

Report No. 1087

Paint

Proficiency Testing Program

Round 27

July 2018

ACKNOWLEDGMENTS

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1. **FOREWORD**

This report summarises the results of the twenty-seventh round of a proficiency testing program covering a series of paint tests. This program is accredited to ISO/IEC 17043:2010 “*Conformity assessment - General requirements for proficiency testing*” by International Accreditation New Zealand (IANZ).

Proficiency Testing Australia (PTA) conducted the program in May 2018. The Program Coordinator was Dr M Li. The Technical Adviser was Ms S Bartlett, Quality Systems. This report was authorised by Mrs K Cividin, PTA Quality Manager. The aim of the program was to assess laboratories’ ability to competently perform the prescribed analyses.

2. **FEATURES OF THE PROGRAM**

- (a) Participating laboratories were each supplied with two 500ml tins of paint labelled “PTA Sample A” and “PTA Sample B”.

Laboratories were asked to perform the following consistency analyses on both Samples A and B:

Density

Consistency - Flow Cup

Consistency - Stormer Viscometer

Measurement of Specular Gloss

- (b) A total of 17 laboratories received samples, comprising of 15 Australian participants, and two overseas participants, including Singapore and Kuwait.
- (c) Laboratories were requested to perform the tests according to the Instructions to Participants provided and to record their results on the accompanying Results Sheet, which was distributed with the samples. Copies of these documents appear in Appendix C.
- (d) Prior to distribution, randomly selected samples were tested for homogeneity. Based on the results of this testing, it was concluded that the samples were sufficiently homogeneous, and therefore, any results later identified as outliers could not be attributed to any significant sample variability (See Appendix B).
- (e) Each laboratory was randomly allocated a unique code number for the program to enable confidentiality of results. Reference to each laboratory in this report is made by its code number only.

- (f) Results (as reported by participants) with corresponding summary statistics (i.e. number of results, median, uncertainty of the median, normalised interquartile range, robust coefficient of variation, minimum, maximum and range) are presented in Appendix A.
- (g) A robust statistical approach, using z-scores, was utilised to assess laboratories' testing performance (see Section 4). Robust z-scores and z-score charts relevant to each test are presented in Appendix A.
- (h) The document entitled *Guide to Proficiency Testing Australia, 2016* (reference [1]) defines the statistical terms and details the statistical procedures referred to in this report.
- (i) A tabulated listing of laboratories (by code number) identified as having outlier results can be found on page no. 5.

3. **FORMAT OF THE APPENDICES**

- (a) Appendix A contains the analysis of results reported by laboratories for the samples. This section contains the following for each determinant, where appropriate:
 - a table of results and calculated z-scores;
 - a list of summary statistics; and
 - ordered z-score charts;

Please note that z-scores have been calculated on the average results, and that a target Coefficient of variation (CV) has been used for Density.
- (b) Appendix B contains details of the homogeneity and stability testing.
- (c) Appendix C contains copies of the *Instructions to Participants and Results Sheet*.

4. **STATISTICAL DESIGN OF THE PROGRAM**

- (a) Outlier Results and Z-scores

In order to assess laboratories' testing performance, a robust statistical approach, using z-scores, was utilised. Z-scores give 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, whereas a z-score with an absolute value greater than or equal to 3.0 is considered to be an outlier and is marked by the symbol "S".

The table on page no. 5 summarises the outlier results detected.

(b) Results Tables and Summary Statistics

Each of these tables contains the results returned by each laboratory, including the method used, and the robust z-score calculated for each result.

For the purpose of consistency in reporting, the results have been rounded to two decimal places for all results.

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 (*Median*);
- the uncertainty of the median; a robust estimate of the standard deviation of the *Median*;
- the normalised interquartile range of the results (*Normalised IQR*);
- the robust coefficient of variation, expressed as a percentage (*Robust CV*) - i.e. $100 \times \text{Normalised IQR} / \text{Median}$;
- 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 a correction 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).

For normally distributed data, the uncertainty of the median is approximated by:

$$\sqrt{\frac{\pi}{2}} \times \frac{\text{normIQR}}{\sqrt{n}} \quad n = \text{number of results}$$

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

(c) Ordered Z-Score Charts

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

These charts contain solid lines at +3.0 and -3.0, so that outliers are clearly identifiable as those laboratories whose "bar" extends beyond these "cut-off" lines.

The y-axis of these charts has been limited, so very large z-scores appear to extend beyond the chart boundary.

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

The following table summarises the results submitted by participants for the program.

TABLE A: SUMMARY OF RESULTS

TABLE A: SUMMARY OF RESULTS

Analyses	Sample	Median	Robust CV	No. of Results
Measurement of Specular Gloss (60°)	A	92.985	1.0%	14
	B	93.050	1.2%	14
Measurement of Specular Gloss (85°)	A	98.300	2.5%	11
	B	98.630	1.3%	11
Consistency-Flow Cup (s)	A	138.000	12.9%	12
	B	138.000	11.8%	12
Consistency- Stormer Viscometer (Krebs Unit)	A	69.700	1.1%	13
	B	70.000	2.1%	13
Density (kg/L) ‡	A	1.160	0.6%	17
	B	1.160	0.6%	17

‡: Target CV 0.6% has been used for Density.

5. STATISTICAL OUTLIER RESULTS

In order to achieve the program's aim of assessing laboratories' testing performance, a robust statistical approach, which uses z-scores has been utilised. The z-score is a measure of how far the result(s) is from the consensus value - a normalised value which gives a "score" to each result relative to the other results in the group. Therefore a z-score close to zero means that the result agrees well with those from other laboratories. An outlier will be any result(s) which has an absolute z-score value greater than or equal to 3.0.

