



Report No. 747

Bitumen Proficiency Testing

Round 3

January 2012

Acknowledgments

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CONTENTS

1. FOREWORD	1
2. FEATURES OF THE PROGRAM.....	1
3. FORMAT OF THE APPENDICES	2
4. STATISTICAL DESIGN OF THE PROGRAM.....	1
Table A: Summary Statistics.....	4
Table B: Summary of Statistical Outliers	4
5. PTA AND TECHNICAL ADVISOR'S COMMENTS.....	5
Table C: Comparison of robust CV's from previous rounds.....	5
6. REFERENCE/S	8

APPENDIX A – Results and Data Analysis

Viscosity at 135.0°C (Pa S)	A1
Density at 15.0°C (bottle) (Kg/m ³).....	A2
Penetration 25.0C, 100g, 5s (Pu)	A3
Softening Point °C	A4
Viscosity at 60.0°C (Pa S)	A5
RTFOT Viscosity Change (%)	A6
RTFOT Viscosity Change after treatment (Pa S).....	A7
Additional Information.....	A8

APPENDIX B – Homogeneity and Stability Testing

Homogeneity Testing.....	B1
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APPENDIX C – Documentation

Instructions to Participants.....	C1
Results Sheet.....	C2

1. FOREWORD

This report summarises the results of a proficiency testing program on selected chemical tests of bitumen. It constitutes the 3rd round of an ongoing series of programs.

The program was conducted in November 2011 by Proficiency Testing Australia (PTA). The aim of the program was to assess laboratories' abilities to competently perform the prescribed analyses.

The Program Coordinator was Ms L Galbraith and the Technical Advisor was Mr B Chik of SAMI Bitumen Technologies Pty Ltd. This report was authorised by Mr P Briggs, General Manager.

2. FEATURES OF THE PROGRAM

- (a) Participants were provided with two 800ml samples of bitumen labelled Sample A and Sample B.
 - (b) A total of 16 laboratories received samples, comprising:
 - Fourteen Australian participants; and
 - Two overseas participants, including:
 - One participant from China and one participant from Singapore.
- A total of 20 sample sets were sent to the laboratories for testing, of these 18 sets of results were returned for inclusion in the final report.
- (c) Laboratories were provided with the *Instructions to Participants* and *Results Sheet* (see Appendix C). Laboratories were requested to perform the tests according to their routine methods and to record their results on the *Results Sheet*.
 - (d) Prior to sample distribution, a number of randomly selected samples were analysed for homogeneity. Based on the results of this testing (see Appendix B), the homogeneity of the samples was established.
 - (e) Each laboratory was randomly allocated a unique code number for the program to ensure confidentiality of results. Reference to each laboratory in this report is by code number only. Please note that a number of laboratories reported more than one set of results and, therefore, their code numbers (with letter) could appear several times in the same data set.

- (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 (for each sample and for each of the analyses performed). Measurement Uncertainty (MU) is also presented where supplied by participants. Please note that this information is presented for information purposes only and has not been used for the formal evaluation of results.
- (g) A robust statistical approach, using z-scores, was utilised to assess laboratories' testing performance (see Section 3). Robust z-scores, z-score charts relevant to each test are presented in Appendix A.
- (h) The document entitled *Guide to Proficiency Testing Australia, 2011* (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 4.

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.
- (b) Appendix B contains details of the homogeneity 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 “§”.

(b) Results Tables and Summary Statistics

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

Results have been entered exactly as reported by participants. That is, laboratories which did not report results to the precision (i.e. number of significant figures) requested on the Results Sheet have **not** been rounded to the requested precision before being included in the statistical analysis.

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;
- 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 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 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.

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

TABLE A: SUMMARY STATISTICS

Test	No. of Results	Median	Normalised IQR
Viscosity @ 135.0°C (Pa S)	17	0.3800	0.0200
Density @ 15.0°C (bottle) (Kg/m ³)	15	1043.50	3.45
Penetration 25.0C, 100g, 5s (Pu)	16	70.0	2.4
Softening Point °C	14	48.0	0.8
Viscosity @ 60.0°C (Pa S)	16	212.3	5.4
RTFOT Viscosity Change (%)	12	180.0	3.2
RTFOT Viscosity Change after treatment (Pa S)	12	384.1	14.5

The following table summarises the statistical outlier results for this program.

TABLE B: OUTLIER RESULTS

Test	Laboratory code
Viscosity @ 135.0°C (Pa S)	--
Density @ 15.0°C (bottle) (Kg/m ³)	--
Penetration 25.0C, 100g, 5s (Pu)	22
Softening Point °C	9, 22
Viscosity @ 60.0°C (Pa S)	9, 40
RTFOT Viscosity Change (%)	1
RTFOT Viscosity Change after treatment (Pa S)	40

Note: A '--' indicates no outlier result was recorded

5. PTA AND TECHNICAL ADVISOR'S COMMENTS

General Comments

The overall performance of laboratories was very good.

A total of 20 sample sets were sent to the laboratories for testing, of these 18 sets of results were returned for inclusion in the final report. Of the 102 total results, 7 outliers were reported; therefore 6.86% of the total results have been identified as outlier results.

The following table gives a comparison of the robust CVs for tests common to the previous programs.

TABLE C: Comparison of robust CVs from previous rounds.

