REPORT NO. 1101

Hardness Testing of Metals

Proficiency Testing Program

Round 14

August 2018

ACKNOWLEDGMENTS

PTA wishes to gratefully acknowledge the technical assistance provided for this program by Mr S Sameem, ARL Laboratory Services Pty Ltd. Also our thanks go to ARL Laboratory Services Pty Ltd, for the supply and homogeneity testing of the samples.

PO Box 7507 Silverwater NSW 2128 AUSTRALIA

CONTENTS

1. FOREWORD

This report summarises the results of a proficiency testing program on the hardness properties of metals. It constitutes the fourteenth round of an ongoing series of programs. 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 testing program in May / June 2018. The aim of the program was to assess laboratories' ability to competently perform the nominated tests.

The Program Coordinator was Dr M Bunt. The Technical Adviser was Mr S Sameem, ARL Laboratory Services Pty Ltd. This report was authorised by Mrs K Cividin, PTA Quality Manager.

2. FEATURES OF THE PROGRAM

(a) A total of 17 laboratories participated in the program, all of which returned results for inclusion in the final report. Laboratories from the following countries received samples:

11	AUSTRALIA
2	NEW ZEALAND
1	CHINA
1	SAUDI ARABIA
1	TANZANIA
1	UNITED KINGDOM

To ensure confidential treatment of results, each laboratory was allocated a unique random code number. Reference to each laboratory in this report is by its code number.

(b) The results reported by participants are presented in Appendix A.

(c) Each laboratory was provided with a steel sample, approximately 60 mm in diameter and approximately 30 mm thick. The sample was to be tested for Brinell, Vickers and Rockwell B hardness testing.

(d) Laboratories were requested to perform the tests according to the *Instructions to Participants* provided and to record the results, along with an estimate of their measurement uncertainty (MU) for each result, on the accompanying *Results Sheet*, which was distributed with the samples. Copies of these documents appear in Appendix C.

(e) Prior to distribution, the samples were tested for homogeneity by ARL Laboratory Services Pty Ltd. Based on the results of this testing, the homogeneity of the samples was established (see Appendix B).

3. FORMAT OF THE APPENDICES

(a) Appendix A is divided into four sections (A1-A4).

Sections A1-A3 contain the analysis of results reported by laboratories for Brinell, Vickers and Rockwell B hardness. These sections contain:

i) a table of results reported by laboratories for each test, with estimates of their MUs and calculated z-scores;
ii) a listing of the summary statistics; and
iii) ordered z-score charts.

Section A4 contains information on the methods used by the participants and the surface preparations they performed.

(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

The summary statistics calculated for each test / sample consists of:

- *No. of Results*: the total number of results for that test / sample;
- *Median*: the middle value of the results;
- *Normalised IQR*: the normalised interquartile range of the results;
- *Uncertainty of the Median*: a robust estimate of the standard deviation of the *Median*;
- *Robust CV*: the robust coefficient of variation expressed as a percentage, *i.e.* 100 x *Normalised IQR* / *Median*;
- *Minimum*: the lowest laboratory result;
- *Maximum*: the highest laboratory result; and
- *Range*: the difference between the *Maximum* and *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:

$$\sqrt{\frac{\pi}{2}} \times \frac{normIQR}{\sqrt{n}}$$

where *normIQR* is the normalised IQR and *n* is the number of results.

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 with an absolute value less than or equal to 2.0 is considered to be satisfactory, 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 "§". Laboratories are also encouraged to review results which have an absolute z-score value between 2.0 and 3.0 (*i.e.* $2.0 < |\text{z-score}| < 3.0$). These results are considered to be questionable results.

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

The ordered z-score charts in Appendix A are limited on the vertical axis to +3.0 and -3.0, so that outliers are clearly identifiable as those laboratories whose "bar" extends beyond the chart boundary.

For further details on the calculation and interpretation of robust z-scores and ordered z-score charts, please see the *Guide to Proficiency Testing Australia (2016)*.