For further information on the calculation and interpretation of z-scores, please see reference [1].

TABLE B: OUTLIER RESULTS

Test	Z-Score Outliers (Laboratory Codes)	
	Sample A	Sample B
Measurement of Specular Gloss (60°)	1, 3	1, 3
Measurement of Specular Gloss (85°)	6	3, 6
Consistency-flow cup (s)	16	16
Consistency- stormer viscometer (Krebs Unit)	16	
Density (kg/L)		

6. **PTA AND TECHNICAL ADVISER'S COMMENTS**

Metrological Traceability and Measurement Uncertainty of Assigned Values

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

Analysis of Results by Method Groups

All participants were required to use the AS 1580 *Paints and related materials - Methods of Test* series, therefore, results were pooled for analysis.

Comments

There were four laboratories with outliers. These participants should investigate the cause of the outliers, such as interferences from the matrix, instrument conditions, transcription and calculation errors, sample preparation errors and human errors. On the whole, the study should provide valuable information to the participants on the performance of the methods and equipment used.

Measurement of Specular Gloss: Laboratory codes 1 and 3 reported outliers for both Sample A and Sample B for the measurement of specular gloss (60°). Laboratory codes 3 and 6 reported outliers for Sample A and Laboratory code 3

also reported an outlier for Sample B for the measurement of specular gloss (85°).

The reproducibility for the geometry selected is four units at 60°, and seven units at 85°. The range at 60° from this round is the double that of the standard and just under at 85°. The batch used for this round was passed at 93 units at 60°. The median result is 92.985 units. It is of concern that the range is greater than the standard.

Consistency - Stormer Viscometer: there is a variation of approximately 4.3 units, which is outside the reproducibility (stroboscope method) of 2.1 (solvent-based). However, not knowing if a stroboscope or digital was used, this is acceptable. Laboratory code 16 reported an outlier for Sample A.

Consistency - Flow Cup: it is of concern to have a variation of more than double the minimum test result. There are some subtleties in determining the end point with this method. A review of the calibration records and oils may be needed. Laboratory code 16 reported outliers for both Sample A and Sample B.

Density: the results are all grouped tightly around the median. This method has good reproducibility data, which is reflected in the results. No outliers were reported for density.

Considering that the samples were sufficiently homogeneous, all laboratories reporting outlier results should conduct an investigation to determine the cause of these results.

7. **REFERENCES**

[1] *Guide to Proficiency Testing Australia*, 2016.

This document can be found on the PTA website at www.pta.asn.au

[2] *AS 1580.202.1 - 1995 Paints and related materials - Density*

[3] *AS 1580.214.2 - 1996 Paints and related materials - Consistency - Flow Cup*

[4] *AS 1580.214.1 - 1997 Paints and related materials - Consistency - Stormer Viscometer*

[5] *AS 1580.602.2 - 1995 Paints and related materials - Measurement of Specular Gloss*

APPENDIX A

Results and Data Analysis

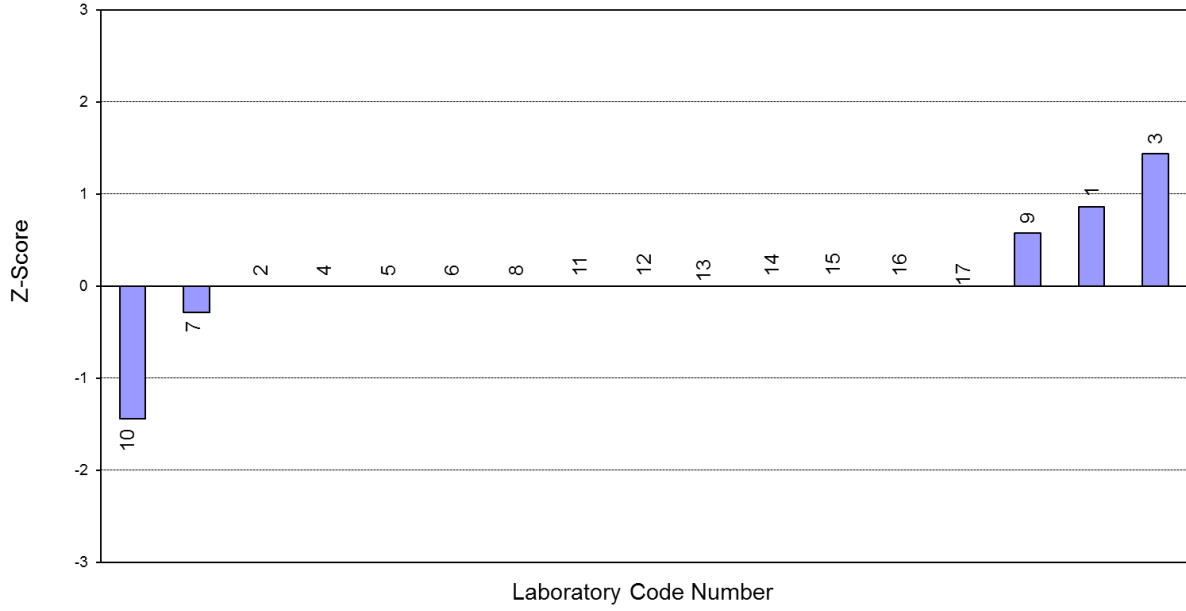
Density	A1
Consistency - flow cup	A3
Consistency - stormer viscometer	A5
Measurement of specular gloss (60°)	A7
Measurement of specular gloss (85°)	A9