Test	Round 1	Round 2	Round 3
Viscosity @ 135.0°C	4.5%	3.9%	5.3%
Density @ 15.0°C	0.05%	0.2%	0.3%
Penetration @ 25.0 °C, 100g, 5s	3.7%	5.7%	3.4%
Viscosity @ 60.0 °C	3.3%	1.6 %	2.5%
RTFOT Viscosity Change	1.4%	2.3%	1.8%
RTFOT Value after treatment	~	4.3%	3.8%
Softening Point °C	~	~	1.6%

Note: ~ indicates that this test was not offered previously.

Comparison of robust CV's from previous rounds demonstrates a sound method in Bitumen analysis. The low CV's are indicative of the level of precision that participants have shown. This has consistently been successful over the life of the program.

Any laboratories reporting results with a z-score between 2 and 3 are encouraged to review their procedures. Outlier laboratories not only need to review their method but perhaps ensure results are to the correct basis or value.

The specified method for performing the tests was AS2341 (relevant sections). The majority of participating laboratories followed this method. Other methods reported included in-house methods and ASTM methods.

The bitumen in this round has less variation because it is not readily oxidised, so comparisons between present precision data and published precision data are invalid.

The precision statement 7a(ii) in the method AS2341.10 shows an unusual high reproducibility of +/-50%. It was concluded that laboratory code 1 result for RTFOT Viscosity Change is not a true outlier due to the high reproducibility. All other test results from laboratory code 1 are good.

A possible source of errors may be that many participants are not following the test method AS2341.10 by checking the oven temperature (RTFO) using a thermometer. We encourage participants to look closely at the oven temperature by physically checking using a thermometer instead of recording from the digital reading displayed on the oven.

5.1 Metrological Traceability and Measurement Uncertainty of Assigned Values

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

The origin of the samples are the SAMI storage tank at Camellia 2009. The standard method AS2008 and other standards were used to prepare the samples. Certified reference materials used include calibration reports on reference thermometers. Calibrations were conducted using a clean and fresh standard silicon oil.

As the assigned value for this program is the median of the results submitted by the participants, the uncertainty of the median has been calculated using the calculation below and is presented in Appendix A along with the corresponding test.

$$\text{Uncertainty (median)} = \frac{\sigma}{\sqrt{n}}$$

where σ is the standard deviation of the results and n is the number of results reported by participants. For this program participants were asked to report Measurement of Uncertainty (MU). Laboratories who submitted results to be included in the final report responded with varying values. Of the 18 sets of results returned, 10 reported MU values. Improvement is apparent in the overall performance of measurement of uncertainties.

5.2 Analysis of Results by Method Groups

In order for methods to be grouped for analysis, PTA requires at least 10 sets of results from the same method group. As there were less than 10 results submitted for methods in Viscosity at 135°C and 60°C, Density at 15°C, RTFOT Viscosity Change and RTFOT Viscosity Change After Treatment, reliable conclusions cannot be drawn from analysing grouped methods on this occasion. Therefore, results from all method groups have been pooled for analysis.

Penetration and Softening Point returned at least 10 sets of results from the same method group that are technically equivalent, therefore results generated using these methods have been pooled for analysis.

	Penetration 25.0C, 100g, 5s (Pu) AS2341.12	Softening Point °C AS2341.18
Number of results	14	10
Median	70.0	48.0
Normalised IQR	1.5	0.9

The results of the grouped analysis comparative to the consensus results show little or no variation. No other methods were so prevalent that they could be analysed as a group method.

6. Reference

- [1] *Guide to Proficiency Testing Australia*, 2011 (This document can be found on the PTA website, www.pta.asn.au)

