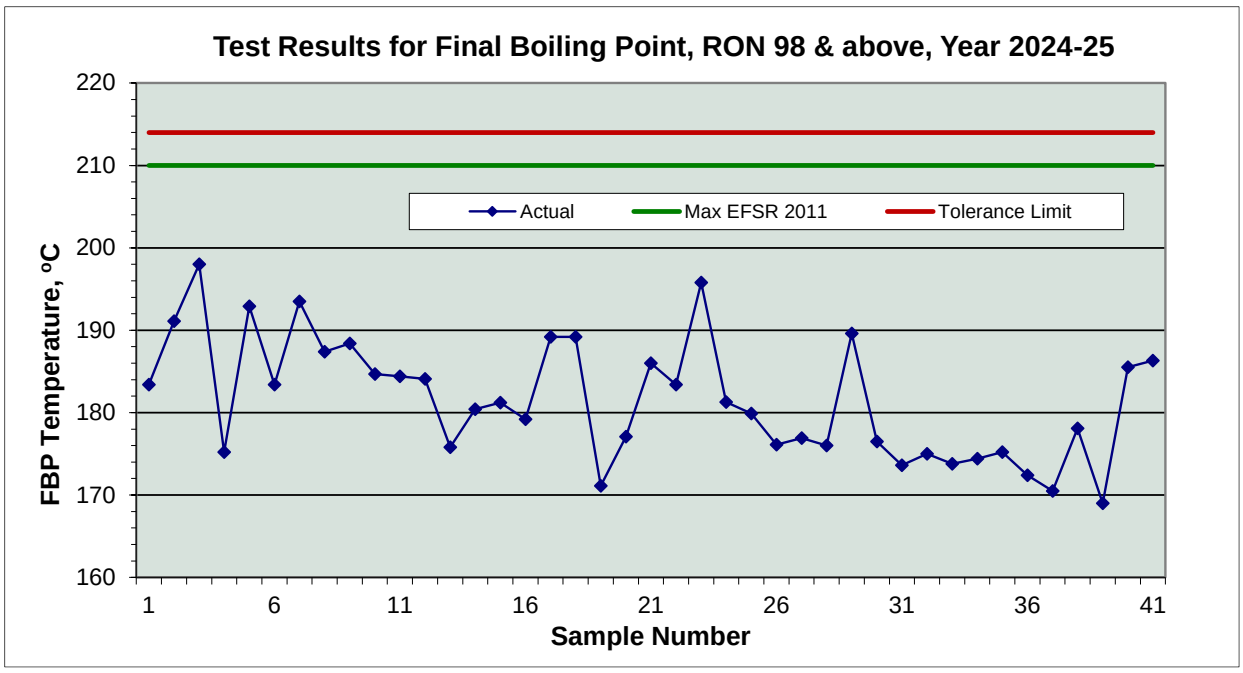

Test Results for Final Boiling Point, RON 98 & above, Year 2024-25
Actual
Max EFSR 2011
Tolerance Limit
FBP Temperature, °C
220
210
200
190
180
170
160
1
6
11
16
21
26
31
36
41
Sample Number

Fig. 7c

Residue

Distillation residue, as defined by ASTM D86 and prescribed in the Regulations, serves primarily as an indicator of the correct operation of the distillation process. It is considered a process control parameter and, due to its nature, is not subject to repeatability or reproducibility requirements within the standard. Consequently, ASTM D86 does not specify a tolerance limit for residue.

All samples tested during the reporting period were found to have residue content below the specified maximum limit of 2% by volume (Fig. 8).

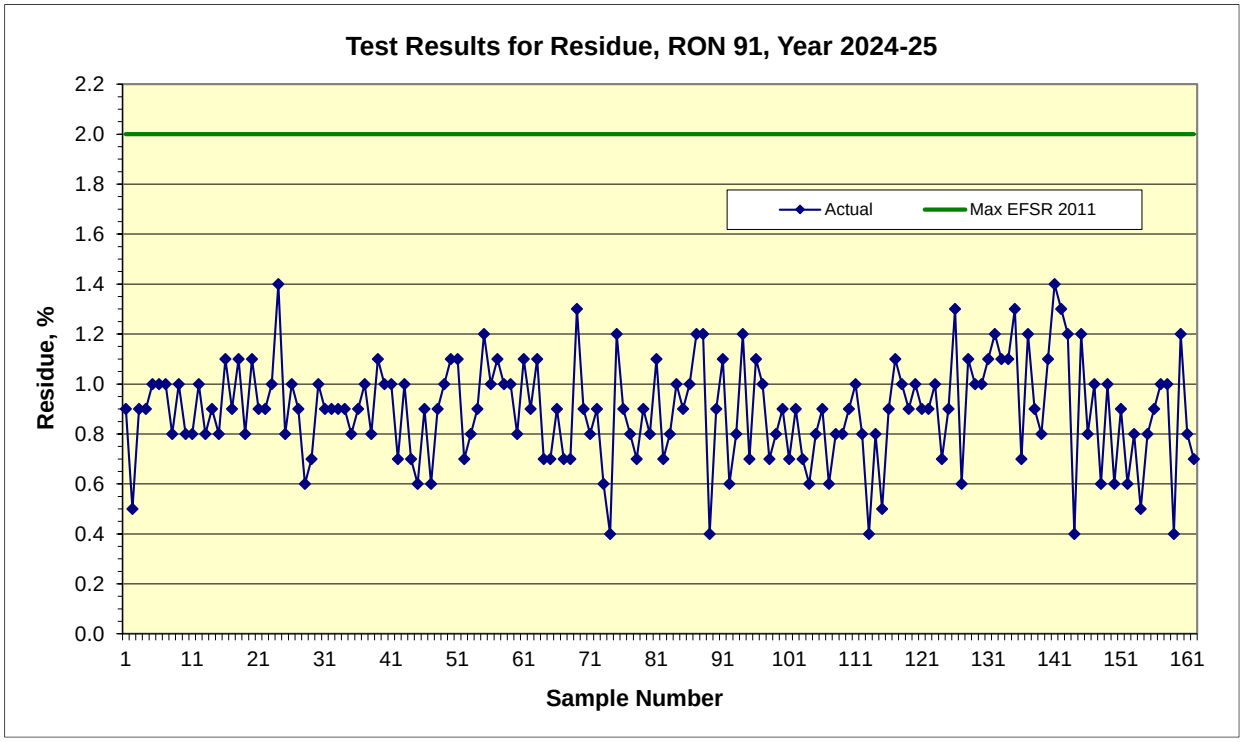


Fig. 8a

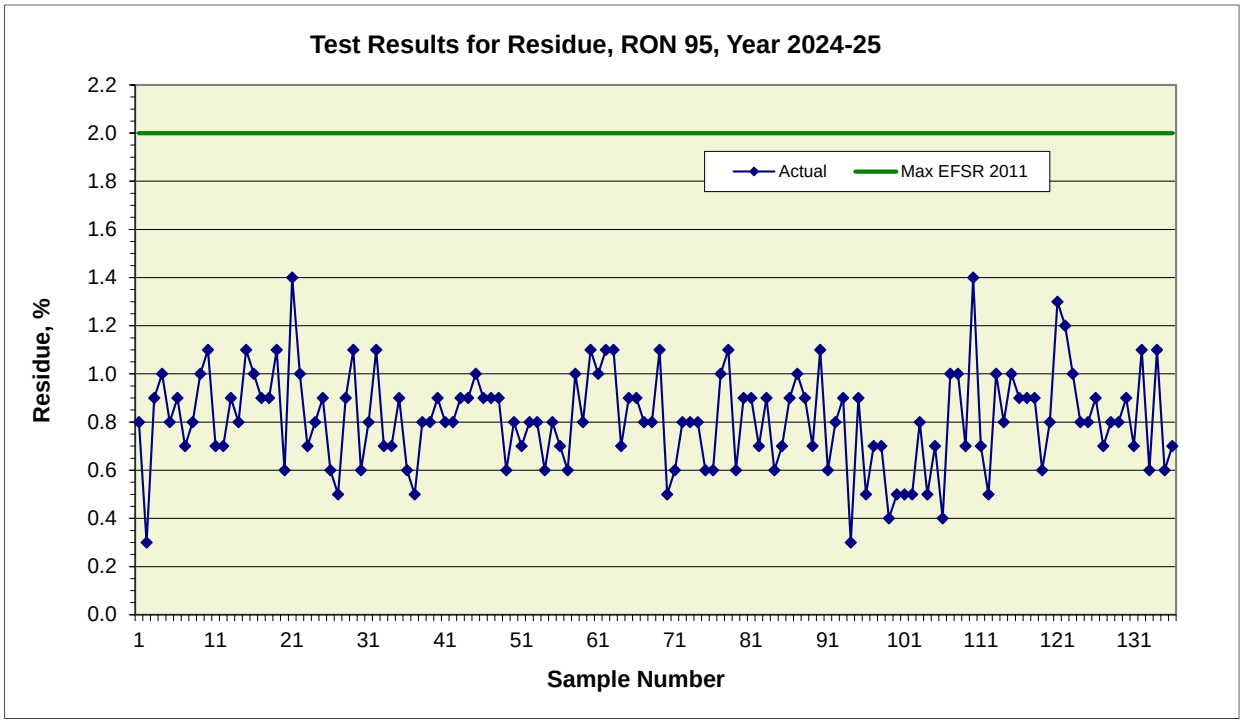

Test Results for Residue, RON 95, Year 2024-25
Residue, %
Sample Number
Actual
Max EFSR 2011
2.2
2.0
1.8
1.6
1.4
1.2
1.0
0.8
0.6
0.4
0.2
0.0
1
11
21
31
41
51
61
71
81
91
101
111
121
131

Fig. 8b

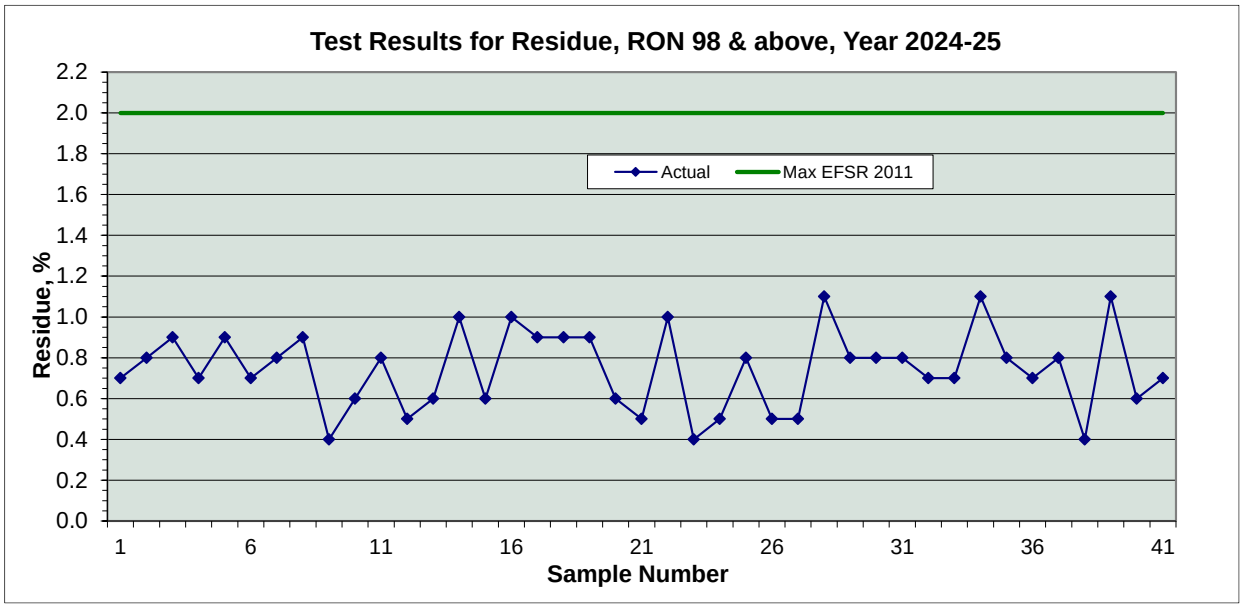

Test Results for Residue, RON 98 & above, Year 2024-25
Residue, %
Sample Number
Actual
Max EFSR 2011
2.2
2.0
1.8
1.6
1.4
1.2
1.0
0.8
0.6
0.4
0.2
0.0
1
6
11
16
21
26
31
36
41

Fig. 8c

Dry Vapour Pressure Equivalent (DVPE)

The test method ASTM D5191[10] is prescribed in the Regulations for determining vapour pressure in petrol. Vapour pressure must be tightly controlled, particularly at high temperatures, to mitigate the risk of hot fuel handling issues such as vapour lock and excessive evaporative emissions. Vapour lock occurs when liquid fuel vaporises within the fuel system, potentially disrupting fuel pump operation, resulting in loss of feed pressure, reduced engine power, or complete stalling. Conversely, at lower temperatures, a sufficiently high vapour pressure is required to ensure reliable engine starting and satisfactory warm-up performance.

The cumulative results for the maximum vapour pressure limits are presented below, combining the lowest prescribed maximum limits for all seasons in a single graph. Generally, if results are below the lowest maximum limit established for a given area, compliance with the Regulations is achieved for all other areas.

For the summer period, as defined in Schedule 1, Section 5 of the Regulations (1 December to 31 March), the lowest maximum limit of 65 kPa applies to Auckland and Northland. This is reflected in Figure 9 as a minimum dip. The subsequent lines represent the next lowest maximum limit of 80 kPa, prescribed for the North Island during autumn (1 April to 31 May) and spring (1 September to 30 November). For winter (1 June to 31 August), the maximum limit for the North Island is 90 kPa, as indicated by the upper lines in the graph. The maximum limit for winter in the South Island is 95 kPa (not shown).

Each sample within the relevant season that appeared to exceed the lowest maximum limit was individually analysed. Tolerance limits related to the maximum specification limits are not shown, as they are approximately 3% above each relevant limit. All samples tested for Dry Vapour Pressure Equivalent (DVPE) were found to be above the prescribed minimum limit of 45 kPa.

RON 91

All 162 samples were found to be within the specification limits for regular petrol (Fig. 9a)

[10] ASTM D5191-22 *Standard Test Method for Vapor Pressure of Petroleum Products (Mini Method)*

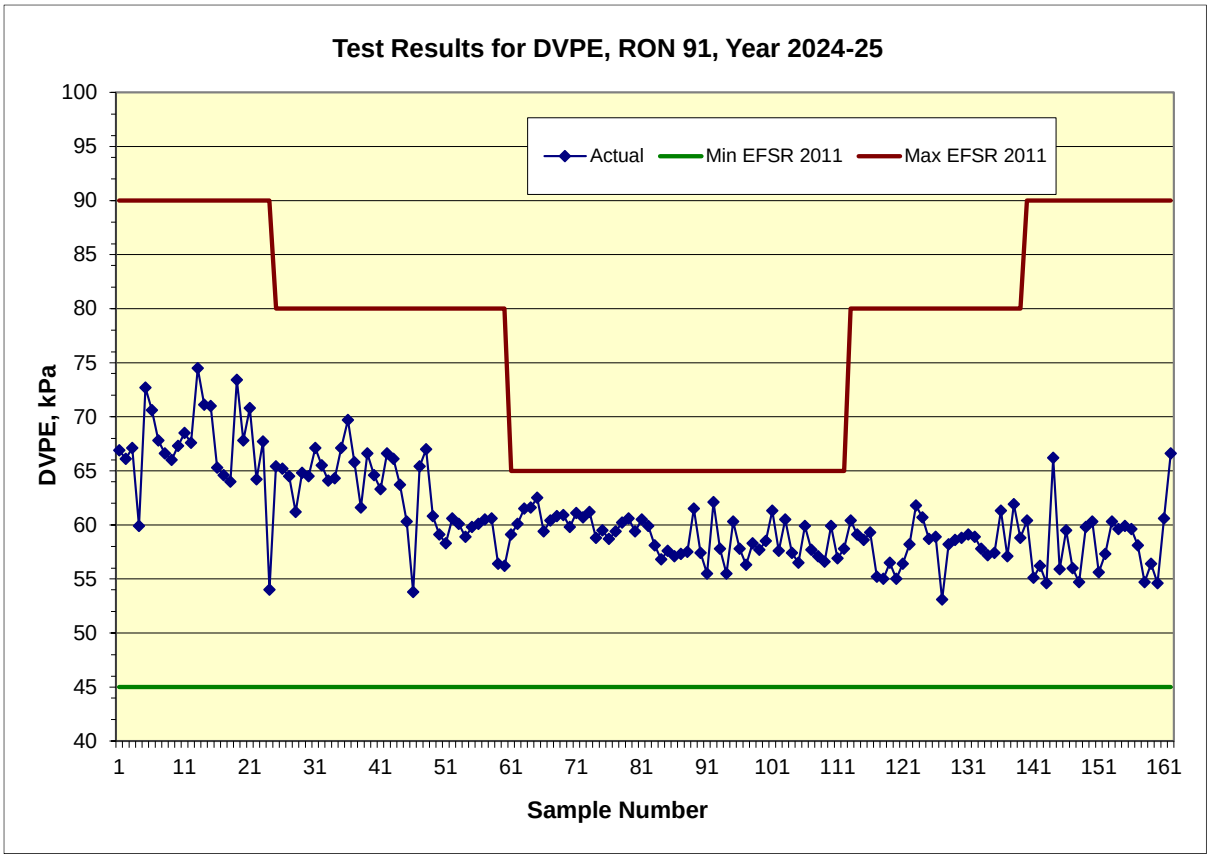


Fig. 9a

RON 95

All 136 samples were found to be within the specification limits for premium petrol (Fig. 9b).