Density - AS 1580.202.1**Results by Laboratory Code**

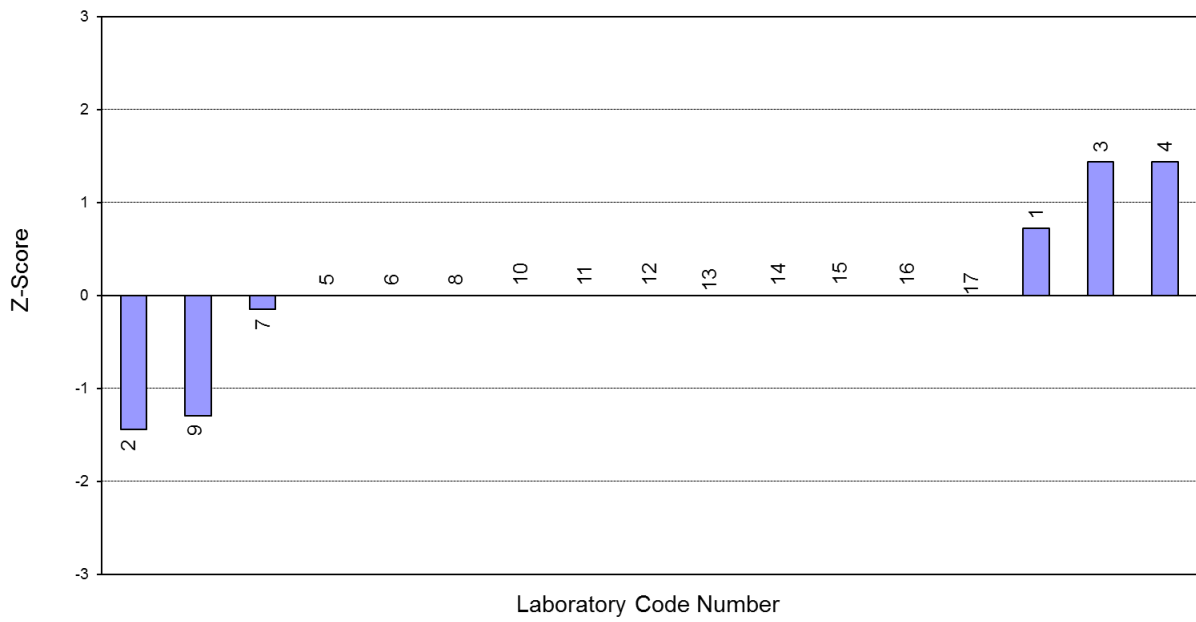
Lab Code	Results (kg/L)		Sample A	Sample B
	Sample A	Sample B	Robust Z-score	Robust Z-score
1	1.166	1.17	0.86	0.72
2	1.16	1.15	0.00	-1.44
3	1.17	1.17	1.44	1.44
4	1.16	1.17	0.00	1.44
5	1.16	1.16	0.00	0.00
6	1.16	1.16	0.00	0.00
7	1.16	1.16	-0.29	-0.14
8	1.16	1.16	0.00	0.00
9	1.16	1.15	0.57	-1.29
10	1.15	1.16	-1.44	0.00
11	1.16	1.16	0.00	0.00
12	1.16	1.16	0.00	0.00
13	1.16	1.16	0.00	0.00
14	1.16	1.16	0.00	0.00
15	1.16	1.16	0.00	0.00
16	1.16	1.16	0.00	0.00
17	1.16	1.16	0.00	0.00
<i>No of Results:</i>	17	17		
<i>Median:</i>	1.160	1.160		
<i>Normalised IQR:</i>	0.000	0.000		
<i>Robust CV:</i>	0.0%	0.0%		
<i>Minimum:</i>	1.15	1.15		
<i>Maximum:</i>	1.17	1.17		
<i>Range:</i>	0.02	0.02		
<i>Uncertainty (Median)</i>	0.002	0.002		
<i>Target CV ‡</i>	0.6%	0.6%		
<i>Target IQR</i>	0.007	0.007		

NOTE: ‡: Target CV 0.6% has been used.

Density (Sample A)



Density (Sample B)