APPENDIX A

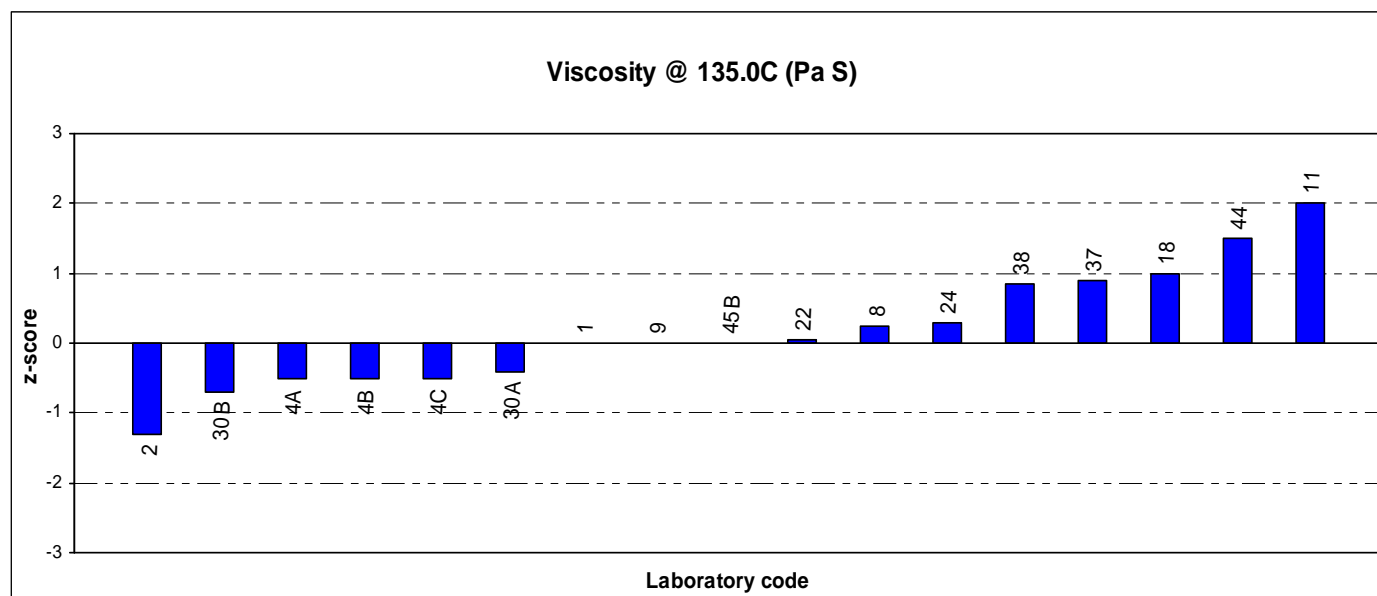
Results and Data Analysis

Viscosity at 135.0°C (Pa S)	A1
Density at 15.0°C (bottle) (Kg/m ³).....	A2
Penetration 25.0C, 100g, 5s (Pu)	A3
Softening Point °C	A4
Viscosity at 60.0°C (Pa S)	A5
RTFOT Viscosity Change (%)	A6
RTFOT Viscosity Change after treatment (Pa S).....	A7
Additional Information.....	A8

Viscosity @ 135.0C (Pa S)				
Laboratory code	Result	MU	Robust z-score	Method
1	0.380 ± 0.046		0.00	AS2341_3
2	0.354	#	-1.30	AS2341.2
4A	0.37 ± 6%		-0.50	TP652
4B	0.37 ± 6%		-0.50	TP652
4C	0.37 ± 6%		-0.50	TP652
8	0.385	#	0.25	AS2341.4
9	0.380	#	0.00	AS2341.2
11	0.420 ± 0.03		2.00	AS2341.3
18	0.40 ± 1%		1.00	AGPT/T111
22	0.381 ± 0.25		0.05	AS2341.4
24	0.386	#	0.30	D-2171
30A	0.372	#	-0.40	AS2341.2
30B	0.366	#	-0.70	AS2341.2
37	0.398	0.010 (k=2)	0.90	ASTM D4402-06
38	0.397 ± 4%		0.85	AS2341.4
44	0.41	#	1.50	AG: PT/T111
45B	0.38	#	0.00	AS2341.3-1993

Number of results	17
Median	0.3800
Uncertainty (median)	0.0061
Normalised IQR	0.0200
Robust CV	5.3%
Minimum	0.354
Maximum	0.420
Range	0.066

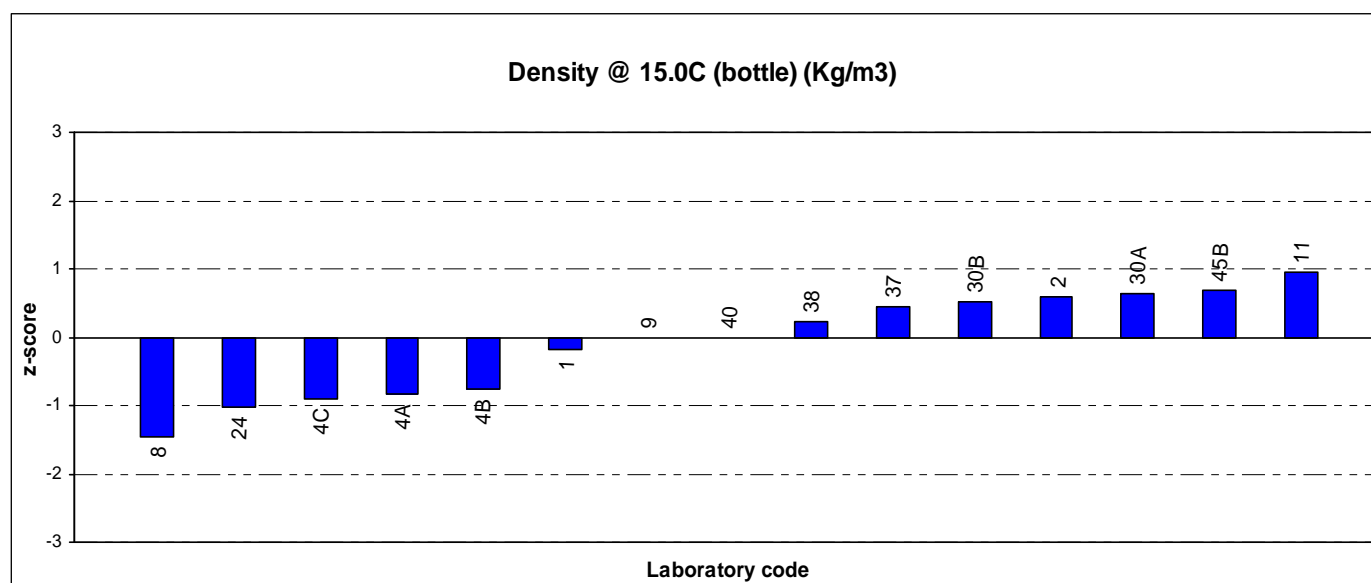
Note: A “#” indicates no response was provided.



