REPORT NO. 818

Correlated Fuel Research Scheme (July 2012 - June 2013) Proficiency Testing Program

August 2013

Acknowledgments

PTA wishes to gratefully acknowledge all the participants who continue to support this scheme through their participation and supply of samples.

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1. Foreword

This report summarises the results of the Correlated Fuel Research (CFR) interlaboratory testing program for petrol and aviation gasoline, conducted between July 2012 and June 2013.

The program was coordinated by Proficiency Testing Australia (PTA). The main aim of the program was to assess laboratories' abilities to competently perform the prescribed analyses. The Program Coordinator was Mrs K Cividin. This report was authorised by Ms W Fajloun, PTA Quality Coordinator.

2. Features of the Program

2.1 A total of 8 laboratories participated in the program. Of these 8, there were 7 Australian participants and 1 participant from New Zealand.

The samples for the program were provided by participants on a rostered basis, and sample suppliers were provided with detailed preparation instructions to maintain standardised sample production (see Appendix B).

2.2 The results, as reported by participants, are presented in Appendix A. All summary statistics were calculated and graphs plotted from these reported results.

2.3 Testing was conducted on (i) petrol samples and (ii) aviation gasoline (AVGAS) samples.

Petrol samples were tested for their Research Octane Number (RON) and Motor Octane Number (MON). AVGAS samples were only tested for a MON result.

2.4 Homogeneity testing was conducted prior to sample distribution, by measuring the density of selected samples according to ASTM D4052 or ASTM D1298. See Appendix B for more information on homogeneity testing.

2.5 As the program was industry based, results were not kept confidential. Monthly summaries were issued to participants with all laboratory results included.

3. Participants

The 8 participants were as follows:

Participant	Location	Samples Tested
BP Refinery (QLD), Bulwer Island	QLD	AVGAS
BP Refinery (WA), Kwinana	WA	Petrol & AVGAS
Intertek Testing Services (NSW), Clyde	NSW	Petrol & AVGAS
Independent Petroleum Laboratory (NZ), Whangarei	NZ	Petrol & AVGAS
Caltex Refineries (NSW), Kurnell	NSW	Petrol
Caltex Refineries (QLD), Lytton	QLD	Petrol
Intertek Testing Services (VIC), Melbourne	VIC	Petrol
Mobil Refining (VIC), Altona	VIC	Petrol

4. Statistical Format

4.1 Summary Statistics

A list of summary statistics appears at the bottom of each of the tables of results and consists of:

- the number of results for that test/sample (*No. of Results*);
- the median of these results - i.e. the middle value (*Consensus Median*);
- the normalised IQR - from July to October 2012 (inclusive) a different correction factor was applied to this calculation;
- the uncertainty of the median;
- the test method reproducibility standard deviation;
- the robust coefficient of variation, expressed as a percentage (*Robust CV*);
- the minimum and maximum laboratory results; and
- the range (*Maximum* - *Minimum*).

Please see reference [1] for further details on these summary statistics.

The test method reproducibility standard deviation is calculated by R ÷ 2.772, where R is the quoted test method reproducibility, RON – 0.7, MON – 0.9 and AVGAS – 2.0.

The Robust Coefficient of Variation (Robust CV) is calculated by dividing the test method reproducibility standard deviation by the median and expressed as a percentage. The Robust CV allows for the variability in different samples/tests to be compared.

4.2 Z-scores

In order to assess laboratories' testing performance, a robust statistical approach, using z-scores, was utilised. The z-score gives a measure of how far a result is from the consensus value (i.e. the median) and gives a "score" to each result relative to the other results in the group. A z-score close to zero indicates that the result agrees well with those from other laboratories. A z-score with an absolute value greater than or equal to 3.0 is considered to be an outlier.

Z-scores are calculated as follows:

$$z\text{-score} = \frac{\textit{(participant result - consensus median)}}{\textit{the test method reproducibility standard deviation}}$$

Outlier results (i.e. those for which |z-score| ≥ 3.0) are marked with a "**§**".

Laboratories reporting results which have not been identified as outliers but have a z-score greater than +2.0 or less than -2.0 are encouraged to review their results (i.e. results for which 2.0 < |z-score| < 3.0).

4.3 Ordered Z-score Charts

On these charts each laboratory's z-score is shown, in order of magnitude. From these charts, each laboratory can readily compare its performance relative to the other laboratories.

5. Presentation of Results

Testing results for (i) RON - petrol; (ii) MON - petrol and (iii) MON - AVGAS are displayed in Appendix A. For each of these tests, Appendix A contains the following:

- A table showing monthly results for each participating engine;
- A table of corresponding monthly z-scores;
- A table of the reported deviations between actual and specified BTSF values; and

- A combined graphical display of (i) monthly consensus median values and (ii) Robust CVs for all results pooled by month of testing.

For each participant, two individual graphs are provided.

The first graph displays the participant's result (▲) for each month between July 2012 and June 2013 as well as the median result (●) for each month. The second graph displays the participant's z-score (▲) and BTSF x10 (●) for each month between July 2012 and June 2013.

The "average z-score" is the mean value of an engine's z-scores over the testing period. Engines with negative "average z-scores" have an overall bias towards low results, whereas a positive "average z-score" would indicate a bias towards high results.

The "average absolute z-score" is the mean of an engine's absolute z-scores over the testing period. This approach avoids the problem of positive and negative z-scores "cancelling each other out" when averaged.

For both of these averages, as for any z-score, values close to zero indicate good performance.

For MON, ASTM D2700 quotes the following reproducibility limits: MON range 80 – 90, R = 0.9 and MON range 102 – 103, R = 2.0. No reproducibility limits are quoted for MON values outside these ranges.

To gain the maximum benefit from this program, results that exceed the reproducibility of the test method should be investigated, the errors identified and corrective action taken. In some cases, engines may have a bias which could indicate that some maintenance is required.

Metrological Traceability and Measurement Uncertainty of Assigned Values

Consensus values (median) derived from participants' results are used in this program. These values are not metrologically traceable to an external reference.

As the assigned value for this program is the median of the results submitted by the participants, the uncertainty of the median for each test has been calculated and is presented in the Appendices.

Analysis of Results by Method Groups

In order for methods to be grouped for analysis, PTA requires at least 11 sets of results from the same method group. As there was usually only one laboratory which reported results using the Compression Ration method,

these results have been pooled with the results reported by the Bracketing method.

The following table shows the Measurement Uncertainties (MU) reported by participants:

Lab Name	MON (MU)	RON (MU)	AVGAS (MU)
BP Refinery (WA) Kwinana	0.9	0.7	2.0
BP Refinery (QLD) Bulwer Island	0.9	0.7	0.6
Caltex Refineries (NSW) Kurnell	0.9	0.7	-
Caltex Refineries (QLD) Lytton	0.9	0.7	-
Intertek Testing Services (VIC) Melbourne	0.9	0.7	-
Intertek Testing Services (NSW) Clyde	0.3	0.3	0.4

6. References

[1] *Guide to Proficiency Testing Australia 2012* (This document can be found on the PTA website, www.pta.asn.au).

[2] *ASTM D2700 – 2012 Standard Test Method for Motor Octane Number of Spark-Ignition Engine Fuel.*

[3] *ASTM D4052 – 11 Standard Test Method for Density, Relative Density, and API Gravity of Liquids by Digital Density Meter.*

[4] *ASTM D1298 – 99 (2005) Standard Test Method for Density, Relative Density (Specific Gravity), or API Gravity of Crude Petroleum and Liquid Petroleum Products by Hydrometer Method.*