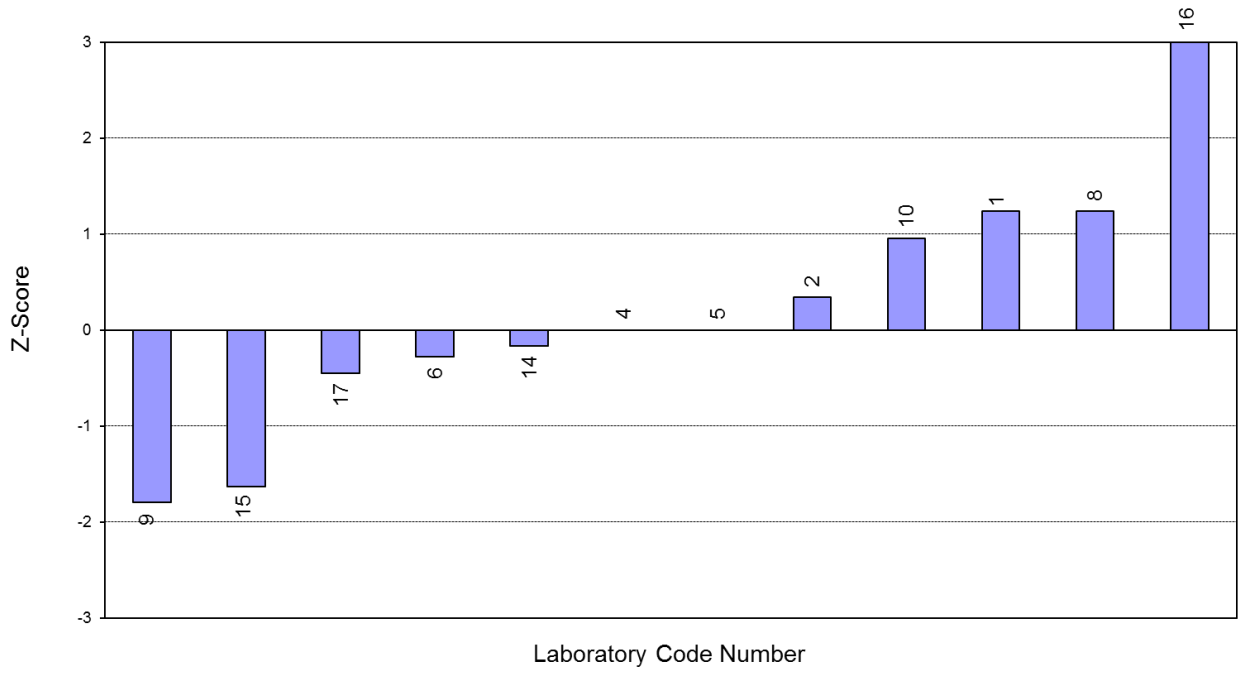
Consistency - Flow Cup - AS 1580.214.2

Results by Laboratory Code

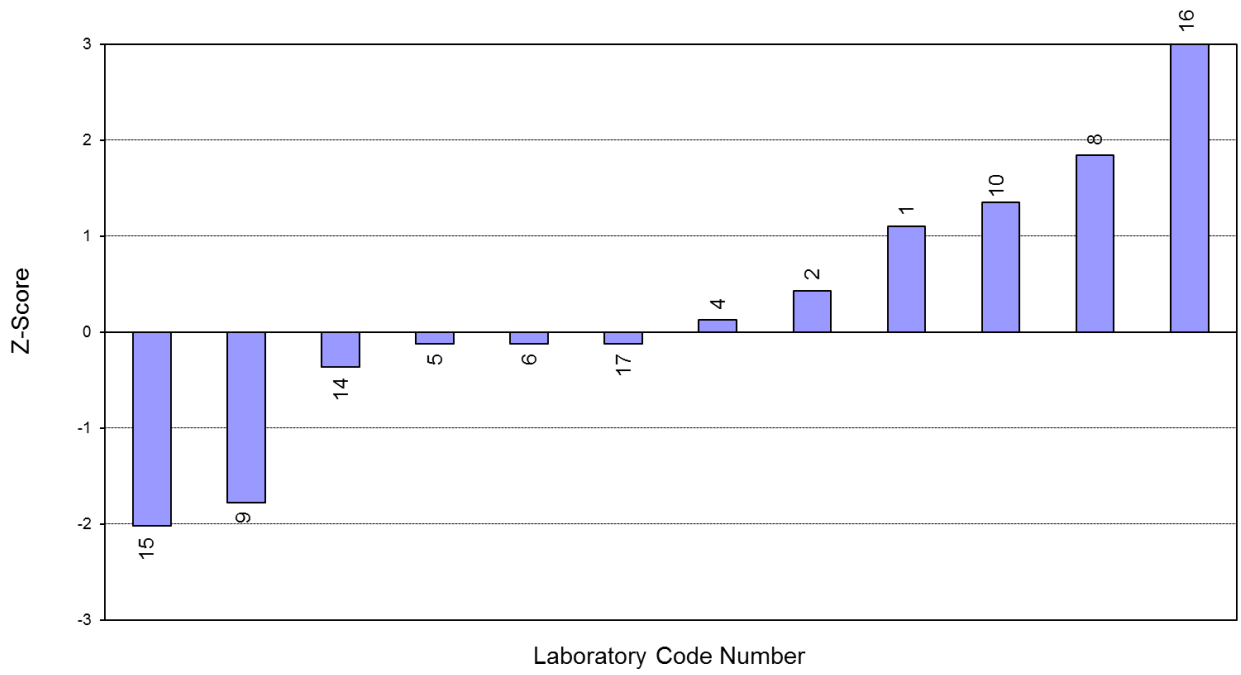
Lab Code	Results (s)		Sample A Robust Z-score	Sample B Robust Z-score
	Sample A	Sample B		
1	160.00	156.00	1.24	1.10
2	144.00	145.00	0.34	0.43
4	138.00	140.00	0.00	0.12
5	138.00	136.00	0.00	-0.12
6	133.00	136.00	-0.28	-0.12
8	160.00	168.00	1.24	1.84
9	106.00	109.00	-1.80	-1.78
10	155.00	160.00	0.96	1.35
14	135.00	132.00	-0.17	-0.37
15	109.00	105.00	-1.63	-2.02
16	262.00	272.00	6.97 §	8.22 §
17	130.00	136.00	-0.45	-0.12
<i>No of Results:</i>	12	12		
<i>Median:</i>	138.000	138.000		
<i>Normalised IQR:</i>	17.791	16.309		
<i>Robust CV:</i>	12.9%	11.8%		
<i>Minimum:</i>	106.00	105.00		
<i>Maximum:</i>	262.00	272.00		
<i>Range:</i>	156.00	167.00		
<i>Uncertainty (Median)</i>	6.44	5.90		

NOTE: "§" denotes an outlier (i.e. $|z\text{-score}| \geq 3.0$).