Density @ 15.0C (bottle) (Kg/m ³)					
Laboratory code	Result	MU	Robust z-score	Method	
1	1042.9 ±	0.9	-0.17	AS2341.7	
2	1045.5	#	0.58	AS2341.7	
4A	1040.6	#	-0.84	AS2341.7	
4B	1040.9	#	-0.75	AS2341.7	
4C	1040.4	#	-0.90	AS2341.7	
8	1038.5	#	-1.45	AS2341.7	
9	1043.5	#	0.00	AS2341.7	
11	1046.8 ±	0.7	0.96	AS2341.7	
24	1040	#	-1.02	D-70	
30A	1045.7	#	0.64	AS2341.7	
30B	1045.3	#	0.52	AS2341.7	
37	1045	2.6 (k=2)	0.44	ASTM D70-09	
38	1044.3	0.5Kg/m ³	0.23	AS2341.7	
40	1043.5	#	0.00	AS2341.7	
45B	1045.9	#	0.70	AS2341.7 - 1993	

Number of results	15
Median	1043.50
Uncertainty (median)	1.12
Normalised IQR	3.45
Robust CV	0.3%
Minimum	1038.5
Maximum	1046.8
Range	8.3

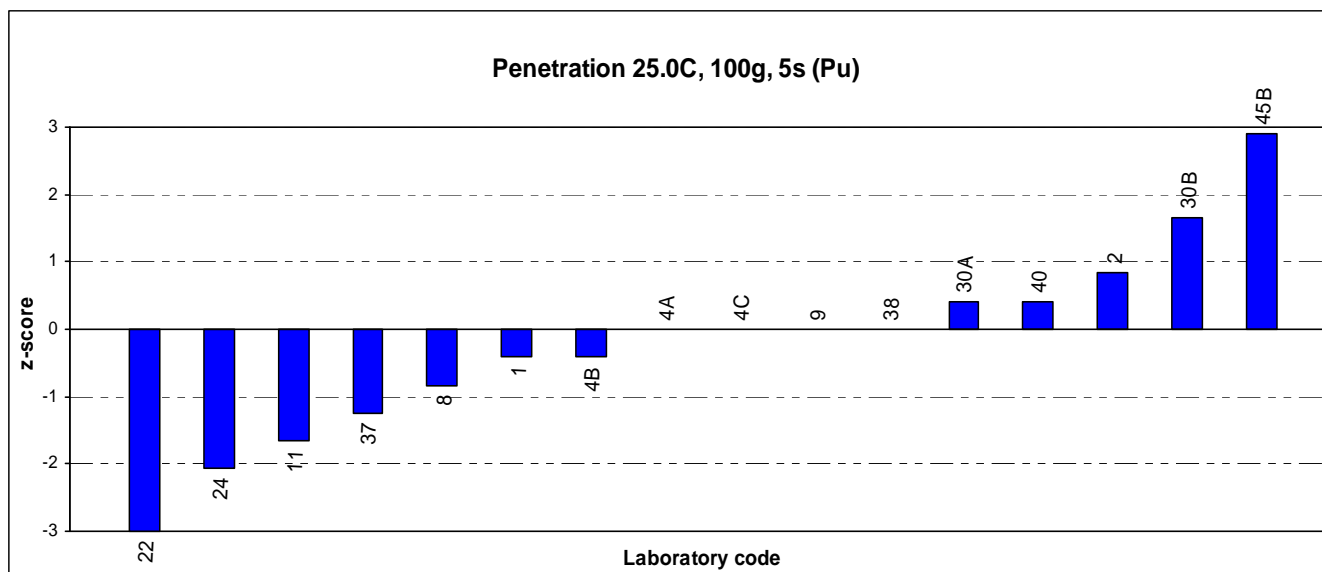
Note: A '#' indicates no response was provided.



Penetration 25.0C, 100g, 5s (Pu)					
Laboratory code	Result		MU	Robust z-score	Method
1	69	±	4	-0.42	AS2341_12
2	72		#	0.83	AS2341.12
4A	70	±	3%	0.00	AS2341.12
4B	69	±	3%	-0.42	AS2341.12
4C	70	±	3%	0.00	AS2341.12
8	68		#	-0.83	AS2341.12
9	70		#	0.00	AS2341.12
11	66	±	1	-1.66	AS2341.12
22	52.3	±	0.11	-7.35	AS2341.12 §
24	65		#	-2.08	D-5
30A	71		#	0.42	AS2341.12
30B	74		#	1.66	AS2341.12
37	67		2 (k=2)	-1.25	ASTM D5-06
38	70		4pu	0.00	AS2341.12
40	71		#	0.42	AS2341.12
45B	77		#	2.91	AS2341.12-1993

Number of results	16
Median	70.0
Uncertainty (median)	0.8
Normalised IQR	2.4
Robust CV	3.4%
Minimum	52.3
Maximum	77
Range	24.7