5. OUTLIER RESULTS

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

Table A: Summary Statistics for All Tests

Test	Summary Statistics	Average Result
Brinell Hardness (HBW)	Number of Results	15
	Median	209.0
	Normalised IQR	4.8
	Uncertainty (Median)	1.6
Vickers Hardness (HV)	Number of Results	15
	Median	222.0
	Normalised IQR	5.2
	Uncertainty (Median)	1.7
Rockwell B Hardness (HRB)	Number of Results	15
	Median	95.50
	Normalised IQR	1.74
	Uncertainty (Median)	0.56

Table B: Summary of Statistical Outliers
(By laboratory code number)

Test	Outliers (Laboratory Code No.)
Brinell Hardness	-
Vickers Hardness	-
Rockwell B Hardness	-

Notes:

1. For each test, the results for all test methods were pooled for analysis.
2. Summary statistics and z-scores were calculated for the average hardness value reported for each test.

6. PTA AND TECHNICAL ADVISER'S COMMENTS

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

The summary statistics, uncertainties of the assigned values and outliers, for each of the tests, are reported in Tables A and B above. Complete details of the statistical analyses appear in Appendix A.

6.1 Return rate

All of the 17 laboratories that participated in the program submitted results for inclusion in the final report. Of these 17 laboratories, 11 (65%) submitted results for all three tests.

The return rate for all tests is as follows:

- Brinell Hardness 15 out of 17 88%
- Vickers Hardness 15 out of 17 88%
- Rockwell B Hardness 15 out of 17 88%

6.2 Performance summary

There were no statistical outliers reported by any of the participants in this round of the program. For comparison, 31% of the participants reported outlier results in Round 13 of this program, while 11% of the results analysed in Round 13 were outlier results (see Report No. 1068 for more details).

6.3 Brinell Hardness

A total of 15 laboratories tested the sample for Brinell hardness. Of these laboratories, eight tested using the AS 1816 method. One laboratory indicated that they used an Australian Standard method. It is assumed that this was the AS 1816 method. One laboratory used both AS 1816 and ISO 6506. Three laboratories tested using the ISO 6506 method. Two laboratories tested using ASTM methods (see Appendix A4 for more details).

There were not enough results submitted for any specific method to draw reliable conclusions from analysing grouped methods on this occasion. The methods were pooled when analysing the results.

For all methods pooled, the median and its standard uncertainty for the Brinell hardness results was 209.0 ± 1.6 HBW.

The CV for the Brinell hardness results for this round was 2.3%. This compares well with the CV of 2.0%, obtained for the Brinell hardness results in Round 13 of this program (see Report No. 1068).

There were no outliers reported for Brinell hardness. Two laboratories (codes 7 and 17) obtained absolute z-scores between 2.0 and 3.0. The higher Brinell hardness results reported by laboratories 7 and 17 may be due to insufficient indentation spacing.

Twelve laboratories reported measurement uncertainties associated with their Brinell hardness test results in this round.

6.4 Vickers Hardness

Of the 15 laboratories that tested the sample for Vickers hardness, nine tested using the AS 1817 method. One laboratory indicated that they used an Australian Standard method. It is assumed that this was the AS 1817 method. One laboratory used both AS 1817 and ISO 6507. Three laboratories tested using the ISO 6507 method. One laboratory tested using the ASTM E384 method (see Appendix A4 for more details).

For the laboratories that used an Australian Standard method, the median and its standard uncertainty for the Vickers hardness results was 221.0 ± 2.0 HV. For all methods pooled, the median and its standard uncertainty for the Vickers hardness results was 222.0 ± 1.7 HV.

The methods were pooled when analysing the results.

The CV for the Vickers hardness results for this round was 2.3%. This is higher than the CV of 0.7%, obtained for the Vickers hardness results in Round 13 of this program (see Report No. 1068).

There were no outliers reported for Vickers hardness. Three laboratories (codes 8, 10 and 11) obtained absolute z-scores between 2.0 and 3.0. The higher Vickers hardness results reported by laboratories 10 and 11 may be due to insufficient indentation spacing, or perhaps these laboratories carried out their Vickers hardness testing later.

Twelve laboratories reported measurement uncertainties associated with their Vickers hardness test results in this round.