Consistency-Flow Cup (Sample A)



Consistency-Flow Cup (Sample B)



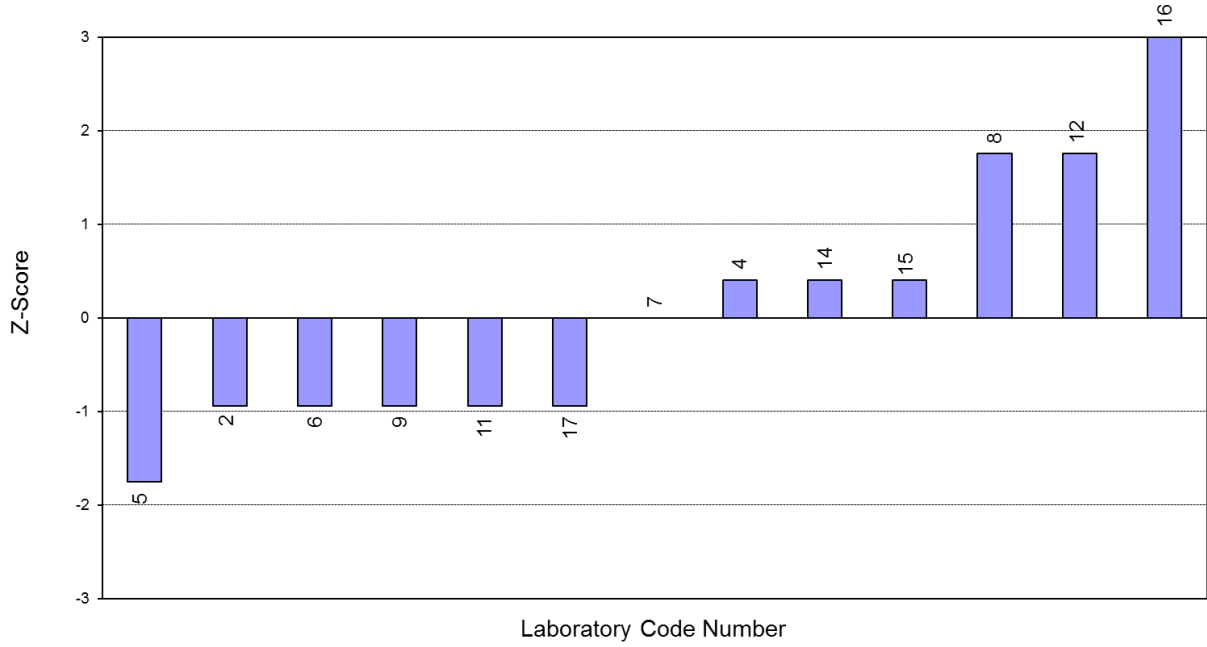
Consistency - Stormer Viscometer - AS 1580.214.1

Results by Laboratory Code

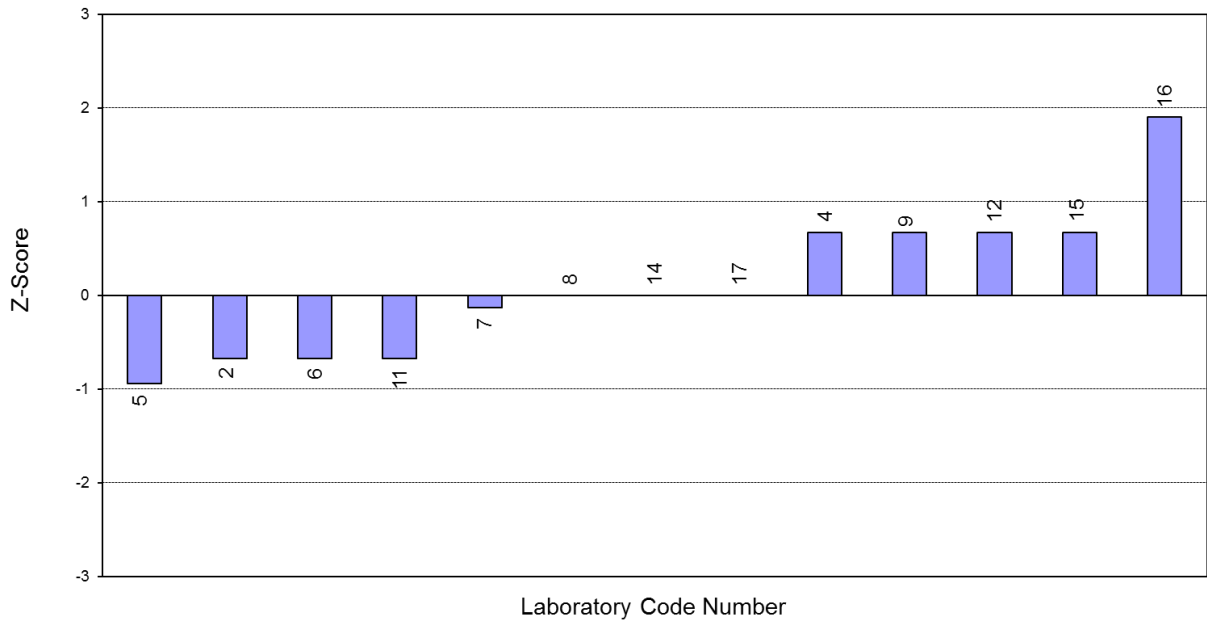
Lab Code	Results (Krebs Unit)		Sample A Robust Z-score	Sample B Robust Z-score
	Sample A	Sample B		
2	69.00	69.00	-0.94	-0.67
4	70.00	71.00	0.40	0.67
5	68.40	68.60	-1.75	-0.94
6	69.00	69.00	-0.94	-0.67
7	69.70	69.80	0.00	-0.13
8	71.00	70.00	1.75	0.00
9	69.00	71.00	-0.94	0.67
11	69.00	69.00	-0.94	-0.67
12	71.00	71.00	1.75	0.67
14	70.00	70.00	0.40	0.00
15	70.00	71.00	0.40	0.67
16	72.82	72.82	4.21 §	1.90
17	69.00	70.00	-0.94	0.00
<i>No of Results:</i>	13	13		
<i>Median:</i>	69.700	70.000		
<i>Normalised IQR:</i>	0.741	1.483		
<i>Robust CV:</i>	1.1%	2.1%		
<i>Minimum:</i>	68.40	68.60		
<i>Maximum:</i>	72.82	72.82		
<i>Range:</i>	4.42	4.22		
<i>Uncertainty (Median)</i>	0.26	0.52		

NOTE: "§" denotes an outlier (i.e. |z-score| ≥ 3.0).