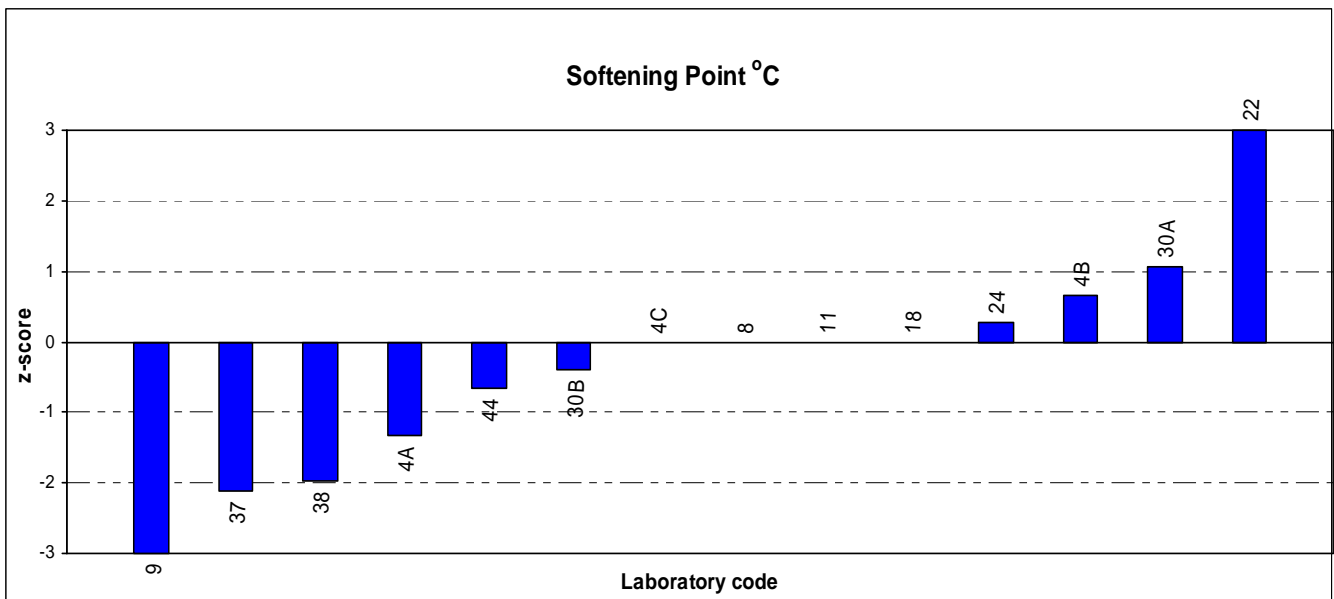
Note: A “#” indicates no response was provided.
 A ‘§’ indicates an outlier.



Softening Point °C					
Laboratory code	Result	MU	Robust z-score		Method
4A	47.0 ± 5%		-1.32		AS2341.18
4B	48.5 ± 5%		0.66		AS2341.18
4C	48.0 ± 5%		0.00		AS2341.18
8	48	#	0.00		AS2341.18
9	45	#	-3.95	§	AS2341.18
11	48 ± 1		0.00		AS2341.18
18	48.0 ± 1.0		0.00		AGPT/T131
22	50.45 ± 0.18		3.22	§	AS2341.18
24	48.2	#	0.26		D-36
30A	48.8	#	1.05		AS2341.18
30B	47.7	#	-0.39		AS2341.18
37	46.4	0.8 (k=2)	-2.11		ASTM D36-09
38	46.5 ± 1.0		-1.97		AS2341.18
44	47.5 ± 0.2		-0.66		AG:PT/T131

Number of results	14
Median	48.0
Uncertainty (median)	0.3
Normalised IQR	0.8
Robust CV	1.6%
Minimum	45
Maximum	50.45
Range	5.45

Note: A “#” indicates no response was provided.
 A ‘§’ indicates an outlier.