6.5 Rockwell B Hardness

A total of 15 laboratories tested the sample for Rockwell B hardness. Of these laboratories, nine tested using the AS 1815 method. One laboratory indicated that they used an Australian Standard method. It is assumed that this was the AS 1815 method. Three laboratories tested using the ISO 6508 method. Two laboratories tested using the ASTM E18 method (see Appendix A4 for more details).

There were not enough results submitted for any specific method to draw reliable conclusions from analysing grouped methods on this occasion. The methods were pooled when analysing the results.

For all methods pooled, the median and its uncertainty for the Rockwell B hardness results was 95.50 ± 0.56 HRB.

The CV for the Rockwell B hardness results for this round was 1.8%. This is higher than the CV of 0.9%, obtained for the Rockwell B hardness results in Round 13 of this program (see Report No. 1068).

There were no outliers reported for Rockwell B hardness.

Twelve laboratories reported measurement uncertainties associated with their Rockwell B hardness test results in this round.

6.6 Measurement Uncertainty

The number and percentage of laboratories that reported estimates of their measurement uncertainty for each test is as follows:

• Brinell Hardness	12 out of 15	80%
• Vickers Hardness	12 out of 15	80%
• Rockwell B Hardness	12 out of 15	80%

The variation between the estimates of measurement uncertainty ranged from not reporting at all, to some reporting numerical values, while others reported percentages.

Any laboratory that reported a measurement uncertainty less than two times the uncertainty of the median may have underestimated their measurement uncertainty.

Any laboratory that reported a measurement uncertainty greater than three times the normalised IQR may have overestimated their measurement uncertainty.

All participants are highly encouraged to report and use measurement uncertainty, so that the program analysis can provide a better outlook of the overall performance for this program.

6.7 General Comments

With no reported outliers, the overall performance of the participating laboratories in this round of hardness testing is very good. This is testament to the effectiveness of participating in these proficiency testing programs at regular intervals. Numerous participants have gained valuable insights into improving their proficiency and technical competency in the hardness testing of metals.

One of the most important factors for any hardness test is to ensure that the indentation spacing is sufficient enough to achieve accurate results. This is especially true when there are different indenter sizes and applied loads, as in this proficiency testing program. It is also highly recommended that participants use the smaller loads first, to avoid a larger area having residual stresses, which may produce higher test results.

Since hardness tests are comparative in nature, it is very important to ensure that the area of testing is highlighted on the samples for proficiency testing purposes. This area is very important, as there may exist some variation in the hardness value from the middle section to the edges of the specimen. The samples were grooved this round to indicate the area to be tested, to help get a better understanding of the hardness results based on the sample size, shape and location.

7. REFERENCES

1. *Guide to Proficiency Testing Australia (2016)*. (This document is located on the PTA website at www.pta.asn.au under Programs / Documents).
2. *ISO/IEC 17043: 2010 Conformity assessment - General requirements for proficiency testing*.
3. *AS 1815.1: 2007 Metallic materials – Rockwell hardness test – Test method (scales A, B, C, D, E, F, G, H, K, N, T)*.
4. *AS 1816.1: 2007 Metallic materials – Brinell hardness test – Test method (ISO 6506-1: 2005, MOD).*
5. *AS 1817.1: 2003 Metallic materials – Vickers hardness test – Test method (ISO 6507-1: 1997, MOD)*.
6. *ISO 6506-1: 2014 Metallic materials – Brinell hardness test – Part 1: Test method.*
7. *ISO 6507-1: 2018 Metallic materials – Vickers hardness test – Part 1: Test method*.
8. *ISO 6508-1: 2016 Metallic materials – Rockwell hardness test – Part 1*: *Test method*.
9. *ASTM A370 – Standard Test Methods and Definitions for Mechanical Testing of Steel Products.*
10. *ASTM E10 – Standard Test Method for Brinell Hardness of Metallic Materials*.
11. *ASTM E18 – Standard Test Methods for Rockwell Hardness of Metallic Materials.*
12. *ASTM E384 – Standard Test Method for Microindentation Hardness of Materials.*

