

# **REPORT NO. 589**

## ***Correlated Fuel Research Scheme (July 2007 - June 2008) Proficiency Testing Program***

**November 2008**

### **Acknowledgments**

PTA gratefully wishes to 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 2007 and June 2008.

The exercise 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 Karen Cividin.

## **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.

Petrol samples were tested every month and AVGAS samples every second month. A detailed testing schedule is tabulated in Appendix B.

- 2.4 Homogeneity testing was conducted prior to sample distribution, by measuring the density of selected samples according to ASTM D4052 or ASTM 1298. See appendix B for more information on homogeneity testing and homogeneity results.

- 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:

<b>Participant</b>	<b>Location</b>	<b>Samples Tested</b>
BP Refinery (QLD), Bulwer Island	QLD	Petrol & 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 interquartile range of the results (*Normalised IQR*);
- the robust coefficient of variation, expressed as a percentage (*Robust CV*);
- the minimum and maximum laboratory results; and
- the range (*Maximum - Minimum*).

The median is a measure of the centre of the data.

The normalised IQR is a measure of the spread of the results. It is calculated by multiplying the interquartile range (IQR) by 0.7413, a factor which converts the IQR to an estimate of the standard deviation. The IQR is the difference

between the upper and lower quartiles (i.e. the values above and below which a quarter of the results lie, respectively).

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

#### 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 three is considered to be an outlier.

Z-scores are calculated as follows:

$$z\text{-score} = \frac{(\text{participant result} - \text{consensus median})}{\text{normalised IQR}}$$

Outlier results (i.e. those for which  $|z\text{-score}| > 3$ ) are marked with a "§".

Laboratories reporting results which have not been identified as extreme but have a z-score greater than +2 or less than -2 are encouraged to "take a close look" at their results (i.e. results for which  $2 < |z\text{-score}| < 3$ ).

Please see reference [1] for further details on these z-scores.

#### 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 (see Appendix C for ASTM theoretical precision limits);

- A combined graphical display of (i) monthly consensus median values and (ii) coefficients of variation 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 2007 and June 2008 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 2007 and June 2008.

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.

**Table 1 – MON Outliers**

Month	Laboratory	Result Reported	Median	Difference
Jul 07	Intertek Melbourne	81.3	82.40	1.10
Nov 07	IPL Whangarei No. 3	85.5	84.30	1.20

## 6. Reference

- [1] *Guide to Proficiency Testing Australia 2008*.  
This document is located on the PTA website at [www.pta.asn.au](http://www.pta.asn.au) under Programs/Documents.

# APPENDIX B

## Sample Preparation and Homogeneity Testing

Sample Supply

B1.1

Sample Preparation & Homogeneity Testing

B1.2 - B1.4

B1.1

**Sample Supply**  
**July 2007 to June 2008**

Petrol Samples (for RON and MON):

<b>Supply Period</b>	<b>Participant/Supplier</b>
July '07 to December '07	Intertek Testing (VIC)
January '08 to June '08	Mobil Altona

AVGAS Samples:

<b>Supply Period</b>	<b>Participant/Supplier</b>
July '07 to June '08	Independent Petroleum NZ

## **Sample Preparation and Homogeneity Testing**

### **Procedure for Preparation - CFR Correlation Samples**

The following procedure is recommended for the preparation of PTA Correlation samples:

- 1) Obtain sufficient quantity of sample from bulk storage in a suitable size drum, leaving not more than 15-20% ullage, close the drum tightly and store in a cool place or at least under shelter overnight.
- 2) Prepare required number of one-litre cans (see table below) plus a few spares with proper size plastic inserts and screw-caps.

Prepare glass tubing, bent at right-angles, fitted with slotted rubber bung (to fit the drum opening), and a stop-cock for syphoning purposes. The extension of tubing below the stop-cock should be long enough to reach the bottom of a one-litre can. A drum fitted with a suitable drain-cock and tubing to reach the bottom of a one-litre can may also be used. Rubber tubing which comes into contact with the gasoline must not be used.

- 3) Set up the drum in an elevated position, fit the siphon so that the tubing immersed in gasoline is only a few centimetres above the bottom of the drum. By the aid of an aspirator and plastic tubing attached to the siphon outlet (below the stop-cock), suck the gasoline into the siphon system and close the stop-cock. Disconnect aspirator assembly.

Before filling the one-litre cans, run some sample into a waste container. Fill the cans (including enough for homogeneity testing – see table below), ensuring that the outlet tube is always inserted into the can and kept only slightly above the bottom of the can to minimise vapour losses. Maintain approximately 10% ullage in cans thus filled.

If the drain-cock assembly is used instead of siphon, flushing into the waste can must also be carried out before filling of cans.

- 4) Fill cans without delay, ensuring that plastic inserts are placed and screwed hand-tight as soon as each can is filled. Number each can in order of filling.
- 5) Verify that all screw-caps are tight, and invert all cans for approximately thirty minutes.
- 6) Verify the absence of leaks by close inspection. Reject any can that is suspect.
- 7) Apply a dab of "unifix" or other suitable cement (silicon or wax sealant) to join the screw-cap to the body of can. This will ensure that no tampering with sample will occur.

B1.3

8) Pre-distribution Testing for Homogeneity :

Prior to distributing the samples, test a number of them according to the table below for density according to ASTM D4052 or ASTM D1298.

No. of Samples Prepared	No. of pre-distribution samples to be tested
< 20	3
20 – 30	4
30 – 40	5
40 – 60	6

One sample should be drawn near the start of the preparation, one near the end and the remainder approximately evenly spread throughout the range. Where possible, density testing should be done by more than one analyst, each testing 2 – 3 samples.

9) Calculate a “low” z-score by taking the difference between the lowest density result and the mean density and dividing this by the test method standard deviation. Test method standard deviation is given by  $R / 2.77$ , where R = test method reproducibility.

Similarly calculate a “high” z-score by taking the difference between the highest density result and the mean density and dividing this by the method standard deviation.

A z-score of  $\leq 2$  indicates satisfactory homogeneity.

Report results of pre-distribution density checks to PTA for inclusion in the monthly results summary.

10) Dispatch samples in accordance with Transport of Dangerous Goods regulations and airline IATA safety regulations. **Note that door to door costs are paid by the supplying laboratory – including customs fees for New Zealand samples.**

**Shandy Samples - Motor Gasoline only**

- 1) Obtain components from the bulk storage, permit to attain the same temperature by keeping in cool place or under shelter.
- 2) Measure each component with minimum delay into a suitable size drum, close tightly and agitate well. Store overnight in cool place or under shelter.
- 3) Before the preparation for one-litre can fillings, agitate the drum again to ensure the homogeneity.
- 4) Fill and dispatch cans following steps 3 to 10 for gasoline samples above.

**Labelling**

It is required that the label contain the name and address of the recipient, together with:

**NATA  
CFR Scheme - Motor Gasoline  
Research or Motor Method (as applicable)  
Date of Test (Day Month Year)**

**Homogeneity Testing Results**

Homogeneity testing was conducted prior to sample distribution, by measuring the density of selected samples according to ASTM D4052 or ASTM D1298. Low and high z-scores are calculated as :  $z = (A - \text{median}) \div B$ , where A is the lowest or highest density result, and B is the test method standard deviation. This is given by  $R \div 2.77$ , where R = test method reproducibility. A  $|z\text{-score}| \leq 2$  indicates satisfactory homogeneity. All homogeneity results had a z-score of  $<2$  and were therefore considered satisfactory.

-----**END REPORT**-----