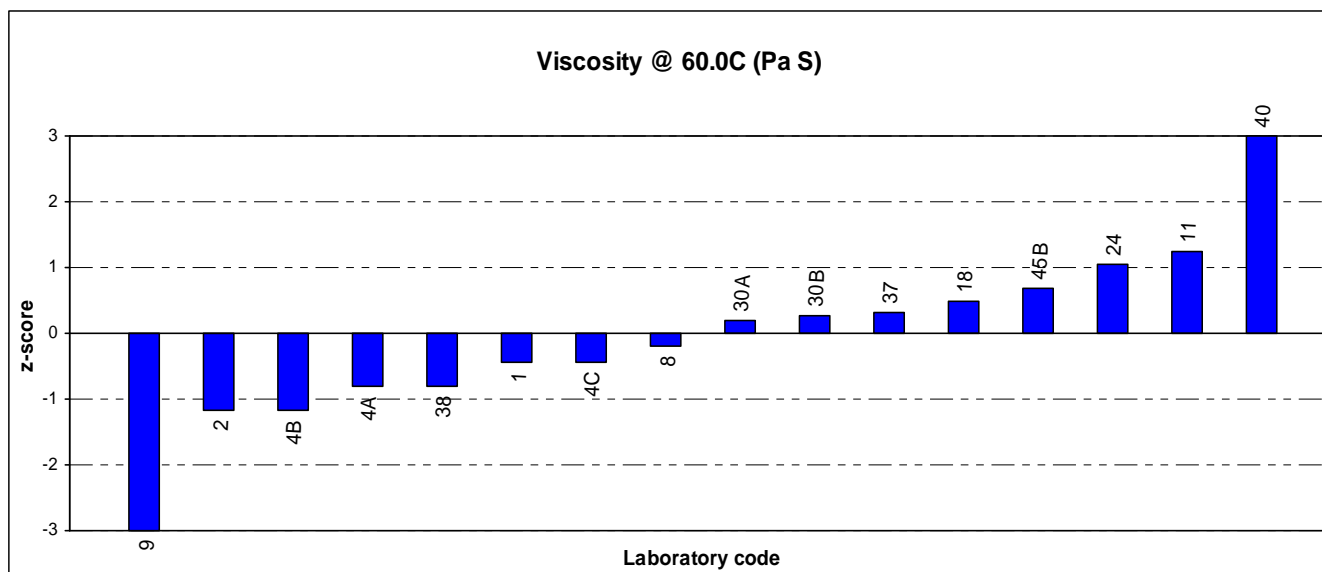


Viscosity @ 60.0C (Pa S)					
Laboratory code	Result	MU	Robust z-score		Method
1	210	± 25.2	-0.43		AS2341_2
2	206	#	-1.18		AS2341.2
4A	208	± 6%	-0.80		TP652
4B	206	± 6%	-1.18		TP652
4C	210	± 6%	-0.43		TP652
8	211.3	#	-0.19		AS2341.2
9	196	#	-3.04	§	AS2341.2
11	219	± 15	1.24		AS2341.2
18	215	±2%	0.50		DTEI-MAT-TP652
24	218	#	1.06		D-2171
30A	213.350	#	0.19		AS2341.2
30B	213.771	#	0.27		AS2341.2
37	214	11 (k=2)	0.31		ASTM D2171-10
38	208	± 3%	-0.80		AS2341.2
40	251	#	7.20	§	AS2341.2
45B	216	#	0.68		AS2341.2-1993

Number of results	16
Median	212.3
Uncertainty (median)	1.7
Normalised IQR	5.4
Robust CV	2.5%
Minimum	196
Maximum	251
Range	55

Note: A “#” indicates no response was provided.

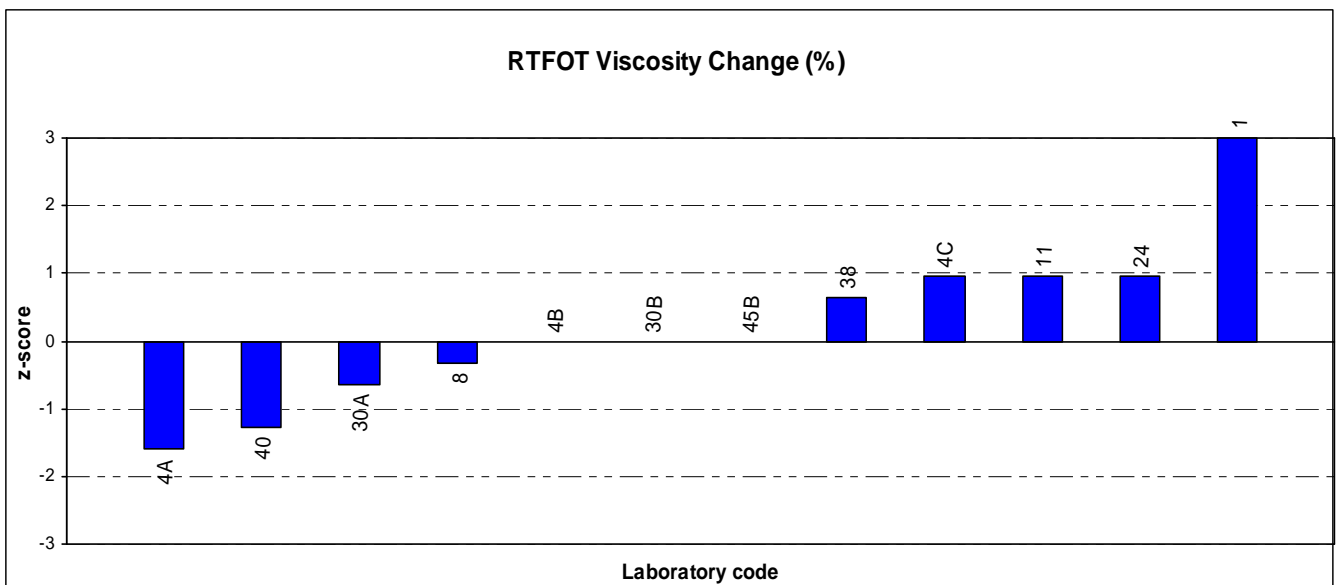
A ‘§’ indicates an outlier.