APPENDIX A

Summary of Results

Section A1

Brinell Hardness

A1.1

Brinell Hardness (HBW) – Results and Z-Scores

Lab Code	Scale	Temp. (^{o}C)	Test 1	Test 2	Test 3	Average	MU (±)	Z-Score
1	10/3000/15	19	205	206	209	207	-	-0.42
2	10/3000/12	22	210	211	210	211	2%	0.42
3	-	25	214	215	216	215	3.4	1.25
4	10/3000/15	25	204	205	201	203	5.5	-1.25
5	10/3000/15	18	209	209	204	207	6	-0.42
6	10/3000/22	22	221	201	209	210	1.6%	0.21
7	10/3000/15	20	223	217	217	219	-	2.08
8	10/3000/12	24	204	202	203	203	-	-1.25
9	10/3000	24.0	217	217	217	217	3.0	1.66
11	10/3000/12	23.1	208	208	210	209	5.7	0.00
12	10/3000/10	22	208	209	207	208	4	-0.21
14	10/3000/12	20	212	213	212	212	1.6%	0.62
15	10/3000/10	22	205	205	214	209	5%	0.00
16	10/3000	21	206	208	208	207	0.96	-0.42
17	10/3000/12	20.4	219	218	220	219	5	2.08

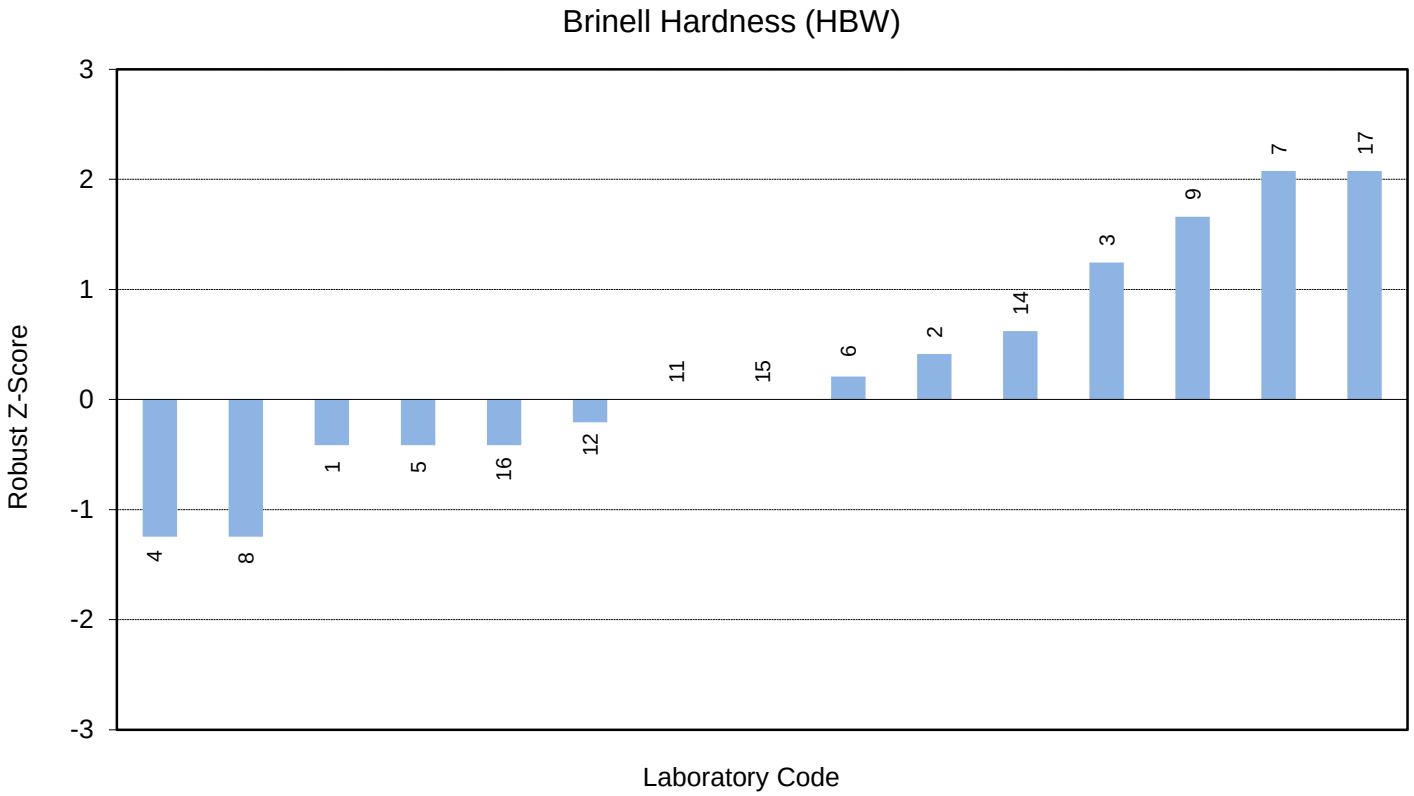
Summary Statistics

Statistic	Average Result
Number of Results	15
Median	209.0
Normalised IQR	4.8
Uncertainty (Median)	1.6
Robust CV	2.3%