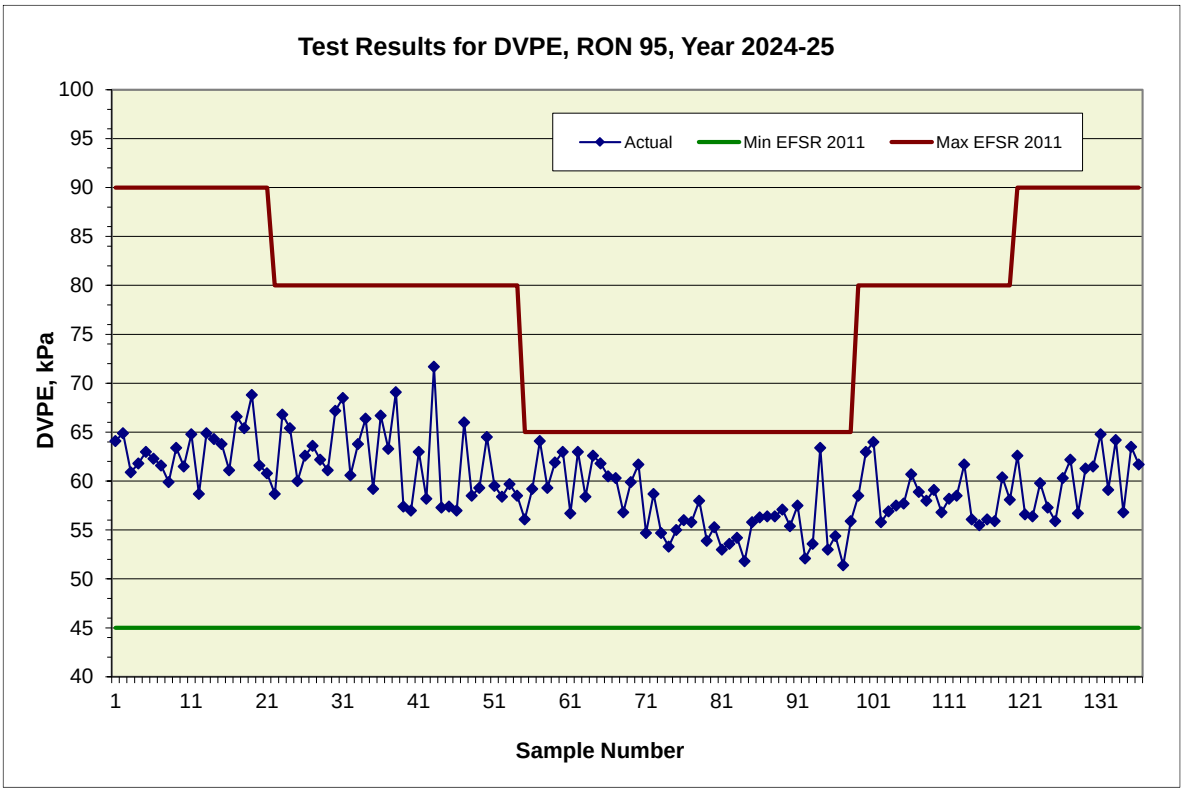


Fig. 9b

RON 98 & above

All 41 samples were found to be within the specification limits for premium petrol RON 98 and above (Fig. 9c).

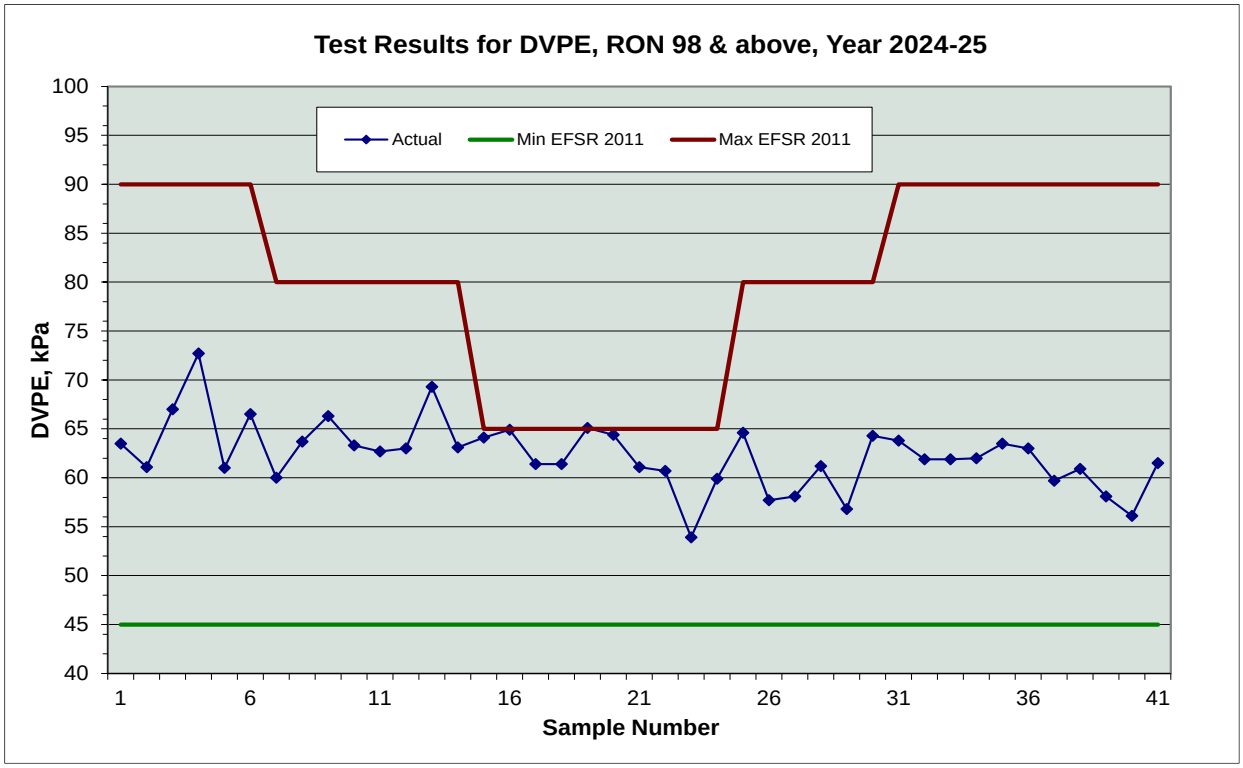


Fig. 9c

Flexible Volatility Index

The Flexible Volatility Index (FVI) is a derived parameter calculated using the measured value of DVPE and the value of E70, according to the formula:

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

FVI serves as an indicator of hot running performance, specifically the tendency for vapour lock under operating conditions. However, no definition or specification for FVI is provided in the relevant ASTM standards prescribed in the Regulations (ASTM D86 and D5191), and as such, no reproducibility value is identified. Consequently, FVI is used solely as a supplementary indicator and is not applied for strict compliance assessment.

RON 91

All samples of regular petrol were found to be within the specification maximum limit of 115.0 (Fig 9d).

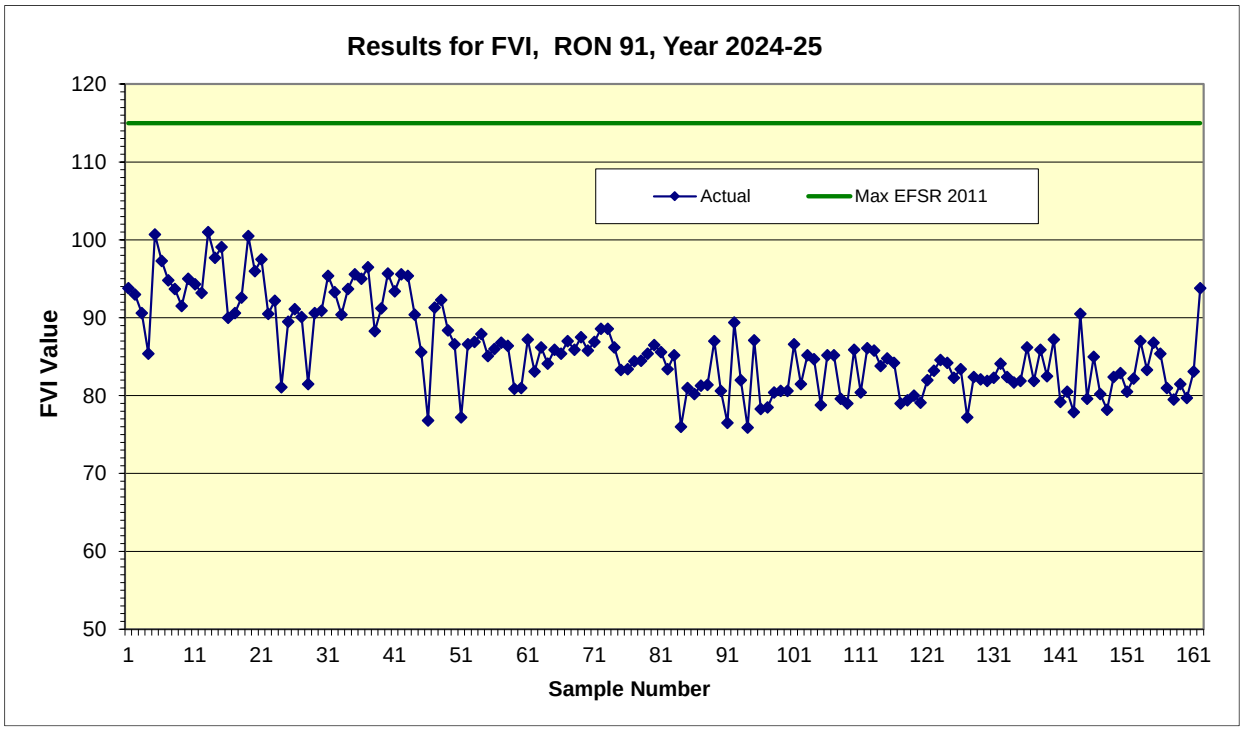


Fig. 9d

RON 95

All samples of premium petrol were found to be within the specification maximum limit of 115.0 (Fig 9e).

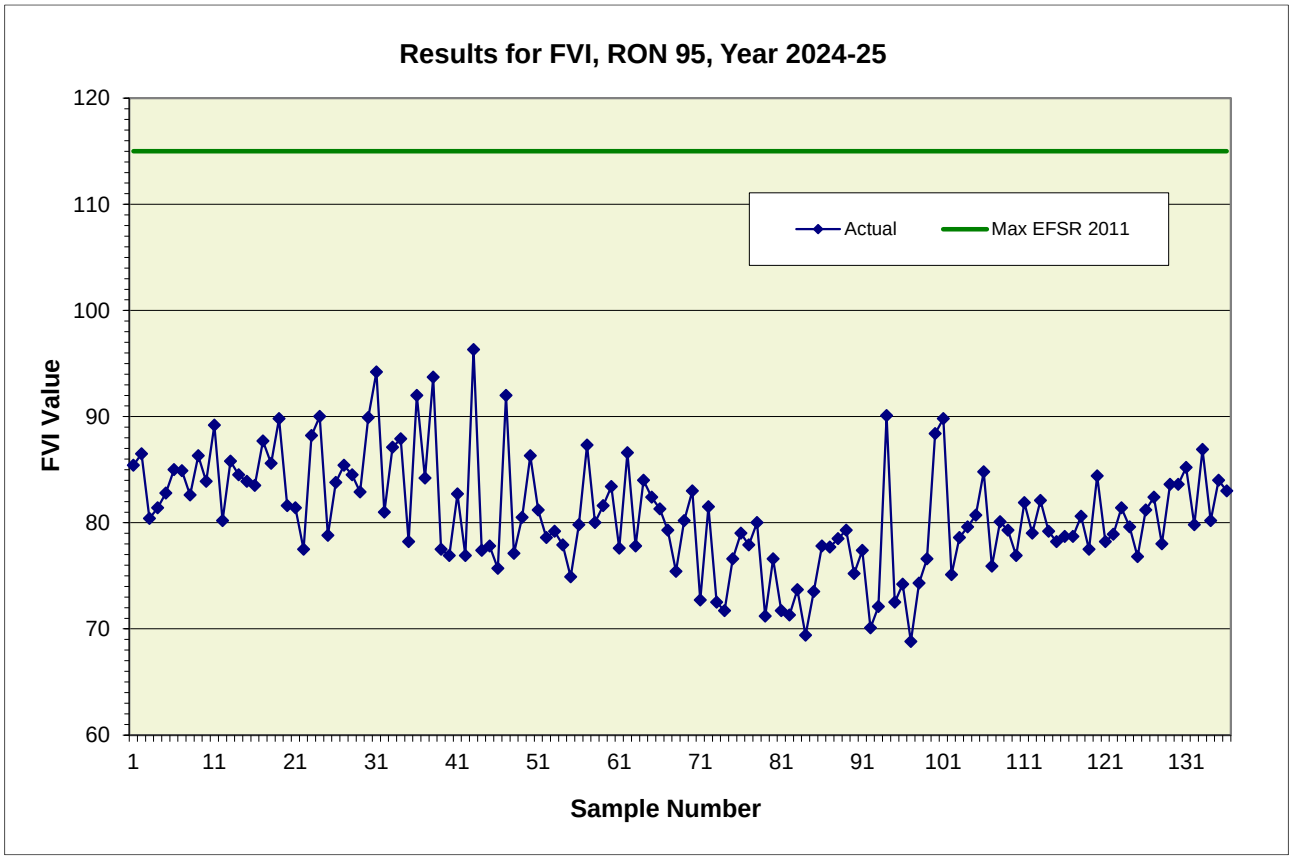


Fig. 9e

RON 98 & above

All samples of premium petrol were found to be within the specification maximum limit of 115.0 (Fig 9f).

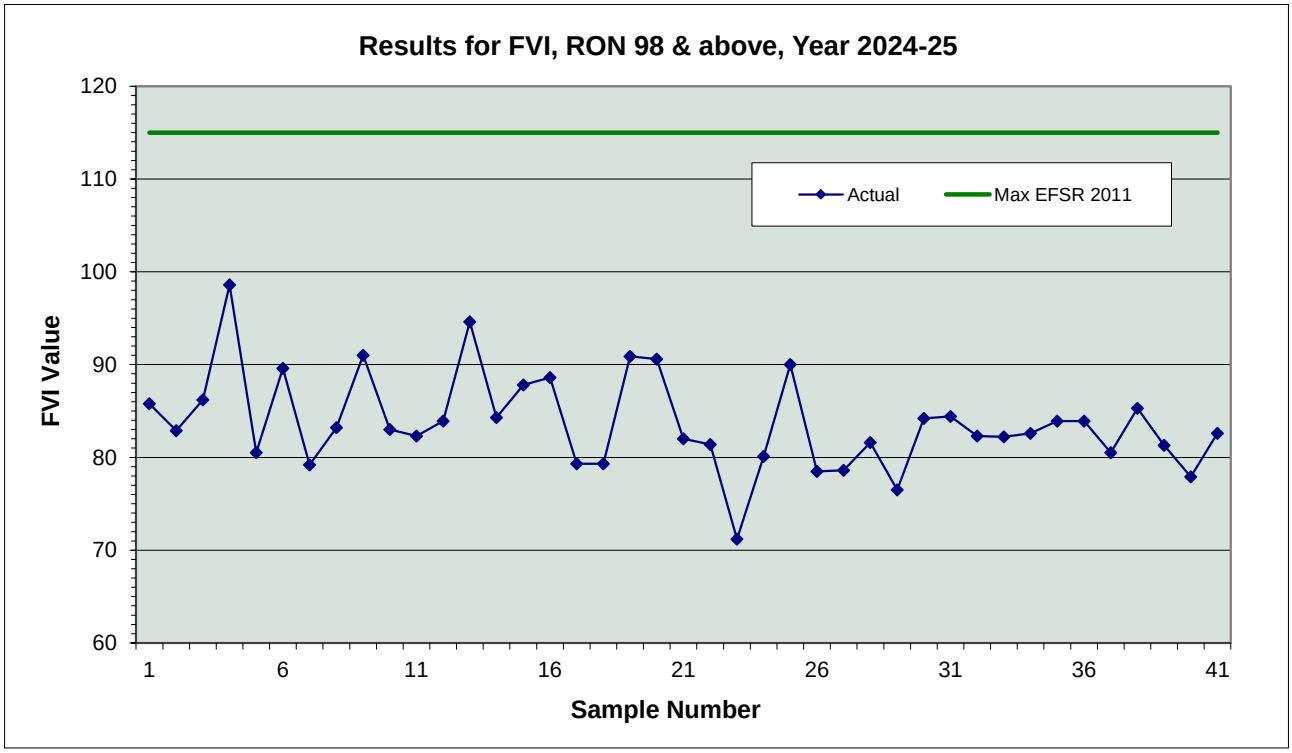


Fig. 9f

Sulphur

Sulphur content in petrol has a significant impact on vehicle emissions, primarily by reducing the efficiency of catalytic converters and adversely affecting heated exhaust gas oxygen sensors. Lowering sulphur levels in petrol leads to immediate reductions in emissions from all catalyst-equipped vehicles.[11]

The Regulations prescribe two primary test methods for determining sulphur content in petrol: IP 497[12] and ASTM D5453[13]. The scope of IP 497 covers a range from 5 to 60 mg/kg, with the lowest reportable result being 5 mg/kg. Since 1 July 2018, the maximum allowable sulphur content in petrol has been set at 10 mg/kg, with a tolerance limit of 11.8 mg/kg. In practice, results at or below 5 mg/kg are considered compliant with the regulatory limit.

ASTM D5453 enables quantification of sulphur down to a fraction of 1 mg/kg, with a tolerance limit of 11.9 mg/kg (shown on the Fig.10 by a red line). This method is widely recognised for its sensitivity and precision in regulatory and quality control applications.

All sulphur test results during the reporting period were found to be within the prescribed specification limits.

RON 91

All 162 samples tested for sulphur in regular petrol were found to be within the prescribed maximum limit.

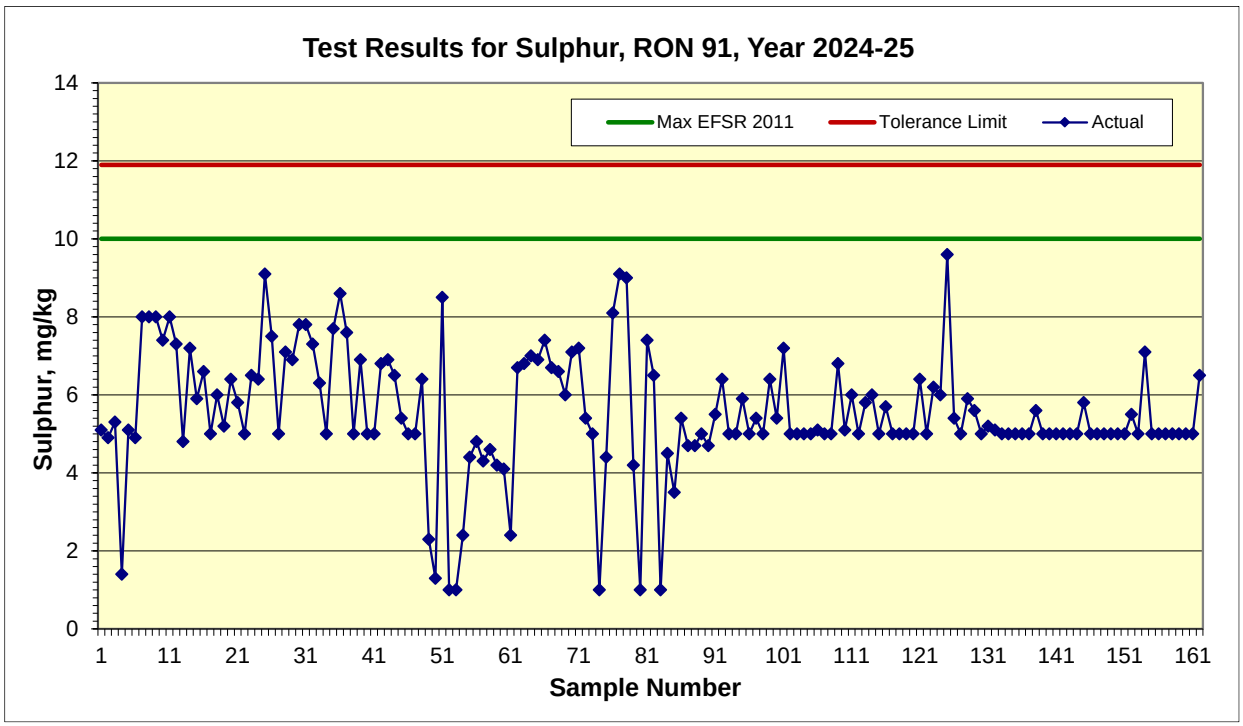


Fig. 10a

[11] *Worldwide Fuel Charter*, 6th Ed., 2019, p.17.
[12] IP497 EN ISO 20884:2019 *Petroleum products - Determination of sulfur content of automotive fuels. Wavelength-dispersive X-ray fluorescence spectrometry*
[13] ASTM D5453–24 *Standard Test Method for Determination of Total Sulfur in Light Hydrocarbons, Spark Ignition Engine Fuel, Diesel Engine Fuel, and Engine Oil by Ultraviolet Fluorescence*

RON 95

All 136 results for premium petrol were found to be within the prescribed maximum limit of 10 mg/kg.