RTFOT Viscosity Change (%)					
Laboratory code	Result	MU	Robust z-score	Method	
1	190	± 22.8	3.17	§*	
4A	175	± 6%	-1.59	AS2341.2	
4B	180	± 6%	0.00	TP652 AS2341.10	
4C	183	± 6%	0.95	TP652 AS2341.10	
8	179	#	-0.32	AS2341.10	
11	183	± 12%	0.95	AS2341.2	
24	183	#	0.95	AS2341.10	
30A	178	#	-0.63	D2873/2171	
30B	180	#	0.00	AS2341.10 / AS2341.2	
38	182	± 10%	0.63	AS2341.10 / AS2341.2	
40	176	#	-1.27	AS2341.2	
45B	180	#	0.00	AS2341.10-1994 / AS2341.2-1993	

Number of results	12
Median	180.0
Uncertainty (median)	1.1
Normalised IQR	3.2
Robust CV	1.8%
Minimum	175
Maximum	190
Range	15

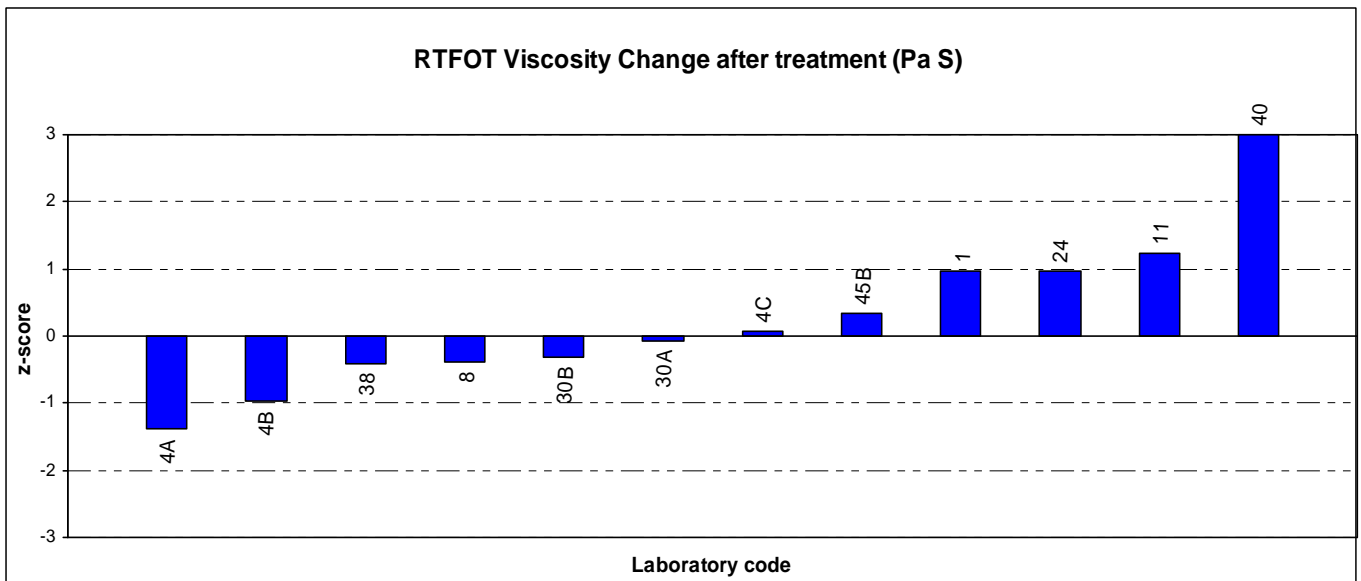
Note: A “#” indicates no response was provided.
 A ‘§*’ indicates not a true outlier.



RTFOT Viscosity Change after treatment (Pa S)					
Laboratory code	Result	MU	Robust z-score		Method
1	398 ±	22.8	0.96		AS2341_2
4A	364 ±	6%	-1.38		TP652 AS2341.10
4B	370 ±	6%	-0.97		TP652 AS2341.10
4C	385 ±	6%	0.06		TP652 AS2341.10
8	378.5	#	-0.38		AS2341.2
11	402	#	1.23		AS2341.10
24	398	#	0.96		D2873/2171
30A	383.109	#	-0.06		AS2341.10 / AS2341.2
30B	379.474	#	-0.31		AS2341.10 / AS2341.2
38	378	#	-0.42		AS2341.10 / AS2341.2
40	442	#	3.98	§	AS2341.2
45B	389	#	0.34		AS2341.10-1994 / AS2341.2-1993

Number of results	12
Median	384.1
Uncertainty (median)	5.3
Normalised IQR	14.5
Robust CV	3.8%
Minimum	364
Maximum	442
Range	78

Note: A “#” indicates no response was provided.
 A ‘§’ indicates an outlier.



Additional information					
Laboratory Code	Make and model of rotational viscometer	Shear rates for all viscosities tested		Filling method in determination of density at 15 °C	Cannon-Manning or Asphalt Institute viscometers used?
		135.0°C	60.0°C		
1	n/a	0.31	2.45	Partial filling method	Cannon-Manning
2	#	996.927	5.2615	partial	Cannon-manning
4A	Haake Viscobalance TP652	n/a	n/a	partial	n/a
4B	Haake Viscobalance	n/a	n/a	partial	n/a
4C	Haake Viscobalance TP652	n/a	n/a	partial	n/a
8	Brookfield - model DV-2t viscometer	39.6	1.9185	partial	Asphalt Institue
9	#	#	#	partial filling method	#
11	#	0.15 s ⁻¹	1.13 s ⁻¹	yes	#
18	Brookefield DV-1	20.4	#	#	#
22	Brookfiled DiV II +	112	#	#	#
24	#	#	#	partial	135°C - Cannon 60°C - AI
30A	n/a	1048.72 5	6.572	partial	Cannon-Manning
30B	n/a	1191.13 1	6.559	partial	Cannon-Manning
37	Brookfield DV-II+Pro	34.0s ⁻¹	#	partial filling	Use Asphalt institute viscometer
38	LVDVII + Brookfield	20.40 sec ⁻¹	1.24 sec ⁻¹	partial filling	Asphalt Institute viscometer
40	#	#	0.862	partial filling	#
44	Brookfield Visocometer LVT	16.5	n/a	#	#
45A	#	#	#	#	#
45B	n/a	n/a	n/a	partial filling	Cannon

Note: A “#” indicates no response was provided.