Minimum	203
Maximum	219
Range	16

Notes:

1. The results for all test methods were pooled for analysis.
2. Summary statistics and z-scores have been calculated for the average results reported.

A1.2


Brinell Hardness (HBW)
Robust Z-Score
3
2
1
0
-1
-2
-3
4
8
1
5
16
12
11
15
6
2
14
3
9
7
17
Laboratory Code

Section A2

Vickers Hardness

A2.1

Vickers Hardness (HV) – Results and Z-Scores

Lab Code	Load	Temp. (^{o}C)	Test 1	Test 2	Test 3	Average	MU (±)	Z-Score
1	10	19	210	215	217	214	-	-1.54
3	-	25	220	224	221	222	1.3	0.00
4	10	25	220	222	228	223	9	0.19
5	10	18	228	222	224	225	6	0.58
6	30	22	222	216	224	220	1.1%	-0.39
7	10	20	217	210	219	215	-	-1.35
8	10	24	209.50	206.00	208.00	207.83	-	-2.73
9	10	24.0	221	221	217	220	4.0	-0.39
10	30	25.1	234	232	234	233	4	2.12
11	10	24.8	219	235	245	233	8.3	2.12
13	10	22	219	222	221	221	1.45	-0.19
14	5	20	225	224	222	224	1.6%	0.39
15	5	22	210	211	221	214	5%	-1.54
16	20	21	222	225	224	224	1.25	0.39
17	30	20.2	234	228	229	230	6	1.54