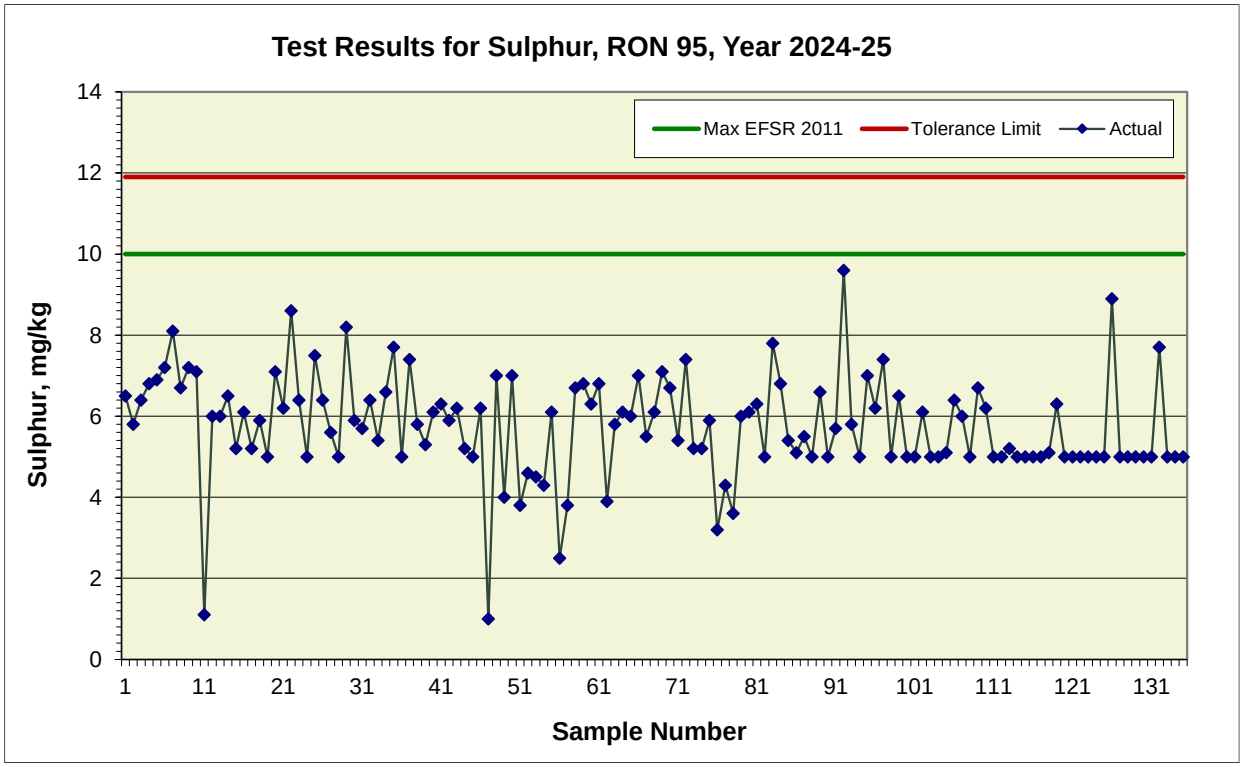


Fig. 10b

RON 98 & above

All 41 results for premium petrol 98 and above were found to be within the prescribed maximum limit not exceeding 8.3 mg/kg.

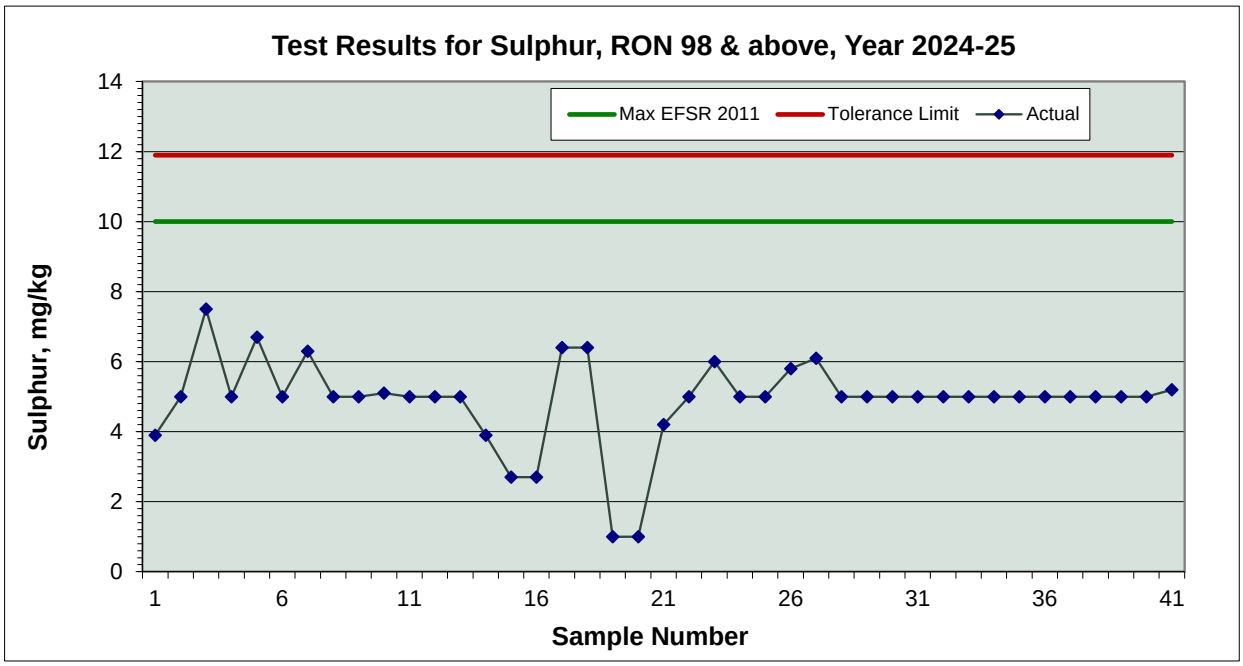


Fig. 10c

Benzene and Total Aromatics

The test method ASTM D5580[14] is prescribed in the Regulations for the determination of aromatic compounds including benzene, in petrol.

All samples tested were found to be within the prescribed maximum limits for both benzene (maximum 1% by volume) and total aromatic compounds (maximum cap of 45% by volume) for both regular and premium grades of petrol. The corresponding tolerance limits are 1.06% for benzene and 46.03% for total aromatics.

RON 91

All 162 results tested for benzene content in regular petrol were found to be below 1% (Fig.11a).

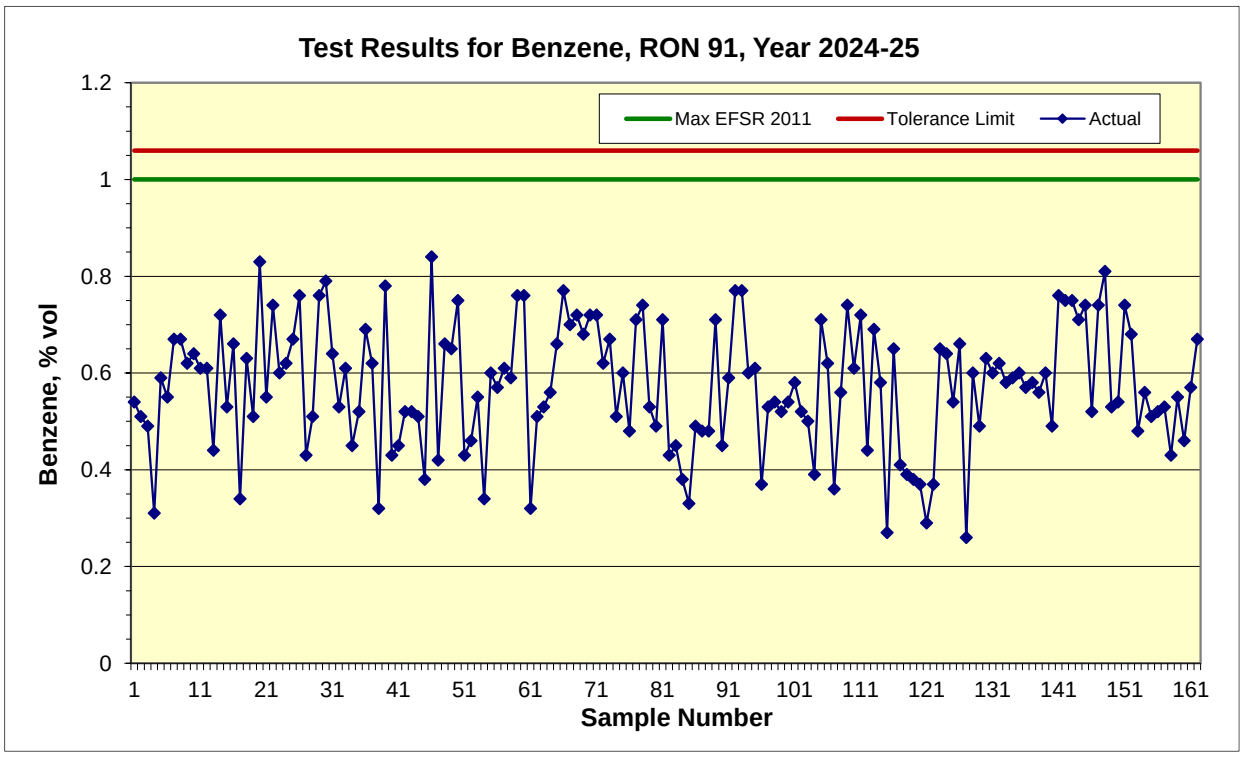


Fig. 11a

All 162 results of total aromatics were found to be within the prescribed limit (Fig. 11b).

[14] ASTM D5580-21 *Standard Test Method for Determination of Benzene, Toluene, Ethylbenzene, p/m-Xylene, o-Xylene, C9 and Heavier Aromatics, and Total Aromatics in Finished Gasoline by Gas Chromatography*

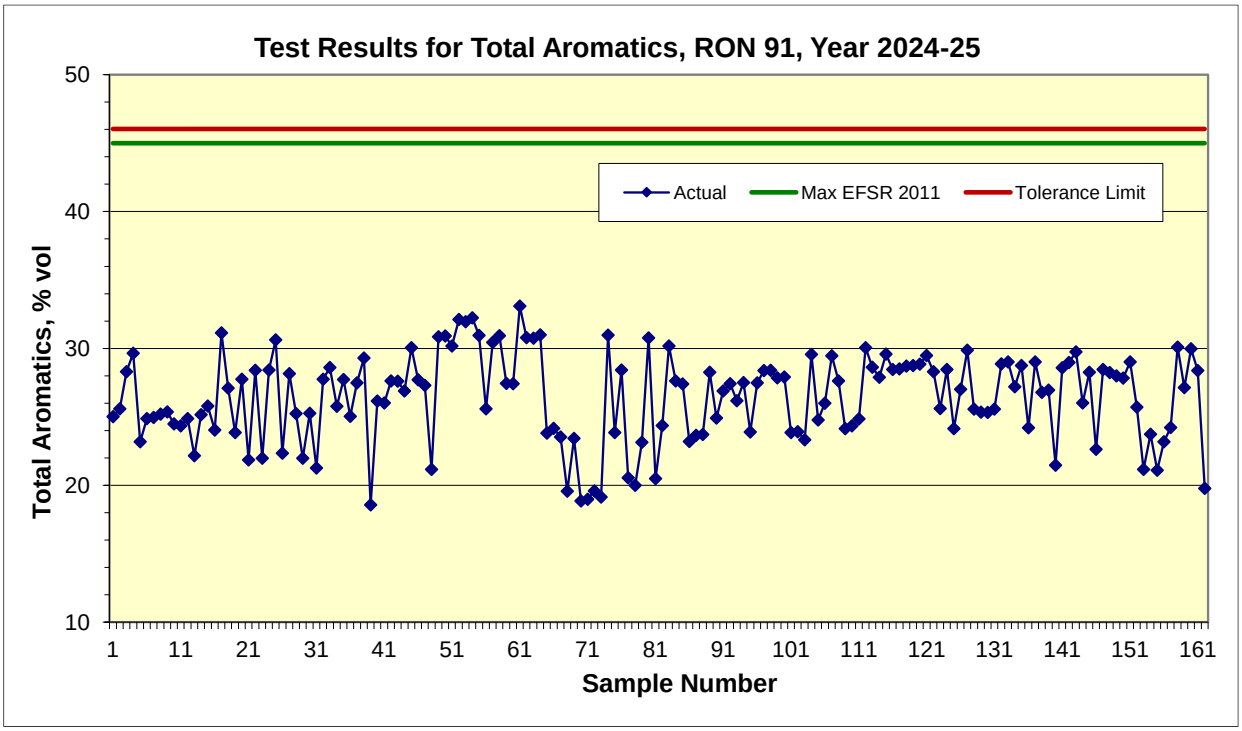


Fig. 11b

RON 95

All 136 samples of premium petrol tested for benzene were found to be within the prescribed maximum limit for benzene (Fig 11c).

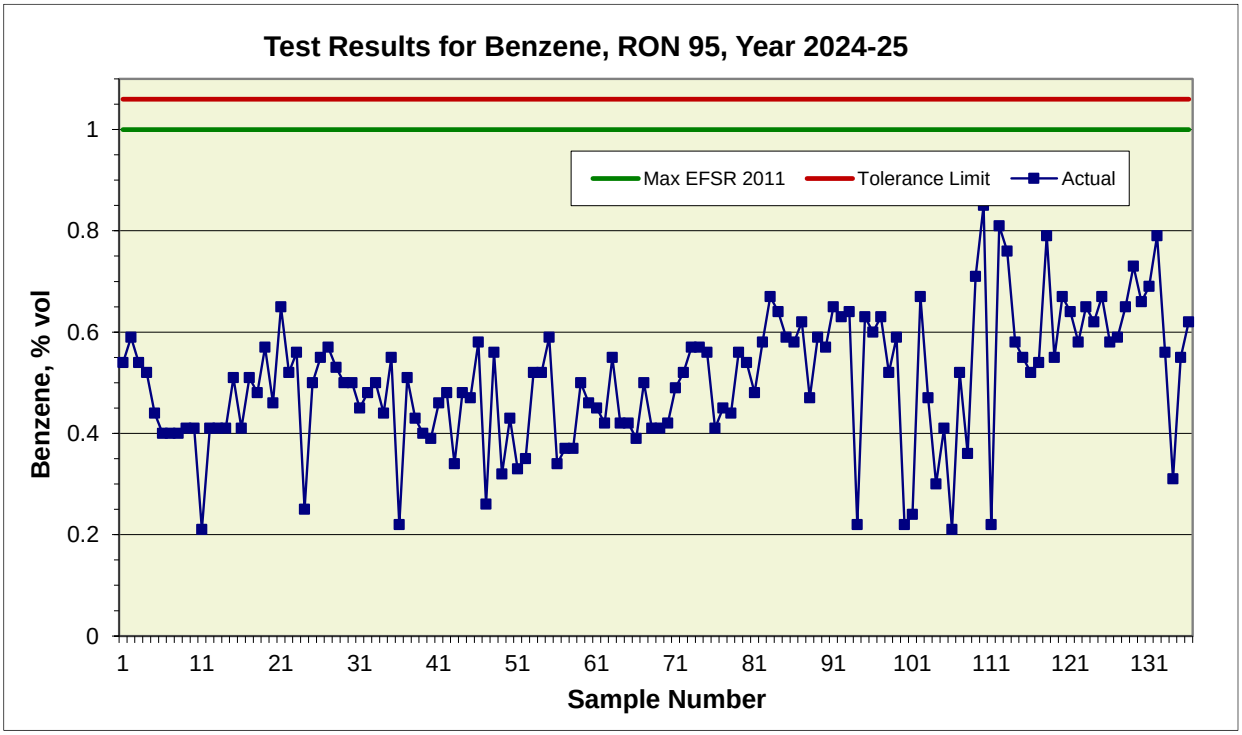


Fig. 11c

For premium petrol, all results on total aromatics were found to be within the maximum limit of 45% (Fig. 11d).

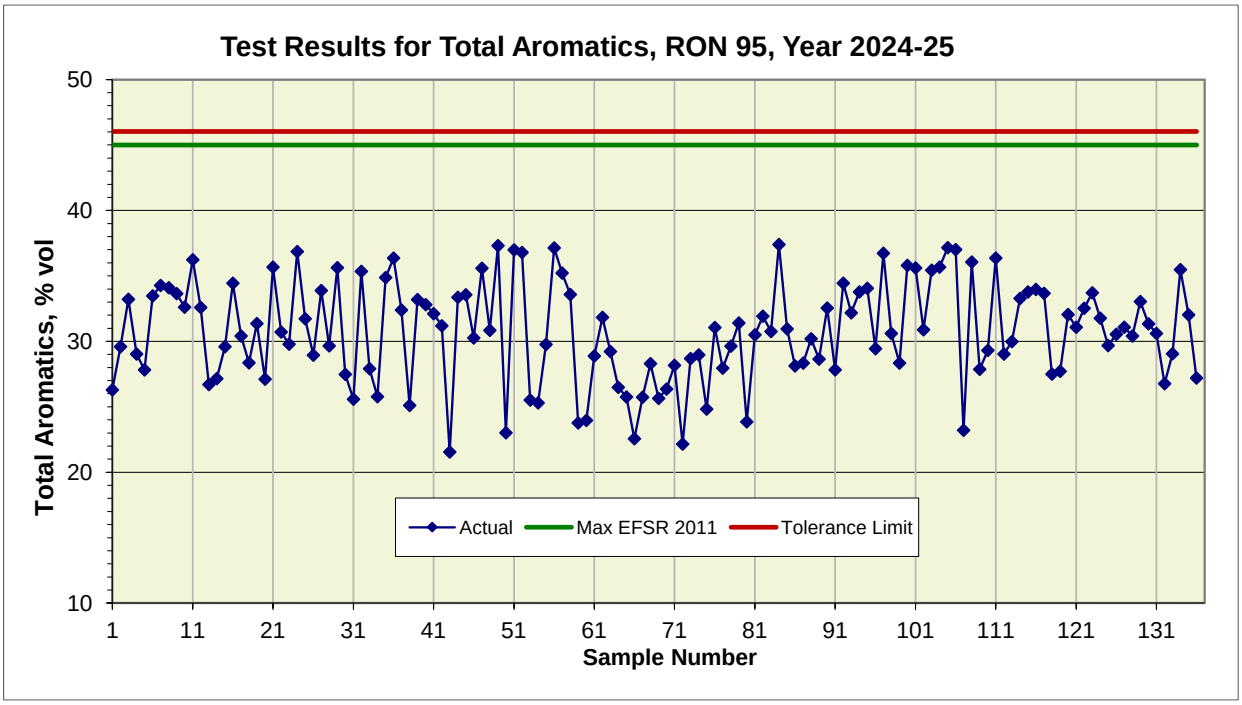


Fig. 11d

RON 98 & above

All 41 samples of premium petrol RON 98 and above tested for benzene were found to be within the prescribed maximum limit for benzene (Fig 11e).