APPENDIX B

Homogeneity and Stability Testing

Homogeneity and Stability Testing

Stability testing was not performed on the Bitumen samples as it is not biologically degradable. Samples are stored in air tight containers to prevent oxidation and stored in low temperatures as contents have high boiling point properties. Care is taken to ensure containers remain in good condition and are checked for breaks before samples are dispatched.

Ten samples were selected at random and analysed in duplicate for Penetration at 25°C (AS2341.12) and Viscosity at 135°C (AS2341.4) . Statistical analysis of the results indicated that no notable sample variability existed. Therefore, it was concluded that any outlier results subsequently identified could not be attributed to sample variability.

PTA Homogeneity Results				
Penetration at 25.0°C AS2341.12			Viscosity at 135.0°C AS2341.4	
Sample No.	Results (p.u).	Deviation	Results (Pa.S).	Deviation
62	66	-0.9174	0.405	-0.37175
72	65	0.6116	0.408	-1.11524
45	65	0.6116	0.407	-0.86741
43	66	-0.9174	0.402	0.37175
1	65	0.6116	0.405	-0.37175
24	65	0.6116	0.408	-1.11524
74	66	-0.9174	0.402	0.37175
90	65	0.6116	0.400	0.86741
19	65	0.6116	0.400	0.86741
10	66	-0.9174	0.398	1.36307
Mean	65.4		0.4035	
%CV	0.8%		0.9%	

Water bath temperature checked = 25.°C

Thermosel temperature checked = 135.°C

Note: Deviation lies within test method requirements.

APPENDIX C

Documentation

Instructions to Participants C1
Results Sheet C2

**PROFICIENCY TESTING AUSTRALIA
BITUMEN PROFICIENCY TESTING PROGRAM
ROUND 3
INSTRUCTIONS TO PARTICIPANTS**

To ensure that results from this program can be analysed properly, participants are asked to adhere carefully to the following instructions.

1. 2 x 800 ml samples labelled PTA Sample A and PTA Sample B are provided to each laboratory.
2. The following tests are to be conducted:

PTA Sample A:

Dynamic Viscosity @ 135°C
Density at 15C (bottle)
Penetration 25°C, 100g, 5s
Softening Point, °C

PTA Sample B:

Dynamic Viscosity @ 60°C (to be tested before RTFOT)
RTFOT Viscosity Change (including the actual value after treatment)

3. Participants can perform any or all of the above mentioned tests.
4. If performing both 'Sample B' tests it is recommended to perform the Vacuum Viscosity @ 60°C test first.
5. Participants should use the routine test methods which would normally be used to test samples. (The Australian Standard method AS 2341 is the preferred method). Please identify the method used on the Results Sheet.
6. Laboratories are also requested to calculate and report an estimate of uncertainty of measurement for each reported measurement result if possible. All estimates of uncertainty of measurement must be given as a 95% confidence interval (coverage factor $k \approx 2$) and reported in \pm reporting unit basis.
7. The results for all determinations are to be recorded on the results sheet to the accuracy and reporting basis indicated.
8. Testing may commence as soon as the sample is received. All laboratories must return the results sheet no later than **2 December 2011** to:

Laura Galbraith
Proficiency Testing Australia
PO Box 7507
SILVERWATER NSW 2128
Phone: 02 9736 8397
Fax: 02 9743 6664
Email: laura.galbraith@pta.asn.au

**PROFICIENCY TESTING AUSTRALIA
BITUMEN PROFICIENCY TESTING PROGRAM
ROUND 3
RESULTS SHEET**

Lab Code

**PTA
SAMPLE A**

TEST (report to)	Result	MU ±	Method
Viscosity @ 135.0°C Pa.s			
Density at 15.0C (bottle) Kg/m ³			
Penetration 25.0°C, 100g, 5s p.u. (0.1 mm)			
Softening Point, °C			

**PTA
SAMPLE B**

TEST (report to)	Result	MU ±	Method
Viscosity @ 60.0°C Pa.s			
RTFOT Viscosity Change (including the actual value after treatment) %			

If rotational viscometer is used for any viscosity determination, please report make and model _____

Also please report:

i) Mean Shear rates for all viscosities tested: @ 135.0°C _____ @ 60.0°C _____

ii) Partial filling method or Total filling method in the determination of density at 15°C _____

iii) If Cannon-Manning viscometers or Asphalt Institute viscometers are used.

Date of tests: _____ Signature: _____

Send results by **2 December 2011** to:
 Laura Galbraith
 Proficiency Testing Australia
 PO Box 7507
 SILVERWATER NSW 2128
 Phone: 02 9736 8397
 Fax: 02 9743 6664
 Email: laura.galbraith@pta.asn.au

- End of Report -