Consistency-Stormer Viscometer (Sample A)



Consistency-Stormer Viscometer (Sample B)



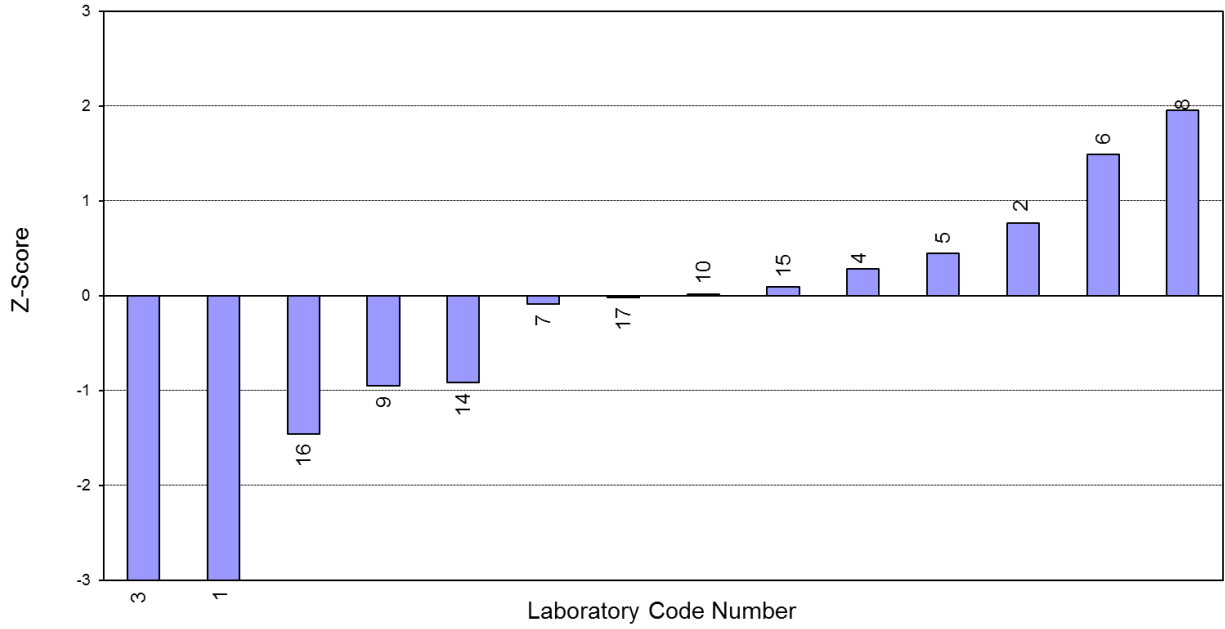
Measurement of Specular Gloss (60°) - AS 1580.602.2

Results by Laboratory Code

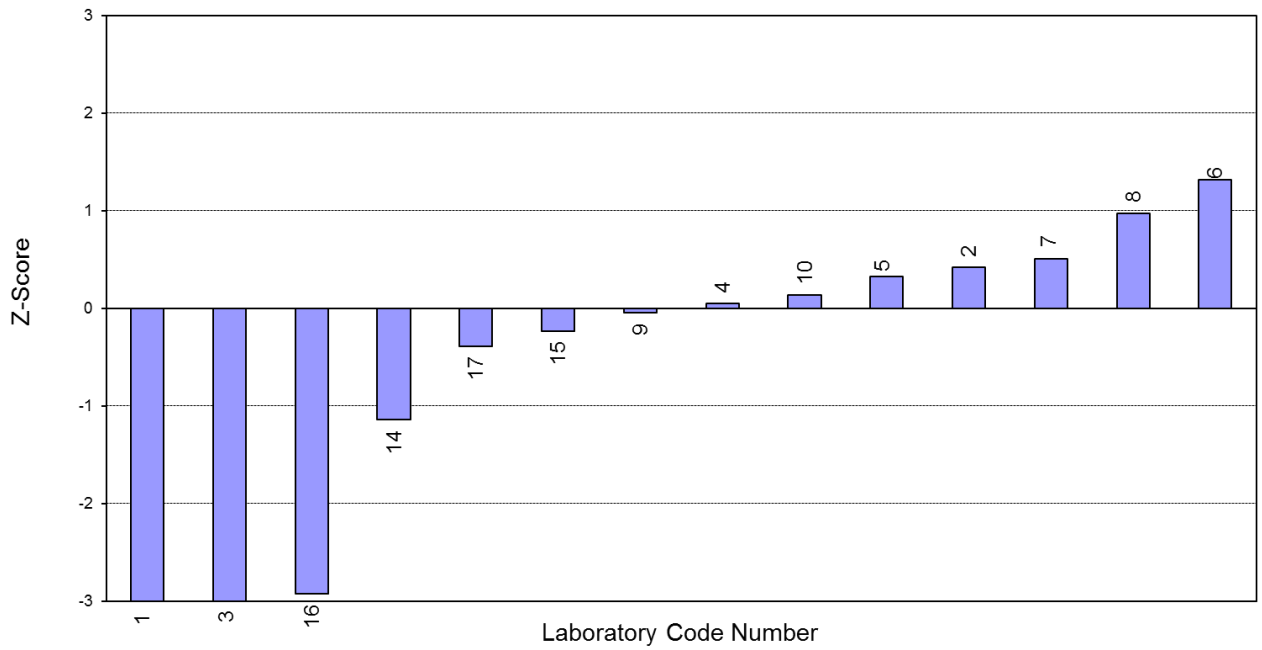
Lab Code	Results		Sample A Robust Z-score	Sample B Robust Z-score
	Sample A	Sample B		
1	87.80	88.15	-5.57 §	-4.55 §
2	93.70	93.50	0.77	0.42
3	86.00	85.89	-7.51 §	-6.65 §
4	93.25	93.10	0.28	0.05
5	93.40	93.40	0.45	0.33
6	94.37	94.47	1.49	1.32
7	92.90	93.60	-0.09	0.51
8	94.80	94.10	1.95	0.98
9	92.10	93.00	-0.95	-0.05
10	93.00	93.20	0.02	0.14
14	92.13	91.82	-0.92	-1.14
15	93.07	92.80	0.09	-0.23
16	91.63	89.90	-1.46	-2.93
17	92.97	92.63	-0.02	-0.39
<i>No of Results:</i>	14	14		
<i>Median:</i>	92.985	93.050		
<i>Normalised IQR:</i>	0.930	1.077		
<i>Robust CV:</i>	1.0%	1.2%		
<i>Minimum:</i>	86.00	85.89		
<i>Maximum:</i>	94.80	94.47		
<i>Range:</i>	8.80	8.58		
<i>Uncertainty (Median)</i>	0.312	0.361		