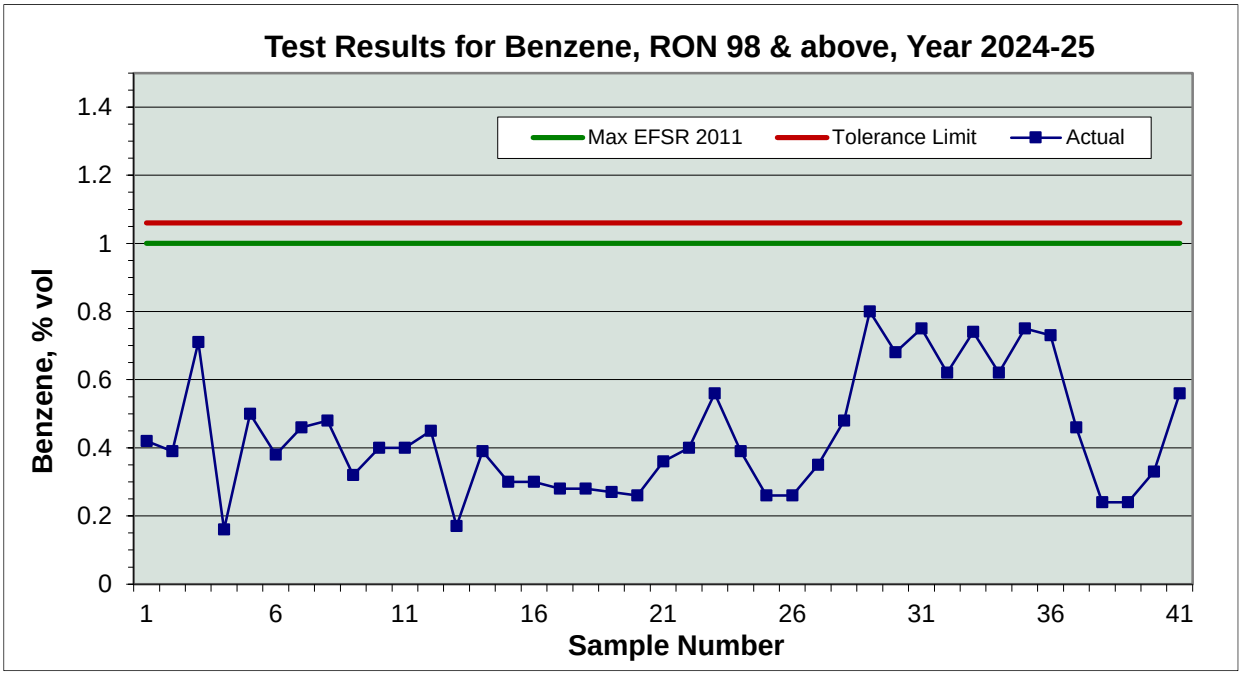


Fig. 11e

For premium petrol RON 98 and above, all results on total aromatics were found to be within the maximum limit of 45% (Fig. 11f).

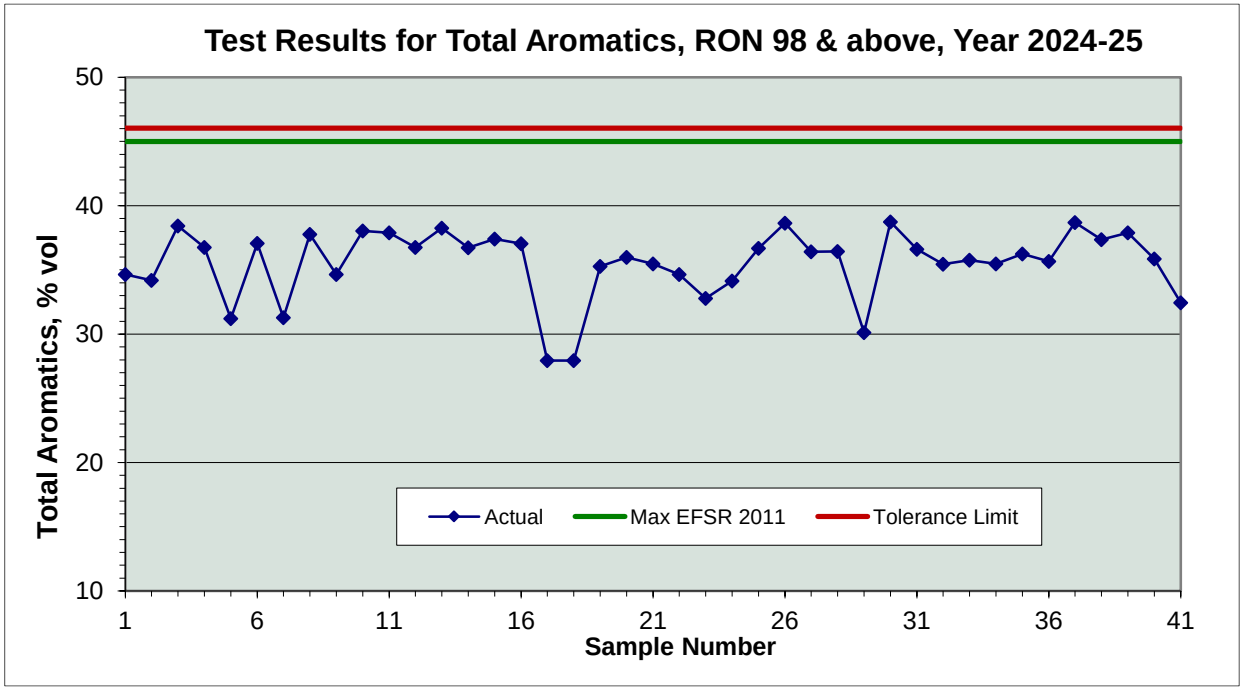


Fig. 11f

Section 19 of the Regulations requires that the actual quantities of petrol produced or imported be used to calculate the 'pool average' for total aromatic compounds for each calendar month. The pool average is defined as the monthly average reported by producers and importers in accordance with the Regulations. The maximum allowable pool average for total aromatics is set at 42% by volume.

During the reporting period, data on the pool average aromatics content in petrol was collected from the fuel importers. All reported results were within the specified regulatory limits. However, due to the commercial sensitivity of the calculation process, the actual figures are not disclosed in this report.

Olefins

The test methods ASTM D1319[15] and ASTM D6839[16] are prescribed in the Regulations for olefins content.

Majority of samples were tested by D6839; all samples were found to be within the specification maximum limit of 18 % vol with the tolerance limit of 19.6 % for D6839 and 20.7 % for D1319.

RON 91

For regular petrol, all the results were found to be below the specified maximum limit of 18% (Fig. 12a).

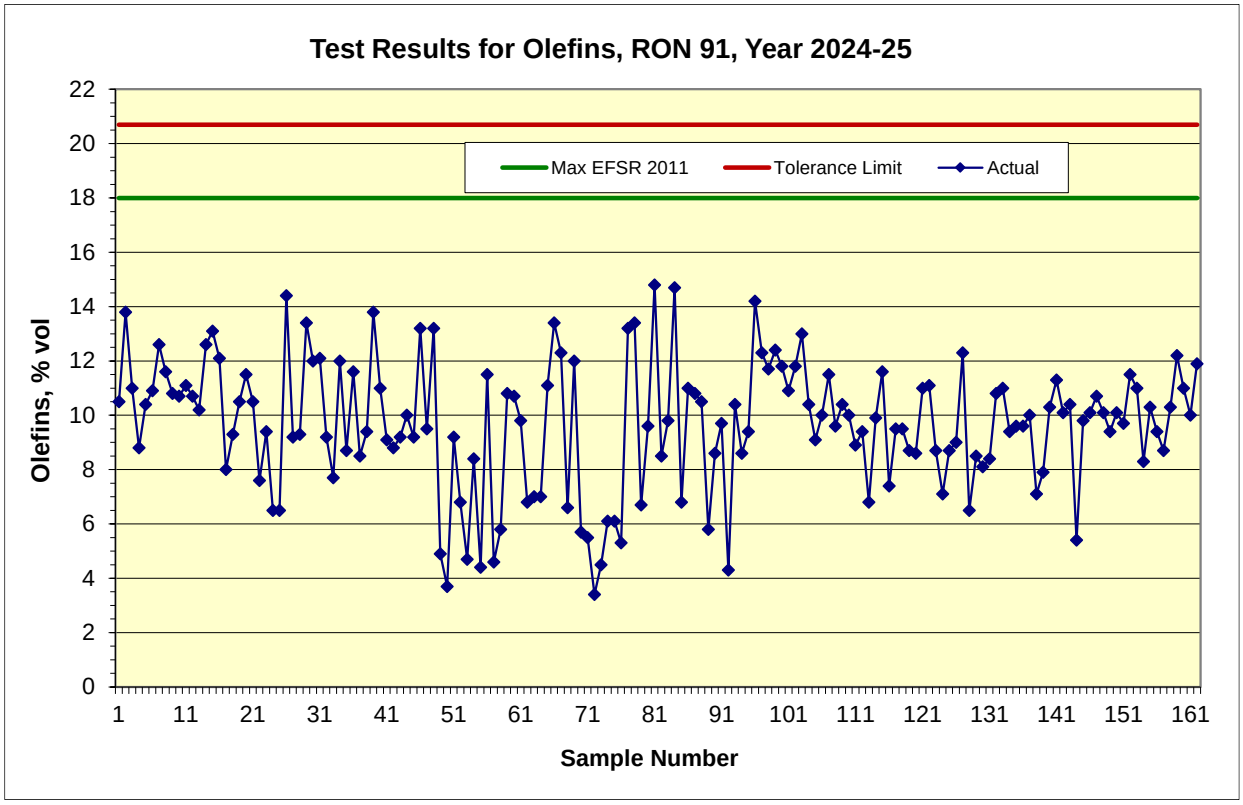


Fig. 12a

RON 95

For premium petrol RON95, all the results were found to be below the specified maximum limit of 18% (Fig. 12b).

[15] ASTM D1319-20a *Standard Test Method for Hydrocarbon Types in Liquid Petroleum Products by Fluorescent Indicator Adsorption*

[16] ASTM D6839-21a *Standard Test Method for Hydrocarbon Types, Oxygenated Compounds, and Benzene in Spark Ignition Engine Fuels by Gas Chromatography*

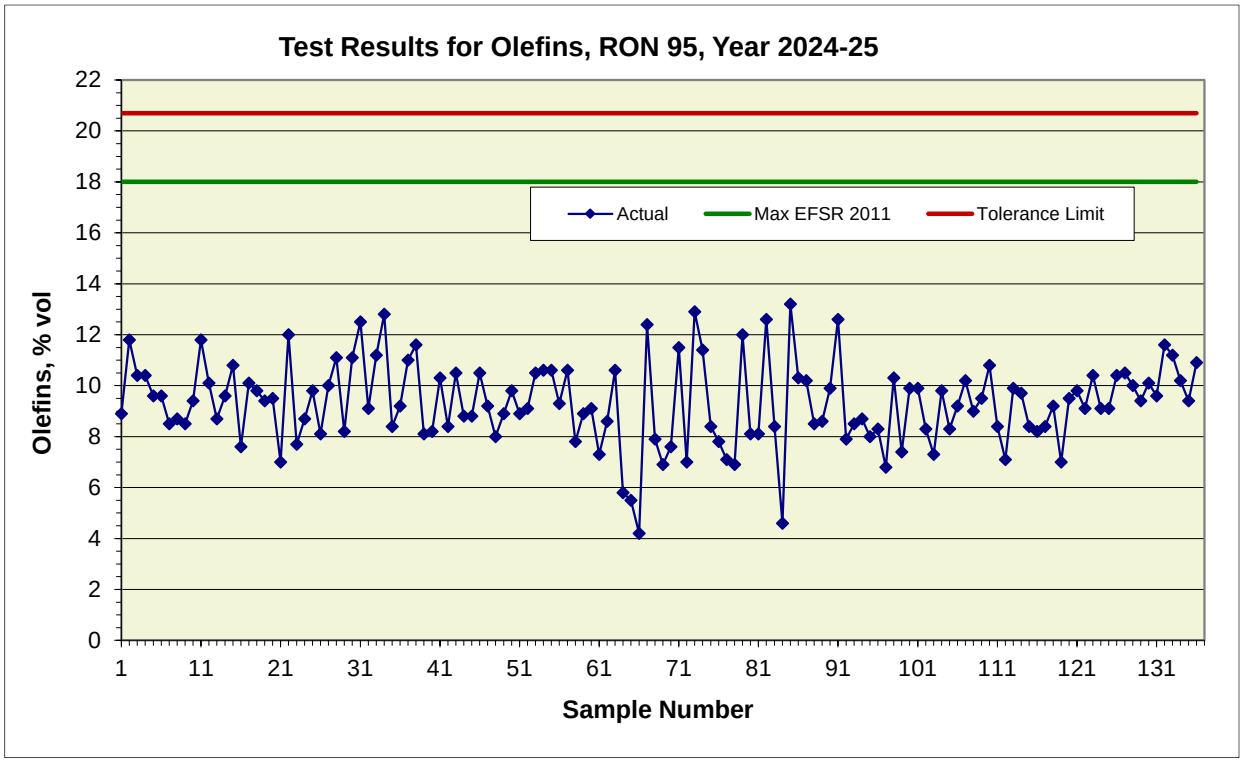


Fig. 12b

RON 98 & above

For premium petrol RON98 and above, all the results were found to be below the specified maximum limit of 18% (Fig. 12c).

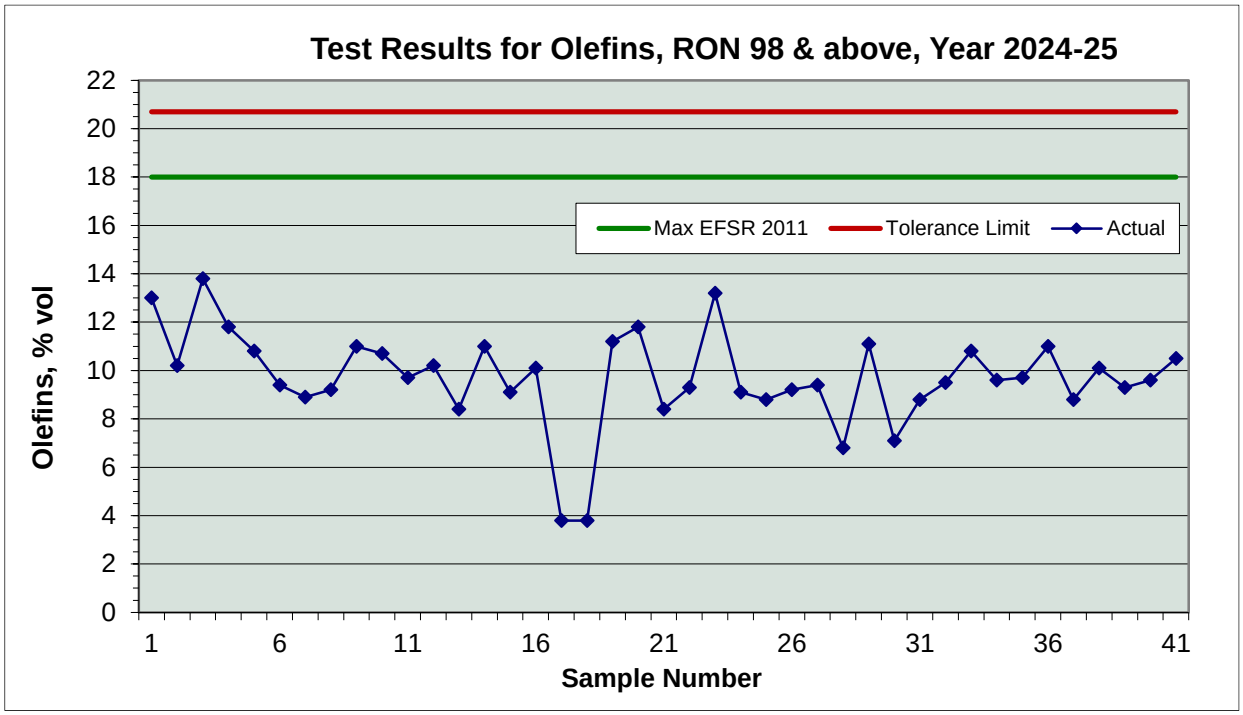


Fig. 12c

Existent Gum (solvent washed)

The test method ASTM D381[17], as prescribed in the Regulations, has a threshold of 0.5 mg/100 mL. Accordingly, the lowest reportable result by this method is 0.5 mg/100 mL, with actual test results found at or below this indicative level. The specified maximum limit for existent gum is 5 mg/100 mL, with a tolerance limit of 7.0 mg/100 mL.

RON 91

For regular petrol, all 162 results were found to be within the maximum specification limit of 5 mg/100mL. (Fig. 13a).

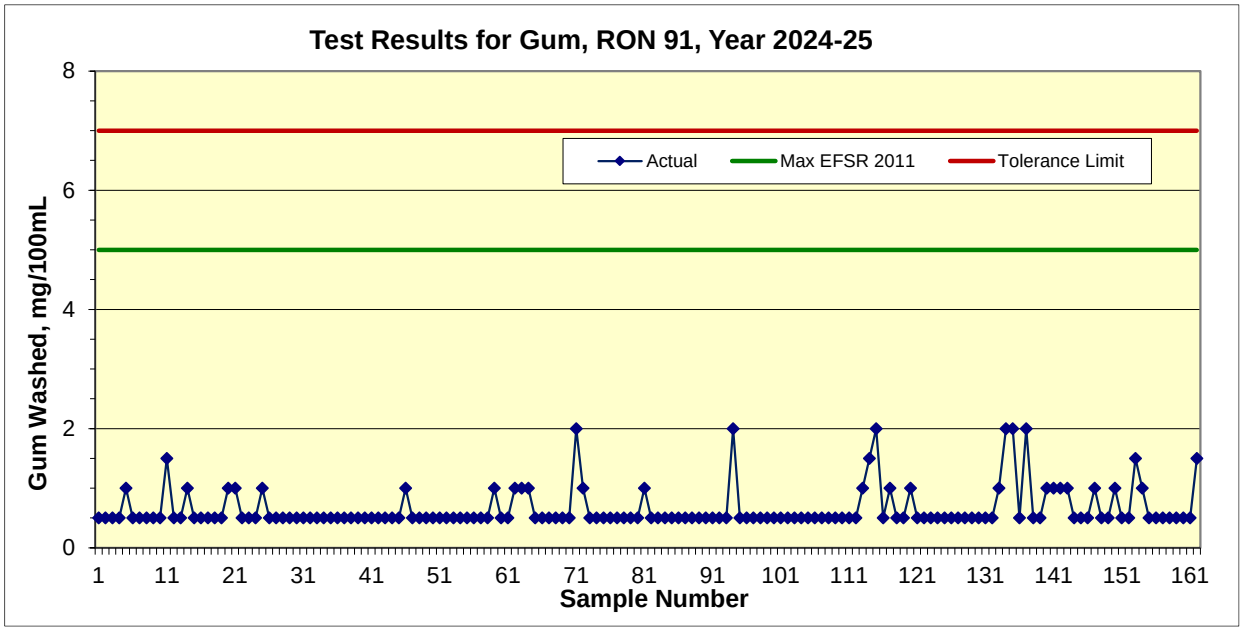


Fig. 13a

[17] ASTM D381-22 *Standard Test Method for Gum Content in Fuels by Jet Evaporation*

RON 95

For premium petrol RON 95, all results were found to be within maximum specification limit as well (Fig. 13b).

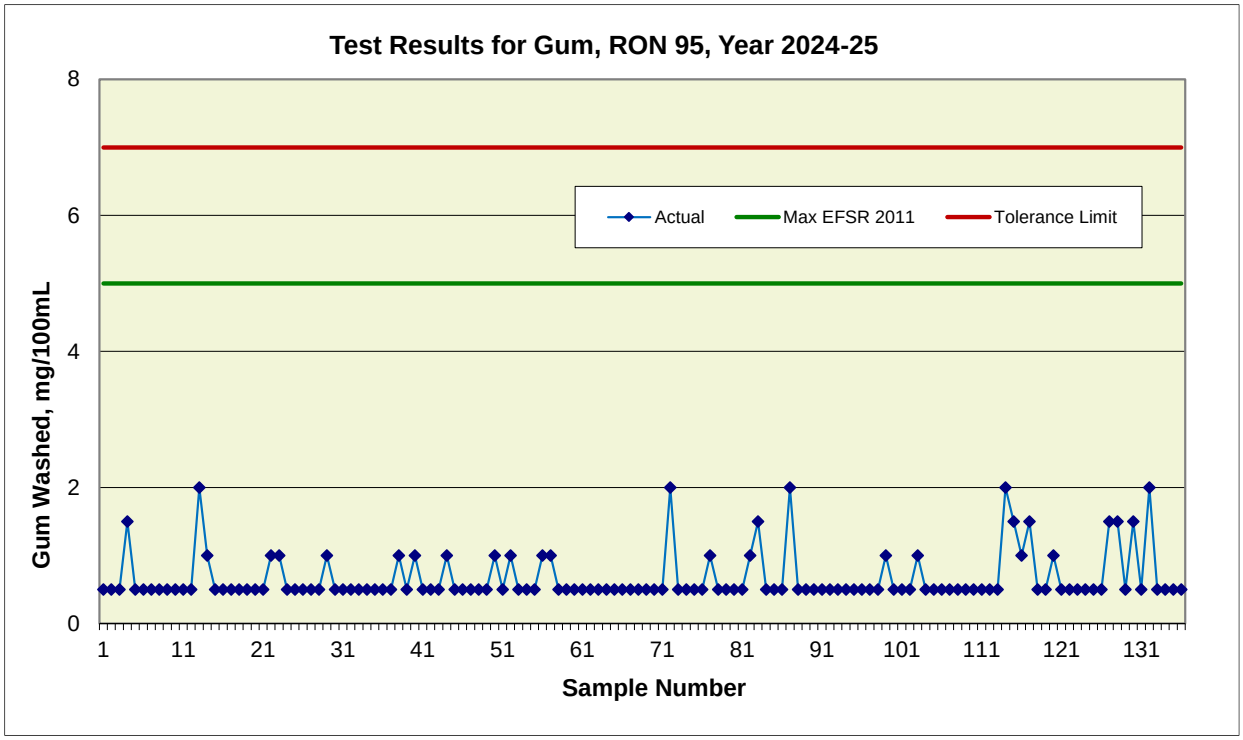


Fig. 13b

RON 98 & above

For premium petrol RON 98 & above, all results were also found to be within maximum specification limit (Fig. 13c).

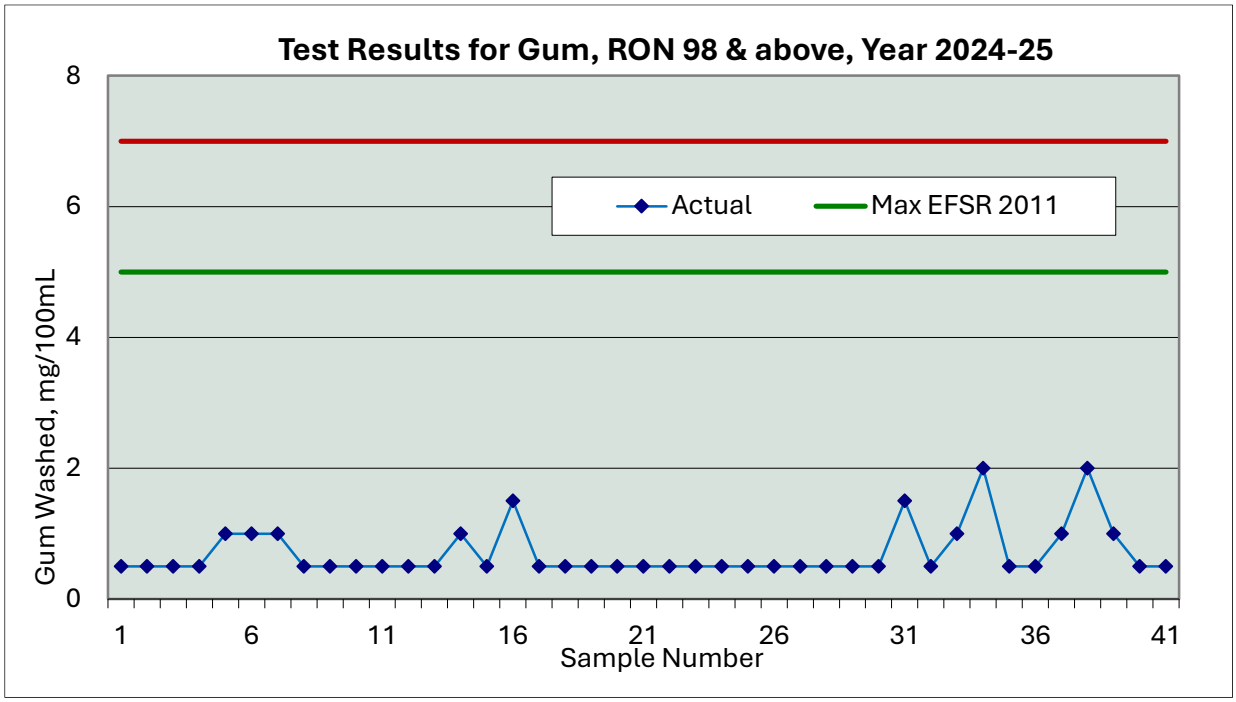


Fig. 13c

Other Parameters Test Results

In addition to the parameters described above, testing and analysis were also conducted—albeit at a lower frequency—on other properties prescribed in the Regulations. These included screening for contaminants such as lead and manganese, which are not expected to be present in fuel. Screening for these elements was performed using test methods conditionally agreed upon between the Ministry and the testing laboratory[18]. For phosphorus, initial identification was carried out at the threshold of resolution by the specified method[19].

Further, 52 samples of regular petrol and 62 samples of premium petrol were tested for copper strip corrosion[20] and 51 samples for oxidation stability[21]; all of them were found to be compliant.

9 samples of petrol with an advertised RON 100+ were tested this year. All results were found to be within the specifications of Schedule 1 in the Regulations.

In addition, 52 regular petrol samples and 62 premium petrol samples were tested for silver strip corrosion. This test helps to detect the presence of active sulphur. The results were acceptable, even though the Regulations have not specified the test method yet. The significance of this test was realised after the active sulphur contamination incident in 2017-18 (refer to the Report for the year 2018-19).

The results of these tests have not been included in this report, as they were generally found to be below the detection threshold and within the relevant specification limits.

Summary for Petrol Test Results

Comprehensive testing of petrol samples collected during the reporting period confirmed compliance with the Regulations. All samples of regular and premium petrol were found to meet the prescribed specification limits for key quality parameters, including RON, MON, evaporation percentage (E70, E100, E150), final boiling point, residue, vapour pressure, and flexible volatility index.

Sulphur content in all samples was well below the maximum allowable limit, supporting reduced vehicle emissions and improved catalyst performance. Benzene and total aromatic compounds were consistently within regulatory limits, and pool average for total aromatics, as reported by fuel importers, did not exceed the specified maximum. Existent gum levels, as well as other monitored contaminants such as lead, manganese, and phosphorus, were found to be below detection thresholds or within specification.

Additional parameters, including copper strip corrosion, oxidation stability, and other trace elements, were also assessed where required, with all results demonstrating compliance.

[18] ASTM D5185–18 *Standard Test Method for Multielement Determination of Used and Unused Lubricating Oils and Base Oils by Inductively Coupled Plasma Atomic Emission Spectrometry (ICP-AES)*
[19] ASTM D3231–24 *Standard Test Method for Phosphorus in Gasoline*
[20] ASTM D130-19 *Standard Test Method for Corrosiveness to Copper from Petroleum Products by Copper Strip Test*
[21] ASTM D525-12a(2019) *Standard Test Method for Oxidation Stability of Gasoline (Induction Period Method)*

Diesel

Density

Density of diesel at 15°C can be tested according to ASTM D1298[22] or ASTM D4052[23] prescribed in the Regulations. Respectively, there are two pairs of tolerance limits identified using the two methods for the minimum limit of 820 kg/m^3 and for the maximum limit of 850 kg/m^3.

All 182 samples were found to be within the specification limits (Fig 14).

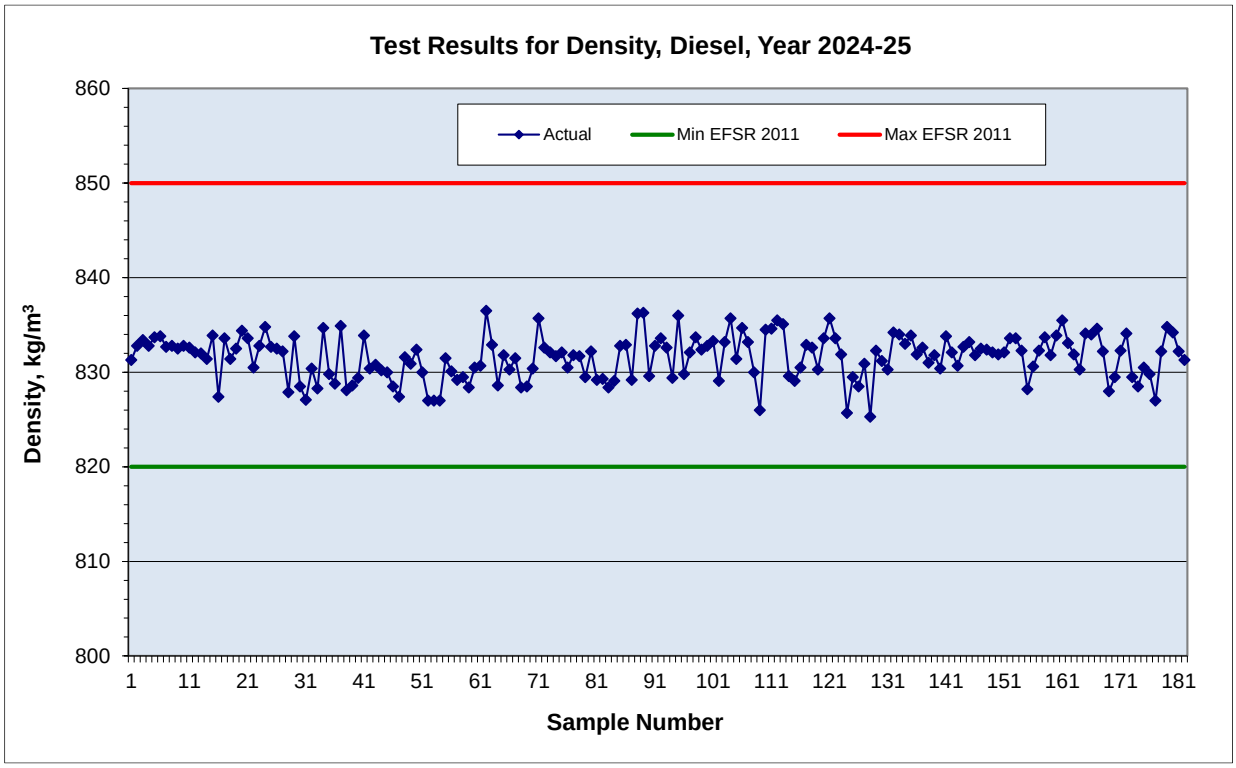


Fig. 14

[22] ASTM D1298-24 *Standard Test Method for Density, Relative Density, or API Gravity of Crude Petroleum and Liquid Petroleum Products by Hydrometer Method*

[23] ASTM D4052-22 *Standard Test Method for Density, Relative Density, and API Gravity of Liquids by Digital Density Meter*

Distillation

The Distillation test means definition of temperature (°C) at which 95% volume recovered. The temperature should be tested by ASTM D86[24] prescribed in the Regulations.

All 182 samples were found to be below the specification maximum limit of 360°C for distillation at 95% volume recovered (T95) at the tolerance limit of 365.5°C. There is no prescribed minimum limit for this property.

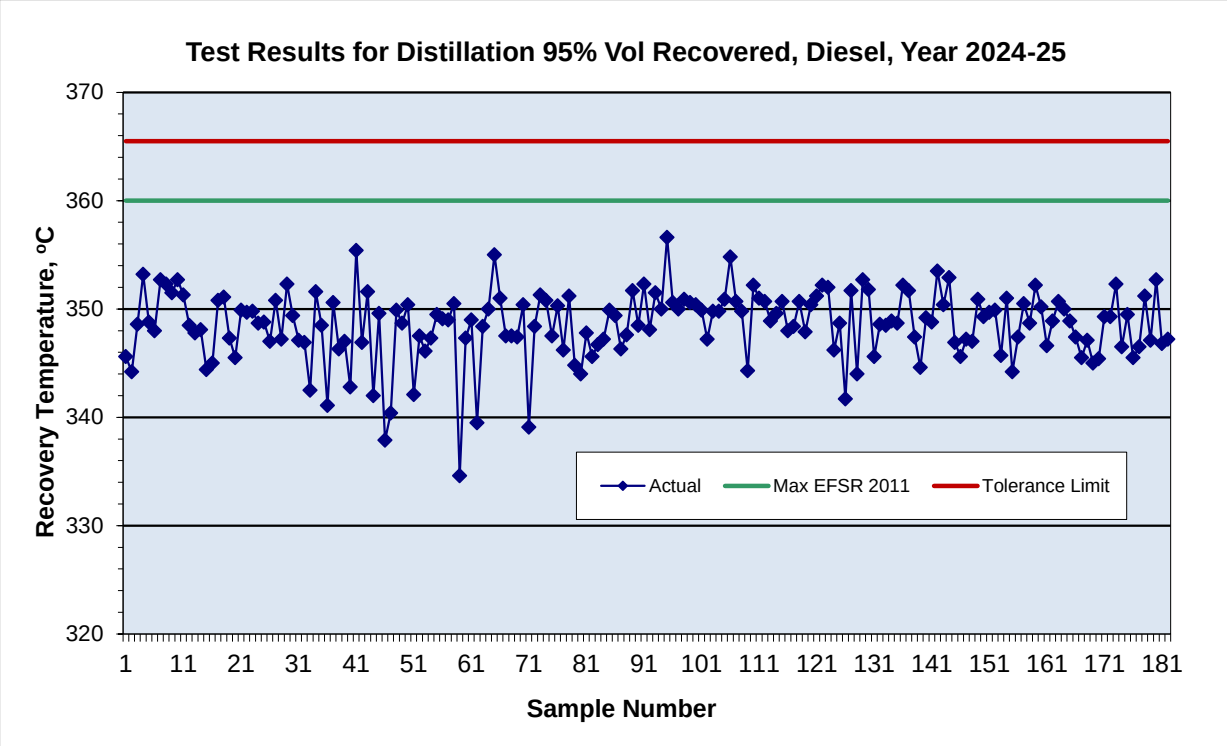


Fig 15

[24] ASTM D86-23ae *Standard Test Method for Distillation of Petroleum Products at Atmospheric Pressure*

Cetane Index

Cetane is a measure of the compression ignition behaviour of a diesel fuel; higher cetane levels enable quicker ignition. Cetane influences cold start-ability, exhaust emissions and combustion noise. In general, higher cetane enables improved control of ignition delay and combustion stability, especially with modern diesels which use high amounts of exhaust gas recirculation.[25]

The cetane index, according to ASTM D4737[26] prescribed in the Regulations, is not tested for but calculated from density and distillation recovery temperature measurements. The calculated cetane index is a tool for estimating cetane number when a test engine for determining cetane number is not available and/or cetane improvers are not used.

Since the reproducibility for cetane index is not defined in the ASTM D4737, it is impossible to exactly define a tolerance limit. However, the Standard specifies that 'the expected error of prediction of Procedure A will be less than ±2 cetane numbers for 65% of the distillate fuels evaluated'. On these grounds, an estimate for the tolerance limit would be derived as 49.8.

Out of the total 182 samples tested for cetane index, two samples failed to meet the specified minimum limit. Both samples recorded average cetane index values of 50.45 and 50.2, respectively. Although these results are below the minimum specification limit of 51, they remain within the estimated tolerance limit for the procedure. This indicates that while the samples are technically out of specification, their cetane index values are not substantially lower than the acceptable range, and they still fall under the expected error margin for the test method employed. (Fig.16).