NOTE: "§" denotes an outlier (i.e. |z-score| ≥ 3.0).

Measurement of Specular Gloss (60°) (Sample A)



Measurement of Specular Gloss (60°) (Sample B)



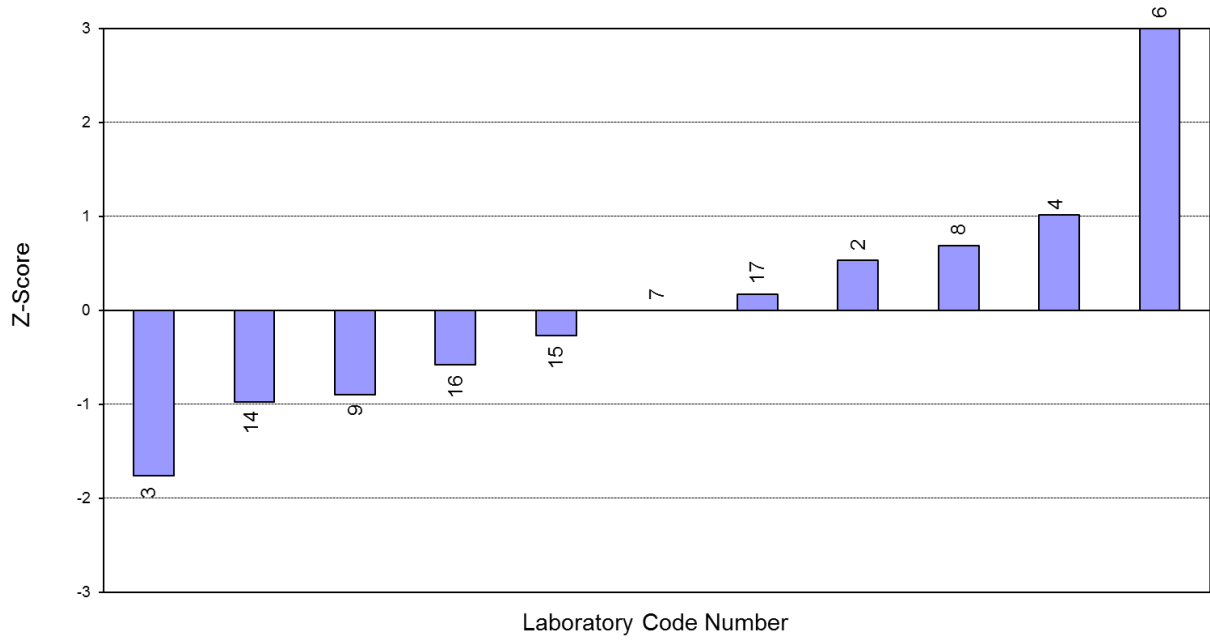
Measurement of Specular Gloss (85°) - AS 1580.602.2