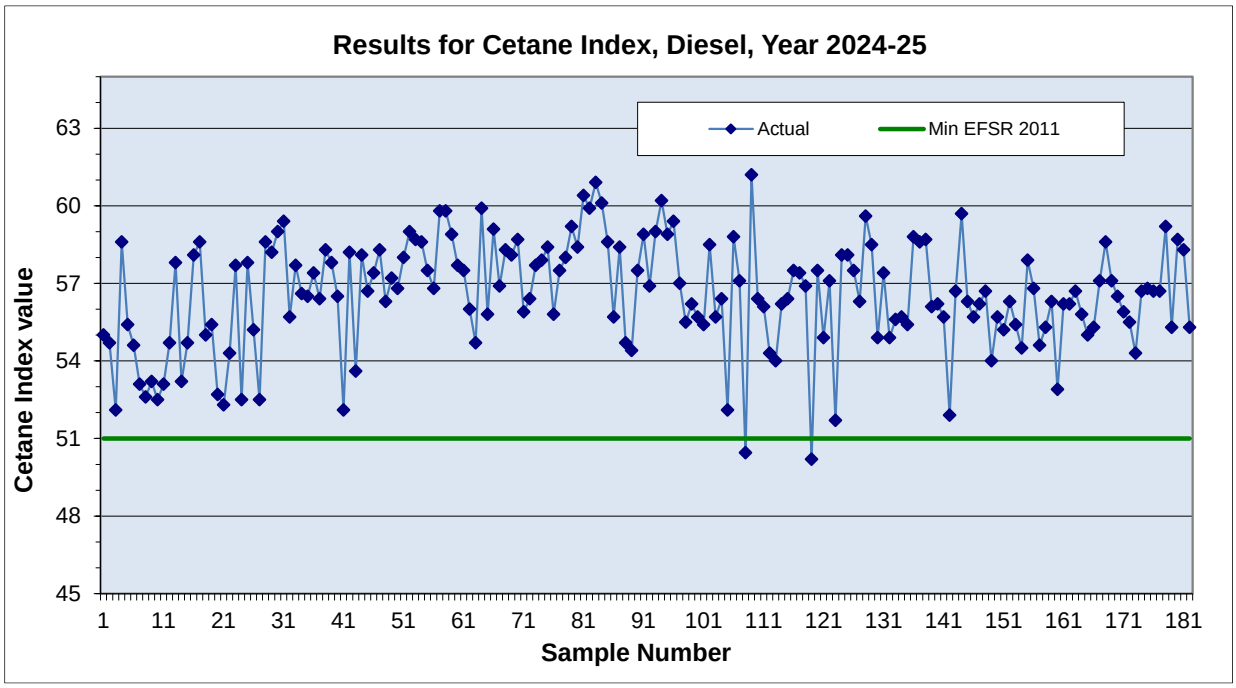


Fig. 16

[25] *Worldwide Fuel Charter*. 6th Ed., 2019, p. 64.
[26] ASTM D4737-21 *Standard Method for Calculated Index by Four Variable Equation*

Water

The test for water content is done according to IP438[27] which determines the total water present in diesel sample held either in solution or in solution and free water.

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.

Testing of all diesel samples for water content revealed that, with one exception, results were within the regulatory specification limit of 200 mg/kg, and also below the tolerance limit of 257 mg/kg. This demonstrates consistent compliance with the required standards for water content in diesel fuel across most samples.

However, there was a single sample that did not conform to these limits, showing an average water content of 301 mg/kg. Analysis of this sample indicated the presence of excessive water as well as elevated microbial content, both of which can impact diesel fuel quality and performance.

In response to these findings, the supplier took corrective actions by removing the excess water from the affected tank and administering a biocide treatment to address the microbial contamination. Following these remedial measures, the site was resampled and subsequent testing confirmed that the collected samples met the required quality parameters.

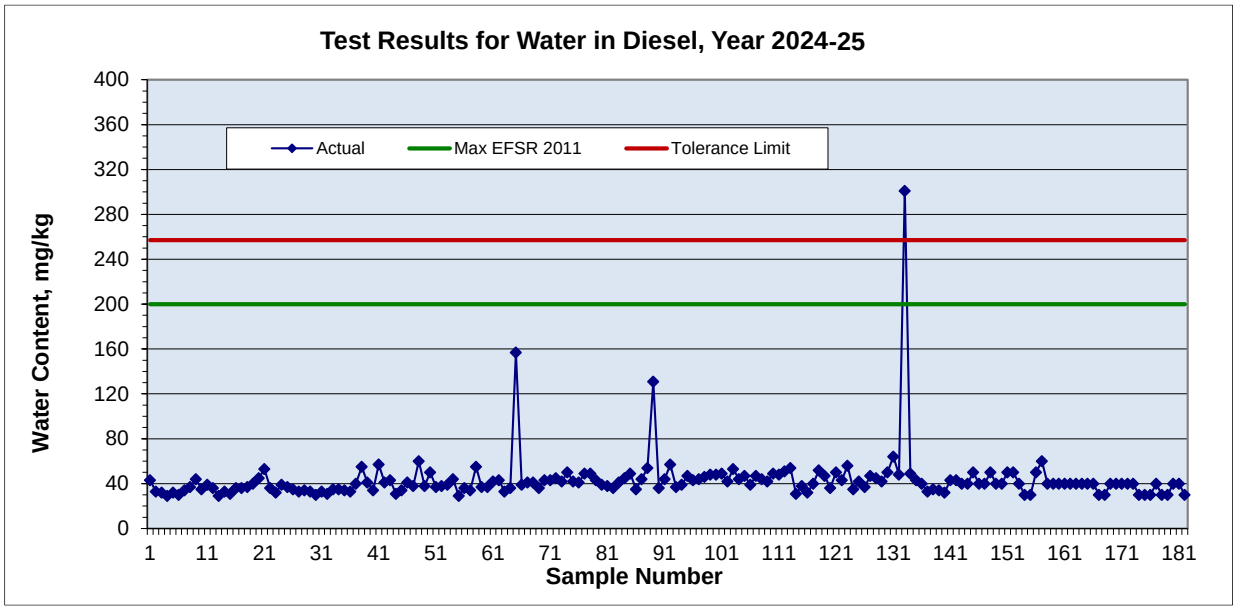


Fig. 17

[27] BS EN ISO 12937:2000, IP 438:2013. *Petroleum products. Determination of content. Coulometric Karl Fischer titration method*

Total Contamination

All 180 samples were found to be below the maximum limit of 24 mg/kg specified in the Regulations (Fig. 18). The tolerance limit for D6217[28] is 27.3 mg/kg.

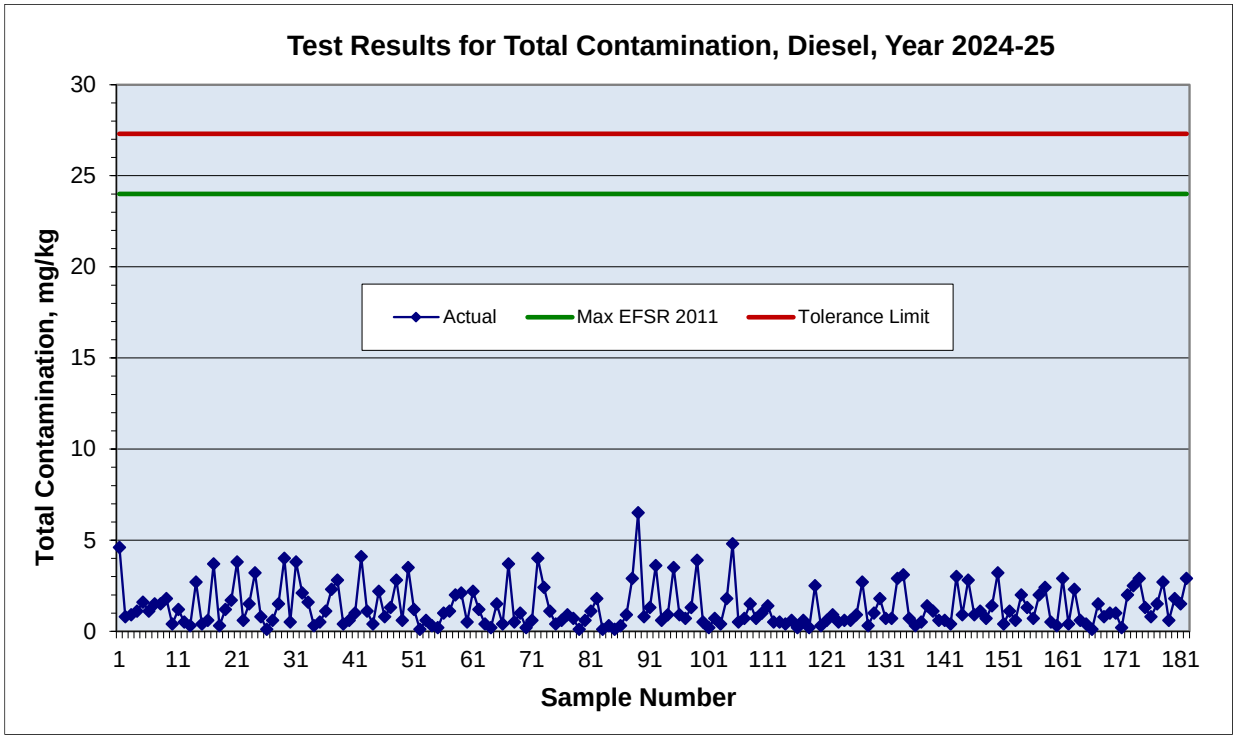


Fig. 18

[28] ASTM D6217-21e1 *Standard Test Method for Particulate Contamination in Middle Distillate Fuels by Laboratory Filtration*

Sulphur

Sulphur content can be tested according to IP 497[29] or ASTM D5453[30] prescribed in the Regulations. Respectively, there are two slightly different tolerance limits identified for the two methods: 11.8 mg/kg for IP497:2019 and 11.9 mg/kg for D5453-19a (the latter is shown on Fig.19).

All the 182 samples tested were found to be below the maximum limit of 10 mg/kg specified in the Regulations (Fig. 19).

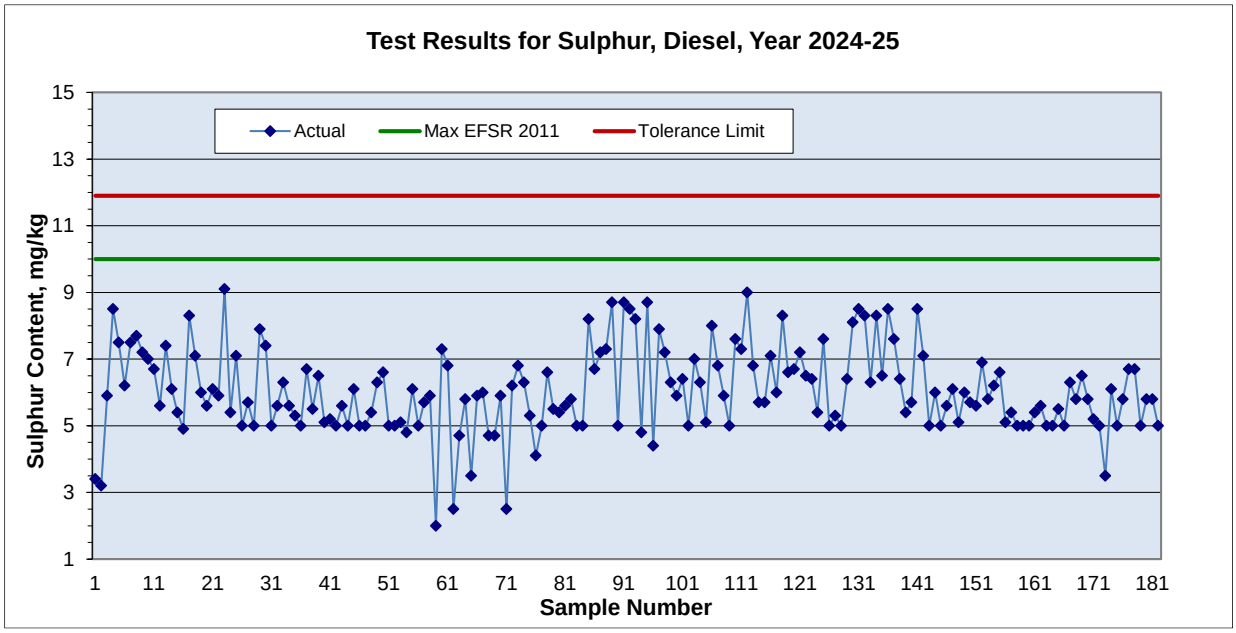


Fig. 19

Cloud Point

Cloud Point (CP) of diesel is the temperature at which the heaviest paraffins start to precipitate and form wax crystals; the fuel becomes 'cloudy'.[31] CP is tested according to ASTM D5773[32] prescribed in the Regulations.

The cumulative results for CP are presented below by combining the lowest prescribed maximum limits for each season in one graph (Fig. 20). Generally, results below the lowest maximum limit established for an area are 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 CP +4°C is prescribed for all New Zealand excluding Auckland and Northland.

The bottom line before the 'pedestal' on the graph in Fig. 20, 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

[29] IP 497 ISO 20884:2019 *Petroleum products — Determination of sulfur content of automotive fuels — Wavelength-dispersive X-ray fluorescence spectrometry*
[30] ASTM D5453-24 *Standard Test Method for Determination of Total Sulfur in Light Hydrocarbons, Spark Ignition Engine Fuel, Diesel Engine Fuel, and Engine Oil by Ultraviolet Fluorescence*
[31] *Worldwide Fuel Charter*, 6th Ed., 2019, p.81.
[32] ASTM D5773-21 *Standard Test Method for Cloud Point of Petroleum Products (Constant Cooling Rate Method)*

prescribed for summer in Auckland and Northland, is +6°C and not shown in the graph. The tolerance limits are 3.4°C and 5.4°C, respectively, for the specified limits of +2°C and +4°C.

All 182 samples appeared to be below the lowest maximum limit within the relevant seasons.

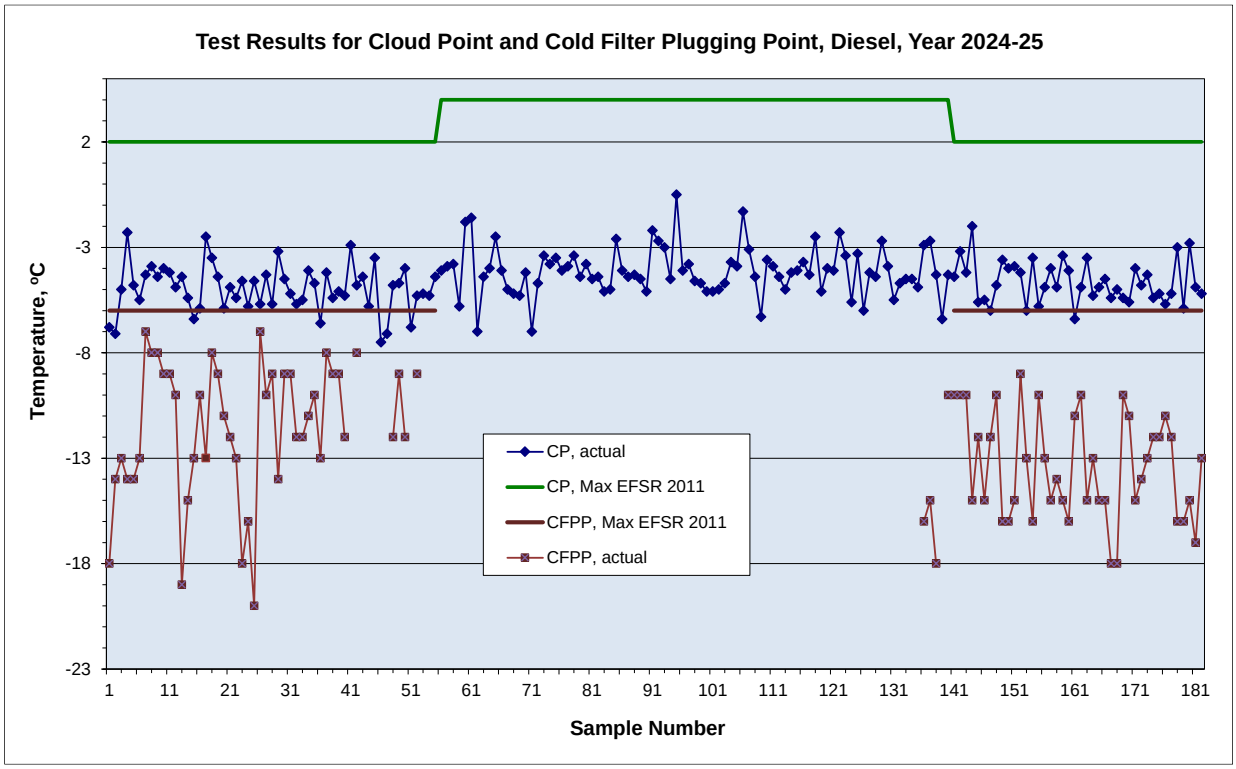


Fig. 20

Cold Filter Plugging Point

Cold Filter Plugging Point (CFPP) of diesel is the lowest temperature at which the fuel can pass through the filter in a standardised filtration test. CFPP should be tested according to IP 309[33] prescribed in the Regulations. The CFPP test was developed from vehicle operability data and demonstrates an acceptable correlation for fuels and vehicles in the market, if the delta between CFPP and CP is below 10°C[34]. CFPP is defined only for the winter season, from 15 April to 14 October inclusive, with the maximum limit of –6°C and the tolerance limit of –5°C.

The test results for the CFPP are presented on the same graph as those for the CP in Fig 20. This combined graphical representation allows for a clear and immediate comparison of the two parameters, providing an overview of the data at a glance and facilitating the identification of any notable trends or differences between the CP and CFPP results where necessary.

Upon analysis, it was determined that all diesel samples tested for CFPP were found to be below the maximum limit specified in the Regulations. This indicates full compliance with the regulatory requirements for CFPP during the reported period.

[33] BS EN 116:2015, IP 309:2016 *Diesel and domestic heating fuels. Determination of cold filter plugging point. Stepwise cooling bath method*

[34] *Worldwide Fuel Charter*, 6th Ed., 2019, p.81.

Polycyclic Aromatic Hydrocarbons

Polycyclic aromatic hydrocarbons are tested by IP 391[35] prescribed in the Regulations.

All 182 tested samples were found to be below the maximum limit of 11% specified in the Regulations at the tolerance limit of 12.4 %.

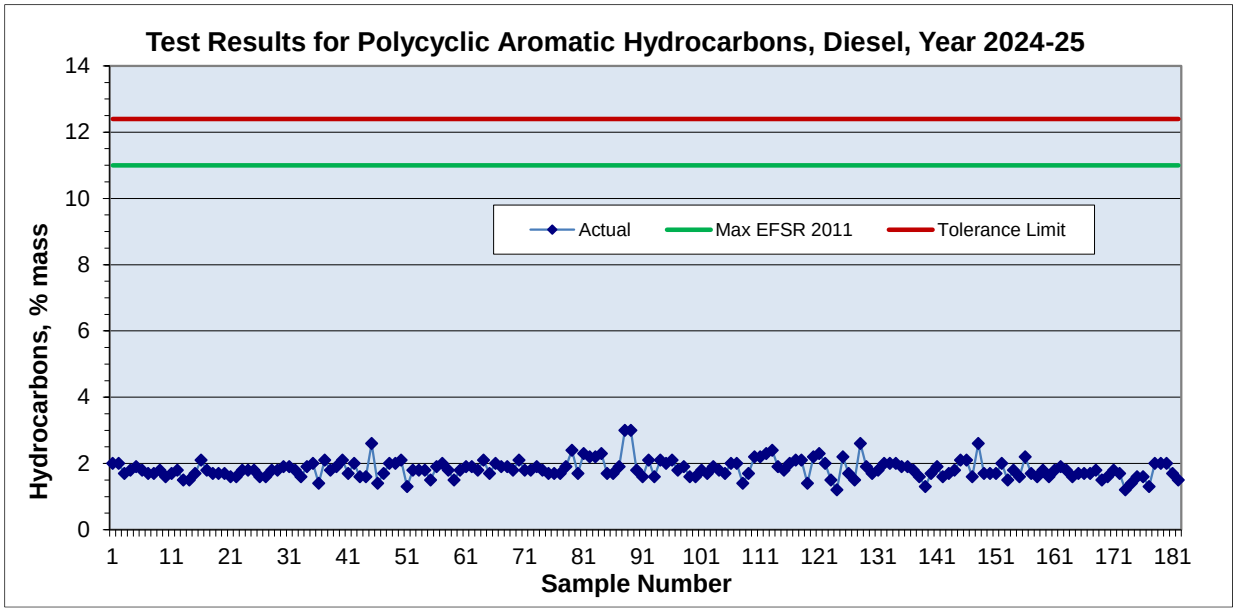


Fig. 21

[35] BS EN 12916:2024 *Petroleum products. Determination of aromatic hydrocarbon types in middle distillates. High performance liquid chromatography method with refractive index detection*

Filter Blocking Tendency

Filter blocking tendency can be tested by IP 387[36] or ASTM D2068[37] prescribed in the Regulations.

All 182 samples were found to be within the specified maximum limit of 2.5 for filter blocking tendency at the tolerance limit of 3.09.

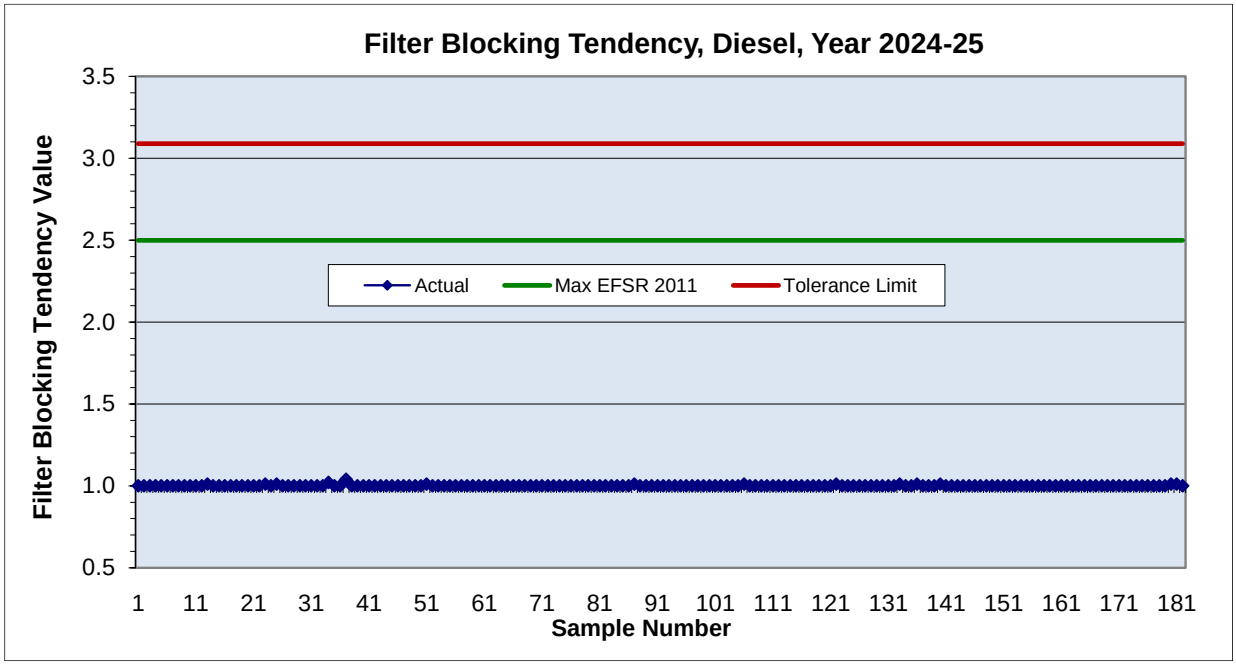


Fig. 22

[36] IP 387:2021 *Determination of filter blocking tendency*
[37] ASTM D2068-24 *Standard Test Method for Determining Filter Blocking Tendency*

Lubricity

Lubricity is identified as a diameter of the wear scar produced on an oscillating ball from contact with a stationary plate immersed in the fluid and are tested by IP 450[38] prescribed in the Regulations.

The lubricity of the tested samples was evaluated according to the prescribed method, with the maximum specification limit set at 460 µm and a tolerance limit of 520 µm. Out of the 182 samples analysed, all but two were found to be within the specified maximum limit for lubricity. The two exceptions exceeded the specification limit but remained within the allowable tolerance limit.

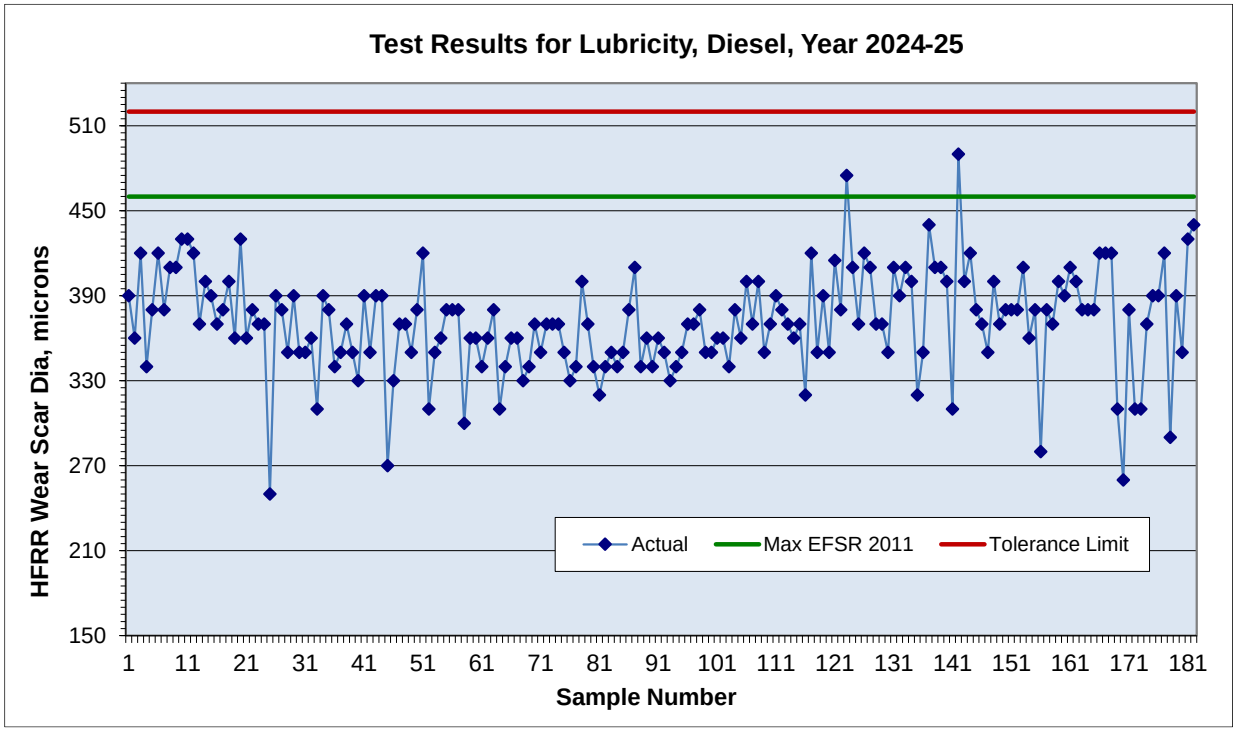


Fig. 23

[38] IP 450:2020 *Diesel fuel – Assessment of lubricity using the high-frequency reciprocating rig (HFRR) – Part 1: Test method (ISO 12156-1:2018)*; BS 2000-450:2000 *Methods of test for petroleum and its products. Diesel fuel. Assessment of lubricity using the high-frequency reciprocating rig (HFRR). Test method.*

Flash Point

Flash point is tested by ASTM D93[39] prescribed in the Regulations.

All 182 samples were found to be above the specified minimum limit of 61 °C for flash point of diesel (Fig 24).

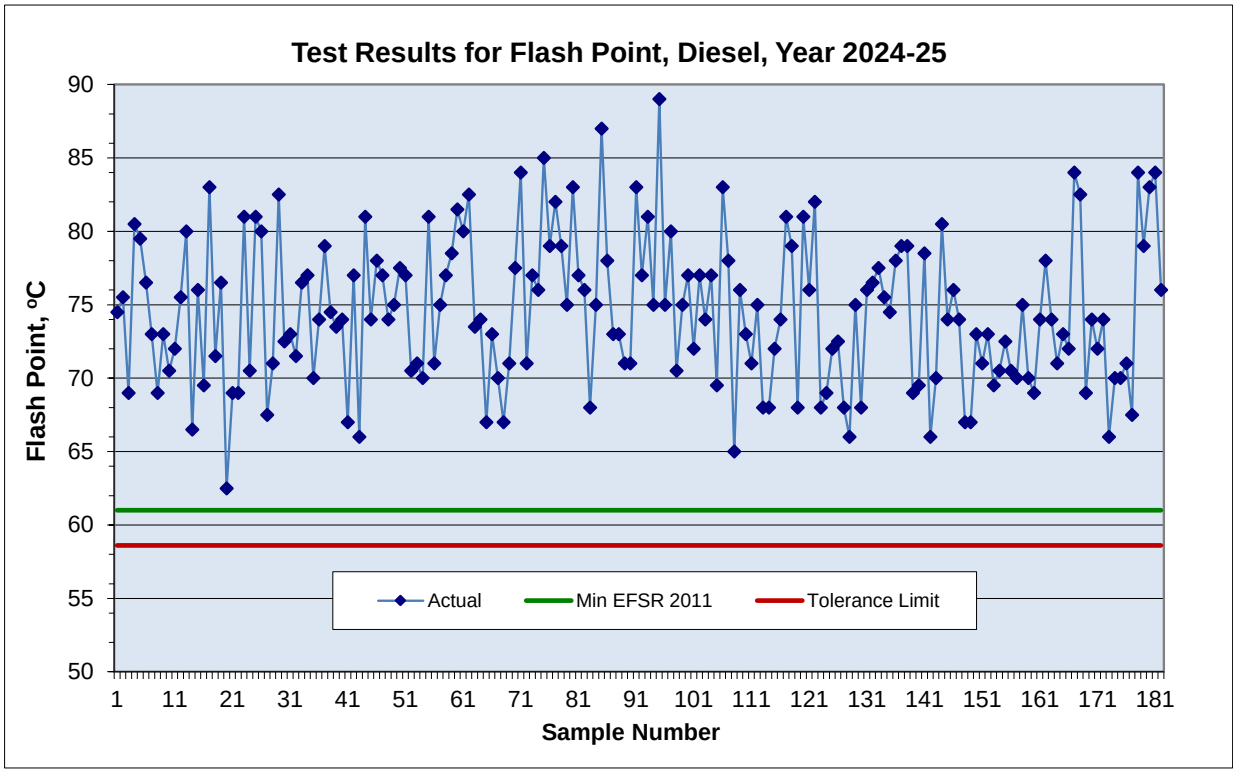


Fig. 24

[39] ASTM D93-20 *Standard Test Methods for Flash Point by Pensky-Martens Closed Cup Tester*

Viscosity

The viscosity is tested at 40 °C by ASTM D445[40] prescribed in the Regulations.

All 182 samples were found to be above the specified minimum limit of 2.0 mm^2 per second and below the specified maximum limit of 4.5 mm^2 per second for viscosity of diesel (Fig 25).

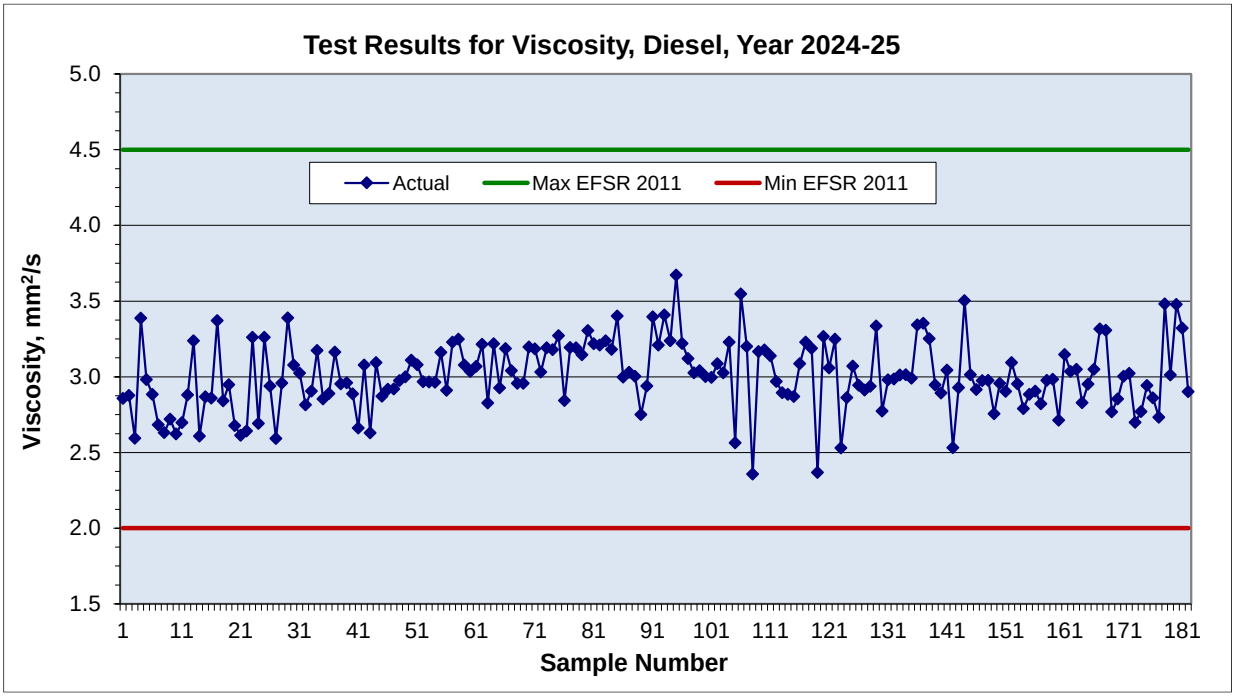


Fig. 25

[40] ASTM D445-24 *Standard Test Method for Kinematic Viscosity of Transparent and Opaque Liquids (and Calculation of Dynamic Viscosity)*

Microbial Content

Microbial content is tested using IP 385[41], an internationally recognised method for measuring microbial content. Although this method is not explicitly stipulated in the Regulations, it is commonly accepted.

It should be noted that microbiological parameters present distinct challenges, and this test provides an indication of the level of contamination rather than a definitive result. It is important to recognise that the precision of microbiological analytical methods generally falls short of those used in the petroleum industry for analysing physical and chemical properties of fuels.

There is no regulatory limit for microbial content in diesel. However, Trading Standards uses internal guidelines based on international best practices to assess risk and determine when further investigation is needed.

Guidelines developed by the Ministry for risk assessment

Category	Level of Microbial Growth (CFU/L)	Action
Category A	Below 4,000	Acceptable
Category B	4,000-10,000	Microbial proliferation may be occurring. If required, investigate by further sampling and testing.
Category C	Above 10,000	Operational problem and spread of contamination likely. Investigate thoroughly if water presence is detected.

It is important to note that microbiological test results alone should not be used to draw conclusions about the quality or fitness of fuel for common purposes. This is true even if the results fall under Category C, as outlined in the guidelines adopted by the Ministry.

The actual data is directly supplied to the industry since the guidelines for microbial content are not in the Regulations.

It is acknowledged that microbial testing is a subjective test and that obtaining representative samples can be challenging[42]. While Trading Standards rarely found microbial content to affect overall diesel quality, monitoring remains important as it can indicate water presence and potential risks to engines.

[41] IP385:2019 (2020) - *Determination of the viable aerobic microbial content of fuels and fuels components boiling below 390°C — Filtration and culture method.*

[42] ASTM D6469 – 20 *Standard Guide for Microbial Contamination in Fuels and Fuel System.*

Summary for Diesel Test Results

There were no instances where a diesel sample would have been identified as noncompliant with the Regulations' requirements.

In one case, a diesel sample was deemed non-compliant with the Regulations due to a suspected issue with the cetane index falling below the required specification. However, upon further investigation, it was found that the cetane index was slightly outside the specified range but still within the estimated tolerance limit.

Further, 48 samples were tested for copper strip corrosion[43] and all of them were found to be compliant. Next, 32 samples were tested for carbon residue[44] and ash[45] and, finally, 28 samples were tested for oxidation stability[46]. All these tests returned the compliant results.

Testing of diesel for appearance according to the ASTM standard D4176[47], which is not listed in the Regulations, was continued to maintain confidence that water, and/or other contamination, if present, would be identified. Notably, the appearance test proved to be a valuable method during investigations in response to complaints and enquiries.

[43] ASTM D130-19 *Standard Test Method for Corrosiveness to Copper from Petroleum Products by Copper Strip Test*
[44] BS EN ISO 10370:2014 *Petroleum products. Determination of carbon residue. Micro method*
[45] ASTM D482-19e01 *Standard Test Method for Ash from Petroleum Products*
[46] ASTM D2274-2014(2019) *Standard Test Method for Oxidation Stability of Distillate Fuel Oil (Accelerated Method)*
[47] ASTM D4176-22e1 *Standard Test Method for Free Water and Particulate Contamination in Distillate Fuels (Visual Inspection Procedures)*

Marine Fuels

Introduction

In May 2022, New Zealand became a party to the International Maritime Organization (IMO) Convention known as MARPOL Annex VI which came into effect in New Zealand in August 2022. Under Annex VI, the IMO has established a sulphur limit for fuel oil and requirements for fuel quality used on ships.

The Ministry and Maritime NZ jointly regulate the fuel quality aspects of MARPOL Annex VI to ensure compliance and promote information and education. The Ministry regulates marine fuel sold domestically, while Maritime NZ regulates ship operators' obligations.

TS maintains a national register of local marine fuel suppliers that are categorised by port and fuel type[48] and regulated by the Programme. Currently, eight companies are registered as marine fuel suppliers in New Zealand.

Properties to Test

Regarding fuel properties to test, MARPOL Annex VI, primarily, stipulates the maximum limit for sulphur content which must not exceed 0.5% m/m.