Results by Laboratory Code

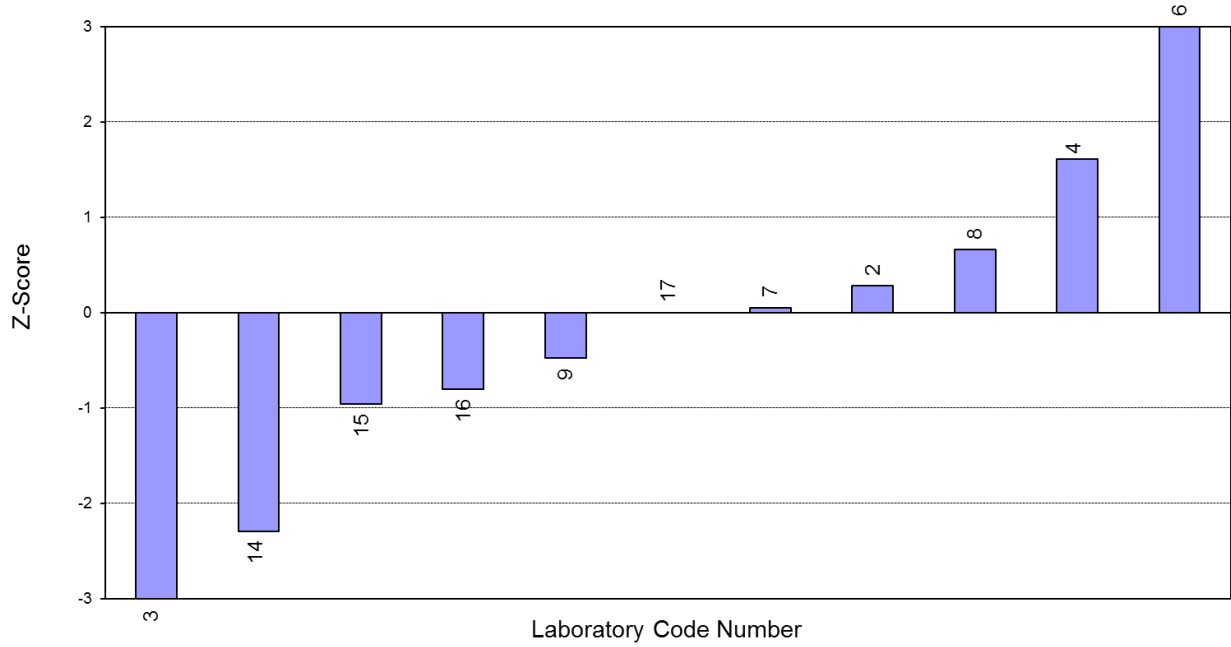
Lab Code	Results		Sample A Robust Z-score	Sample B Robust Z-score
	Sample A	Sample B		
2	99.60	99.00	0.53	0.28
3	93.98	94.21	-1.76	-3.35 §
4	100.80	100.75	1.02	1.61
6	107.70	107.77	3.83 §	6.93 §
7	98.30	98.70	0.00	0.05
8	100.00	99.50	0.69	0.66
9	96.10	98.00	-0.90	-0.48
14	95.90	95.60	-0.98	-2.30
15	97.63	97.37	-0.27	-0.95
16	96.87	97.57	-0.58	-0.80
17	98.73	98.63	0.17	0.00
<i>No of Results:</i>	11	11		
<i>Median:</i>	98.300	98.630		
<i>Normalised IQR:</i>	2.457	1.320		
<i>Robust CV:</i>	2.5%	1.3%		
<i>Minimum:</i>	93.98	94.21		
<i>Maximum:</i>	107.70	107.77		
<i>Range:</i>	13.72	13.56		
<i>Uncertainty (Median)</i>	0.929	0.499		

NOTE: "§" denotes an outlier (i.e |z-score| ≥ 3.0).

Measurement of Specular Gloss (85°) (Sample A)



Measurement of Specular Gloss (85°) (Sample B)



APPENDIX B

Sample Homogeneity

HOMOGENEITY TESTING

The samples utilised in this program were supplied by the Sherwin-Williams Company. Each participant was provided with two samples, labelled Sample A and Sample B.

For this program, five samples were randomly selected, and tested for homogeneity. Statistical analysis showed that the samples were sufficiently homogeneous so that any results identified as outliers could not be attributed to sample variability.

The results of the homogeneity testing, along with the summary statistics are provided in Table C.

TABLE C
Homogeneity Testing Results

Sample	Density	
1	1.1594	1.1592
2	1.1584	1.1586
3	1.1574	1.1585
4	1.1592	1.1586
5	1.1586	1.1582
<i>Mean:</i>	1.1586	1.1586
<i>st dev</i>	0.001	0.000
<i>CV</i>	0.1%	0.0%

APPENDIX C

Documentation

Instructions to Participants

C1

Results Sheets

C2

PROFICIENCY TESTING AUSTRALIA

Paint Proficiency Testing Program Round 27

INSTRUCTIONS TO PARTICIPANTS

Please read the following carefully **BEFORE** commencing testing.

Each participant will be supplied with two 500ml tins of paint. These have been labelled "PTA Sample A" and "PTA Sample B".

To ensure the appropriate analysis of results, participants are asked to adhere carefully to the following instructions:

- 1) The following tests are to be performed on samples A and B as per the Results Sheet:
 - (i) AS 1580.202.1 - density
 - (ii) AS 1580.214.1 - consistency - stormer viscometer
 - (iii) AS 1580.214.2 - consistency - flow cup
 - (iv) AS 1580.602.2 - measurement of specular gloss
- 2) Determinations on each sample are to be conducted in accordance with the appropriate method (stated on the Results Sheet). All laboratories are also encouraged to attempt those tests not included as part of their routine methods.
- 3) The following specific instructions will apply:
 - a. Report the nominal volume of the pycnometer used for AS1580.202.1.
 - b. AS1580.602.2 Measurement of specular gloss - readings shall be taken with 60° & 85° angles of incidence as per 10.2.
- 4) For this program your laboratory has been allocated the following code number: «Code». This is to allow for the confidential treatment of your results in the final report.
- 5) Testing may commence as soon as samples are received. Please return results,

NO LATER THAN 21 May 2018, to:

Dr Michael LI Proficiency Testing Australia PO Box 7507 Silverwater NSW 2128 Email: michael.li@pta.asn.au TEL: (02) 9736 8397 FAX: (02) 9743 6664
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PROFICIENCY TESTING AUSTRALIA

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Results Sheet

Lab «Code»

Test	AS 1580	PTA Sample A	PTA Sample B
Density (report in kg/L to 2 decimal places)	202.1		
Consistency - stormer viscometer (report to the nearest Krebs Unit)	214.1		
Consistency - flow cup (report to the nearest second)	214.2		
Measurement of specular gloss (60°) (report to 2 decimal places)	602.2		
Measurement of specular gloss (85°) (report to 2 decimal places)	602.2		

NOTES:

1. Report the nominal volume of the pycnometer used for AS1580.202.1.

Signed: _____ **Date:** _____

Results are to be returned to PTA by 21 May 2018.

Dr Michael LI
 Proficiency Testing Australia
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 Email: michael.li@pta.asn.au TEL: (02) 9736 8397 FAX: (02) 9743 6664

-- End of Report --