Properties that are considered critical for MARPOL Annex VI, are specified in Schedule 5 of the EFSR. These properties include sulphur, density, viscosity, flash point, hydrogen sulphide, acid value, and cetane index for distillates or Calculated Carbon Aromaticity Index (CCAI) for residuals.

The two groups of marine fuel, distillate and residual, are defined in the Interpretation section of EFSR.

Furthermore, MARPOL Annex VI explicitly requires certain information to be included in Bunker Delivery Notes (BDN) of ships 400 GT and more:

- Density at 15°C (kg/m^3) l
- Sulphur content (% m/m)
- declaration signed and certified by the fuel oil supplier's representative that the fuel oil supplied is in conformity with regulation 18.3 of the Annex VI[49].

Regulation 18.3 of Annex VI specifies the desired characteristics of marine fuel but does not mandate specific test methods. These requirements align with ISO 8217[50], an international standard referenced in EFSR and widely accepted by the global shipping. The standard refers to other IMO regulatory documents such as Safety of Life at Sea (SOLAS) and Marine Environment Protection Committee (MEPC) circulars, which, in turn, refer to the standard.

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[48] https://fuelquality.tradingstandards.govt.nz/marine/register-of-marine-fuel-suppliers/

[49] MARPOL Annex VI, Resolution MEPC.328(76) https://wwwcdn.imo.org/localresources/en/KnowledgeCentre/IndexofIMOResolutions/MEPCDocuments/MEPC.328(76).pdf

[50] ISO 8217:2024(E) *Products from petroleum, synthetic and renewable sources — Fuels (class F) — Specifications of marine fuels*

Specific considerations for monitoring the quality of marine fuel, are also set out in an international Publicly Available Standard (PAS)[51], which aligns with the objectives of MARPOL Annex VI and includes a section on the application of ISO 8217 to 0.50 mass % sulphur fuels.

TS conducts regular testing of all relevant fuel properties as outlined in ISO 8217 Tables 1 (for distillates) and 2 (for residuals), and in Schedule 5 of the Regulations, for both Marine Gas Oil (MGO) and Very Low Sulphur Fuel Oil (VLSFO).

Distillate marine fuel is referred to as MGO and Residual marine fuel is referred to as VLSFO in this report.

Summary of Test Results

Fuel from New Zealand Suppliers

MGO was sampled from various fuel storage terminals across the country, as well as during fuel deliveries to client vessels (bunkering operations).

In total, 21 distillate samples were tested, in which 18 samples were tested according to the full list of properties in Table 1 as well as for microbial content. All samples were found to be compliant with the requirements of MARPOL Annex VI. In particular, the sulphur content was reported to be below 0.015% m/m in six samples and below 0.0025% m/m in 15 samples, significantly lower than the 0.5% m/m stipulated in MARPOL Annex VI.

Currently, there is only one supplier of VLSFO in New Zealand which was sampled seven times throughout the period of this report. All samples were found to be compliant with the requirements of MARPOL Annex VI. The sulphur content was found to be in a range from 0.464% m/m to 0.497% m/m.

Other properties were also found to be compliant with the requirements of regulation 18.3 of MARPOL Annex VI.

Deliveries were sampled by TS during the bunkering of various types of vessels, including container ships, fish factory ships, cargo ships, and passenger cruise ships.

Fuel Sampled on Board In-Use

Marine fuel oil samples were collected from vessels operating within New Zealand's domestic fleet, as well as from ships registered under foreign flags entering New Zealand waters, in accordance with MNZ guidelines. The sampling process specifically targeted fuel oil stored in ship compartments intended for on-board use.

Trading standards obtained a total of 47 samples from twelve vessels. Among these, 23 samples were classified as Marine Gas Oil (MGO), while the remainder comprised Very Low Sulphur Fuel Oil (VLSFO). Two types of VLSFO were identified—RME180 and RMG380—in alignment with Table 2 of ISO 8217 standards.

[51] ISO/PAS 23263:2019 *Petroleum products — Fuels (class F) — Considerations for fuel suppliers and users regarding marine fuel quality in view of the implementation of maximum 0,50 % sulfur in 2020*

MNZ sampled 12 ships, including various types such as container ships, tankers, vehicle carriers, bulk carriers, passenger cruise ships, and ferries.

All samples were found to be compliant with the requirements of MARPOL Annex VI.

In particular, the sulphur content in VLSFO categorised as per Table 2 ISO 8217, was found to be compliant. However, two results from different compartments on one ship were found to be 0.517 % m/m and 0.519 % m/m i.e. above the maximum specification but still withing the tolerance limit of 0.528 % m/m. According to the BDNs for VLSFO fuel loaded onto this ship within two months prior inspection, the sulphur content was 0.48 % m/m.

There were three instances where the sulphur content exceeded 0.5% m/m in samples from one ship. The average results after repeated testing in two instances were found to be 3.34 % and 3.48 % m/m. The results are in the Fig 26, their relevant values of viscosity are in Fig 27.

The ship in question was found to be equipped with an Exhaust Gas Cleaning System (EGCS) unit capable of operating in a closed loop mode. The unit was certified as complying with Scheme B (continuous emissions monitoring with parameter checks), as specified in IMO Resolution[52] .

Upon further investigation, it was found that, according to the relevant BDNs for VLSFO fuel of RMG380 grade loaded onto this ship, the sulphur content was subsequently 3.47 % mass and 3.48 % m/m. It was declared that the fuel is in conformity with regulation 18.3 of MARPOL Annex VI and that the sulphur content of the fuel supplied does not exceed the purchaser's specified limit of 3.5 % for use with an equivalent arrangement permitted by regulation 4.1 of MARPOL Annex VI.

[52] *IMO Resolution MEPC.259 (68) 2015 Guidelines for the Approval and Survey of Exhaust Gas Cleaning Systems*

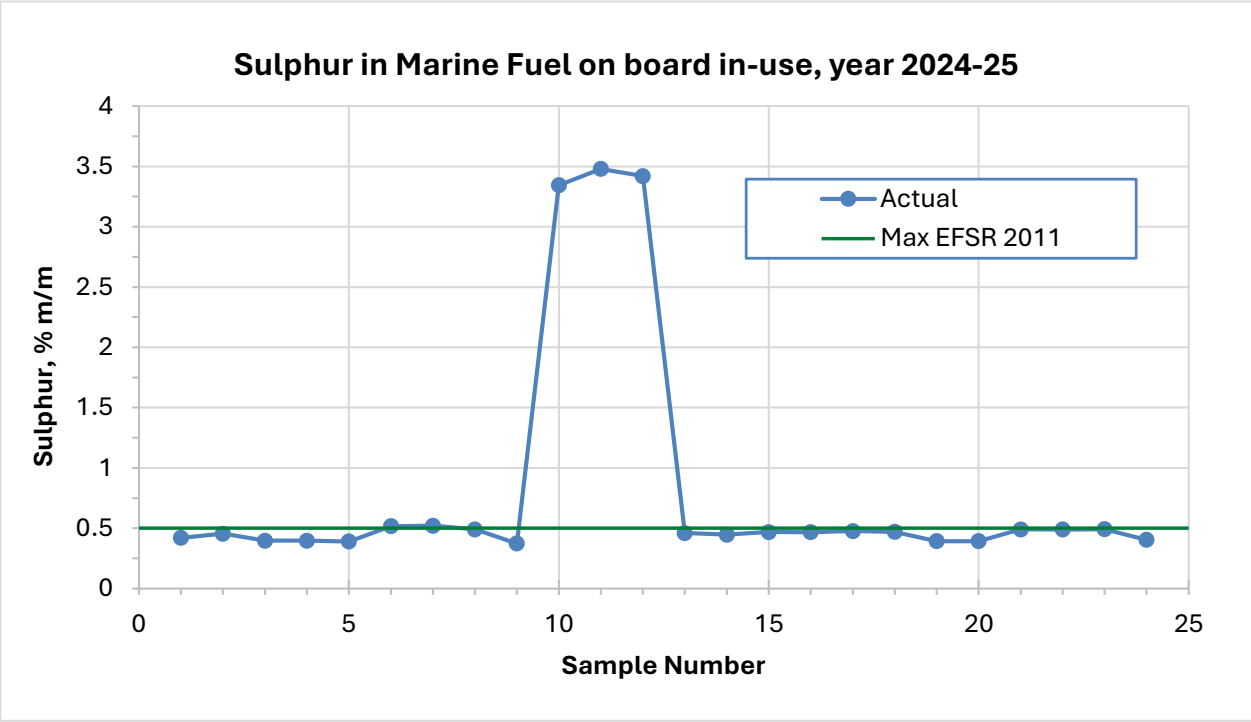

Fig. 26 The results of sulphur content testing in samples of residual fuel that was collected from ships' compartments as on board in-use fuel.

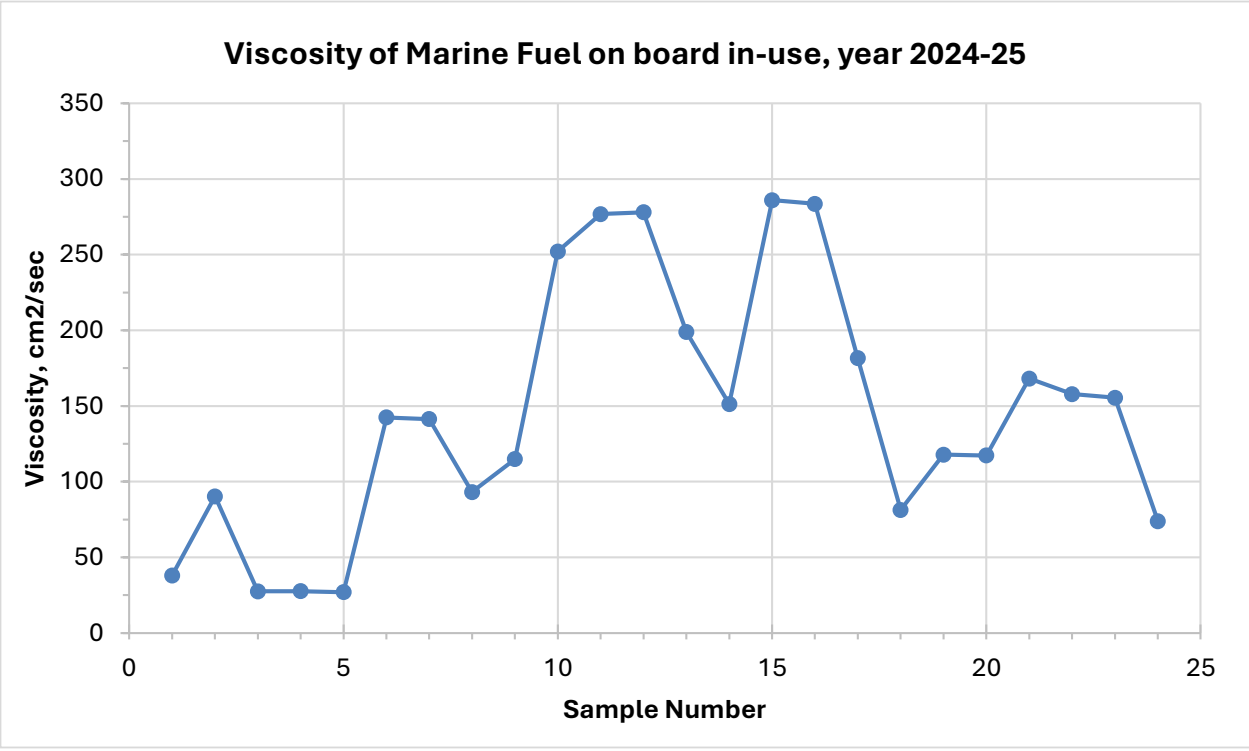

Fig. 27 The results of viscosity testing in samples of residual fuel that was collected from ships' compartments as on board in-use fuel.

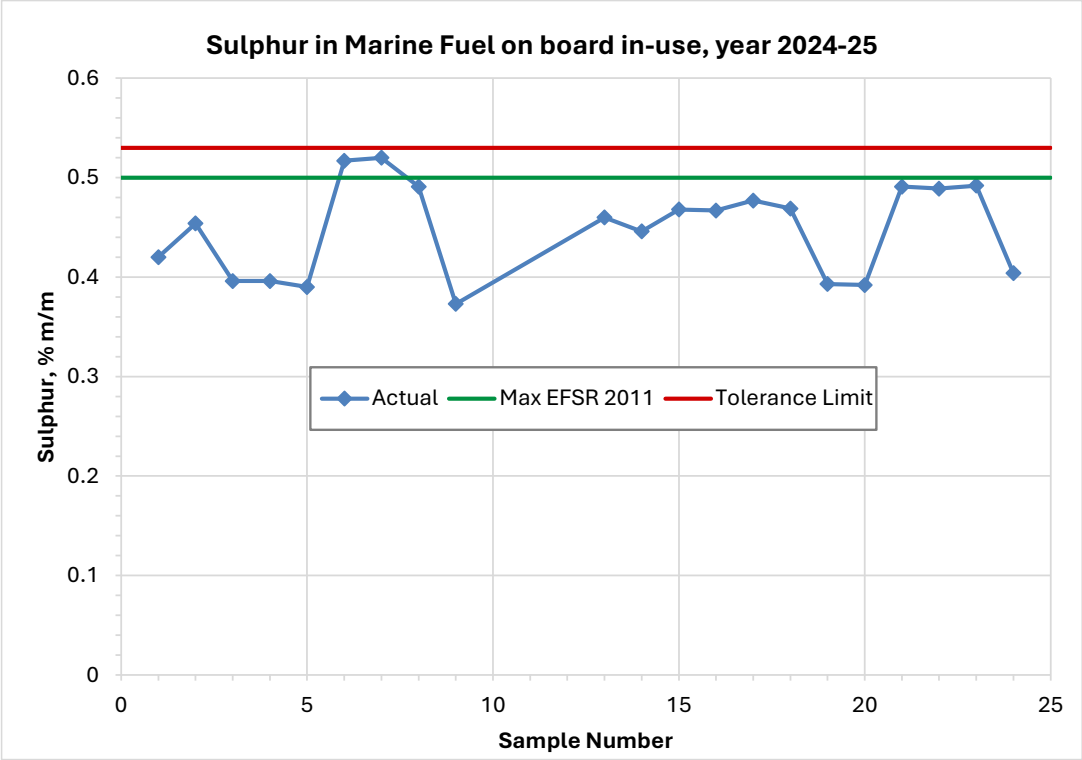

Fig. 28 The results of sulphur content testing in samples of residual fuel that was collected from ships' compartments as on board in-use fuel; as Fig. 26 excluding three results close to 3.5 %.

Water Content

ISO 8217 specifies a maximum water content of 0.5% vol for residual fuels. Among residual fuel samples, one sample was found to be above the limit with actual figures after repeated testing of 31.0 %, and 22.0 %. Due to high water content in this sample, testing wasn't possible to complete on flash point, pour point, ash content and sediment.

Microbial Content

MGO samples were tested for microbial content. Six samples on board in-use were found to be in Category C (refer to Diesel Microbial Content section of the TS FQM Annual Report 2023-24) which was confirmed by comparative testing in a separate laboratory. Among these samples, four were found to have filter blocking tendency above the maximum limit according to Schedule 2. However, this property is not specified for distillate fuel and serves only as indicative parameter. Notably, the six above samples with the high microbial content were collected from compartments on board ships. Apart from that, one sample of MGO from New Zealand suppliers was attributed to the category C.

Conclusion

Marine fuels supplied in New Zealand and fuels used on board ships were regularly tested for compliance with the EFSR and MARPOL Annex VI. Sulphur content in fuel samples remained within the specified limits, and most properties including acidity, flash point, toxicity (Hydrogen Sulphide) were on specification. Additionally, it was found that water content met the ISO 8217 standard, except for a single case of residual fuel in-use on board with high water content. Overall, the marine fuel samples which were tested were compliant with the Regulations and indicated safe and environmentally responsible maritime operations.

Appendices

A Brief Glossary and Abbreviations

ASTM - American Society for Testing and Materials

BS EN - British Standard European Norm

B100 - Biodiesel according to Schedule 3 of the Regulations

Bunkering - The transfer of fuel from land-based or floating facilities into ships' permanent tanks or connection of portable tanks to the fuel supply system.

CEDS – The Community Emissions Data Systems

CEN - Comité Européen de Normalisation (French for: European Committee for Standardization)

CFPP - Cold filter plugging point of diesel *i.e.*, the lowest temperature at which the fuel can pass through the filter in a standardised filtration test.

Cetane - A measure of the compression ignition behaviour of a diesel fuel; higher cetane levels enable quicker ignition.

CP - Cloud point of diesel *i.e.*, the temperature at which the heaviest paraffins start to precipitate and form wax crystals; the fuel becomes 'cloudy'.

Engine fuel - Any gaseous or liquid fuel that can be used as a fuel for engines, and includes biofuel, diesel, petrol (which is called motor spirit in the Excise and Excise-equivalent Duties Table (as defined in section 5(1) of the Customs and Excise Act 2018)), synthetic fuel, and blends of these.

EFSR- Engine Fuel Specifications Regulations 2011

Exhaust Gas Cleaning System (EGCS)- An EGCS, or exhaust scrubber, is type of machinery that removes particulate matter and harmful emissions, such as SOx, from exhaust gases. Washwater from an open loop exhaust scrubber may be discharged into the sea where this is allowable. Residue from a closed loop exhaust scrubber must be stored on board until it can be disposed of via port reception facilities on land. A hybrid exhaust scrubber can be switched from open to closed loop mode. Washwater or residue must be discharged or disposed of according to the hybrid scrubber mode used.

E85 – Fuel ethanol *i.e.,* a blend of petrol and ethanol, containing not less than 70 % and not more than 85 % ethanol by volume.

FAME - Fatty acid methyl esters, *i.e.*, the main component of biodiesel according to Schedule 3 of the Regulations

FQMS – Fuel Quality Monitoring Systems

Gross tonnage (GT) - The gross tonnage calculated in accordance with the tonnage measurement regulations contained in Annex I to the International Convention on Tonnage Measurements of Ships, 1969, or any successor Convention.

In-use sample - A sample of fuel oil in use on a ship.

IMO – International Maritime Organization

IP – Institute of Petroleum, UK

IPL – Independent Petroleum Laboratory

ISO - International Organization for Standardization (a common short name not an acronym)

Marine fuel oil - Any fuel delivered to and intended for combustion purposes for propulsion or operation on board a ship, including gas, distillate, and residual fuels.

Octane – usually in RON (Research Octane Number) or MON (Motor Octane Number), petrol's ability to resist auto-ignition; auto-ignition can cause engine knock, which can severely damage engines: the higher the octane number the greater the fuels resistance to knock. RON is an indicator of the fuel's anti-knock performance at lower engine speed and typical acceleration conditions. MON is an indicator of the anti-knock performance under higher engine speed and higher load conditions.

On board sample - A sample of fuel oil intended to be used or carried for use on board that ship.

UST – Underground Storage Tank

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