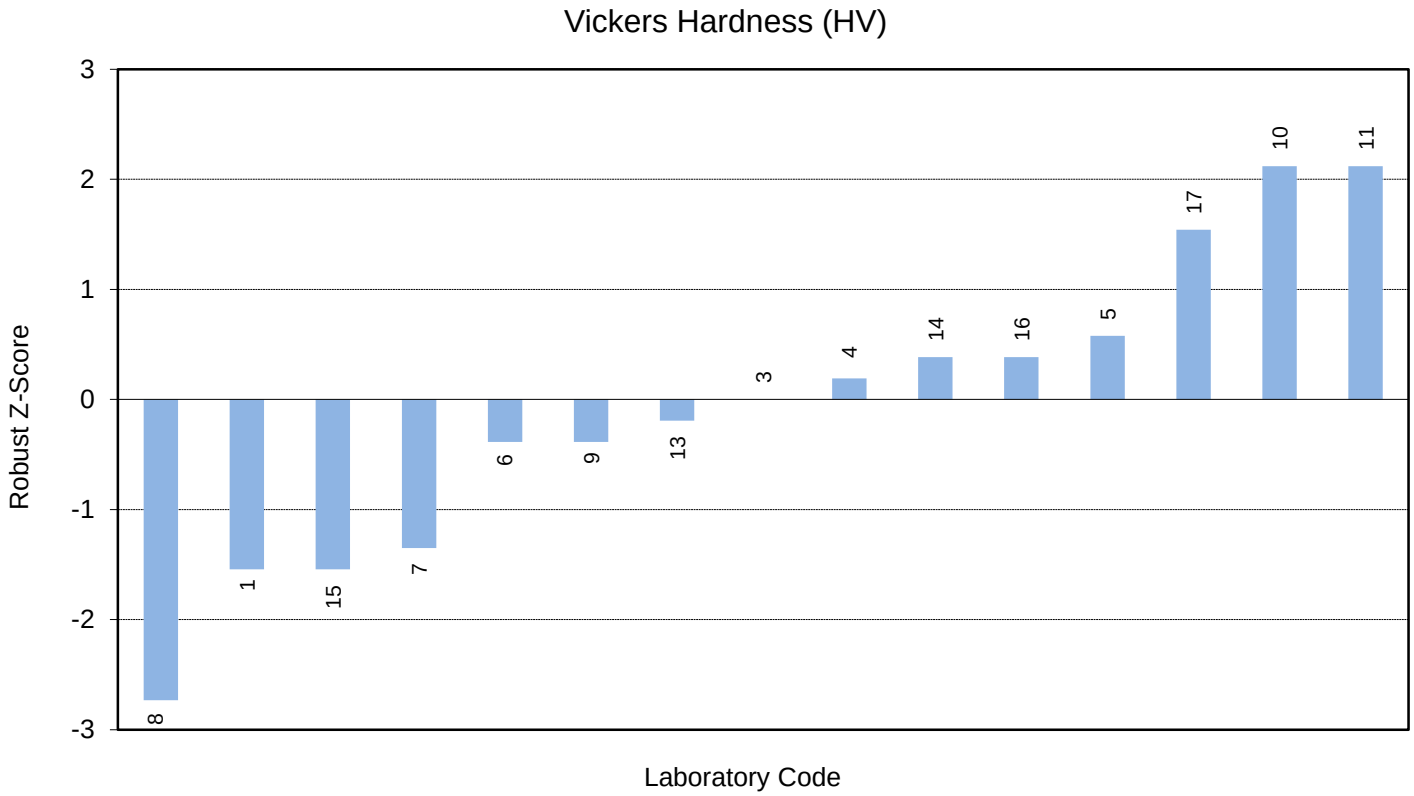
Summary Statistics

Statistic	Average Result
Number of Results	15
Median	222.0
Normalised IQR	5.2
Uncertainty (Median)	1.7
Robust CV	2.3%
Minimum	208
Maximum	233
Range	25

Notes:

1. The results for all test methods were pooled for analysis.
2. Summary statistics and z-scores have been calculated for the average results reported.

A2.2


Vickers Hardness (HV)
Robust Z-Score
3
2
1
0
-1
-2
-3
8
1
15
7
6
9
13
3
4
14
16
5
17
10
11
Laboratory Code

Section A3

Rockwell B Hardness

A3.1

Rockwell B Hardness (HRB) – Results and Z-Scores

Lab Code	Temp. (°C)	Test 1	Test 2	Test 3	Average	MU (±)	Z-Score
1	19	95.5	95.4	95.6	95.5	-	0.00
2	22	94.6	94.5	94.4	94.5	2%	-0.57
3	25	99.1	96.1	97.2	97.5	2.16	1.15
4	25	94.2	93.6	95.0	94.3	1.1	-0.69
5	19	96.0	96.1	95.0	95.7	1.2	0.11
6	22	92.4	92.9	93.5	92.9	1.2	-1.49
7	20	95	95	95.5	95.2	-	-0.17
8	24	92.00	94.80	93.00	93.26	-	-1.29
9	24.0	96.5	97	97	96.8	0.5	0.75
10	25.1	96.8	97.0	96.5	96.8	1	0.75
11	23.6	92.5	94	94.5	93.7	1.4	-1.03
12	22	94.5	94.5	95.0	94.7	2	-0.46
13	22	96.3	96.0	95.8	96.0	0.90	0.29
15	22	94.8	97.9	97.4	96.7	5%	0.69
17	20.3	97	97.1	97.1	97.1	2	0.92

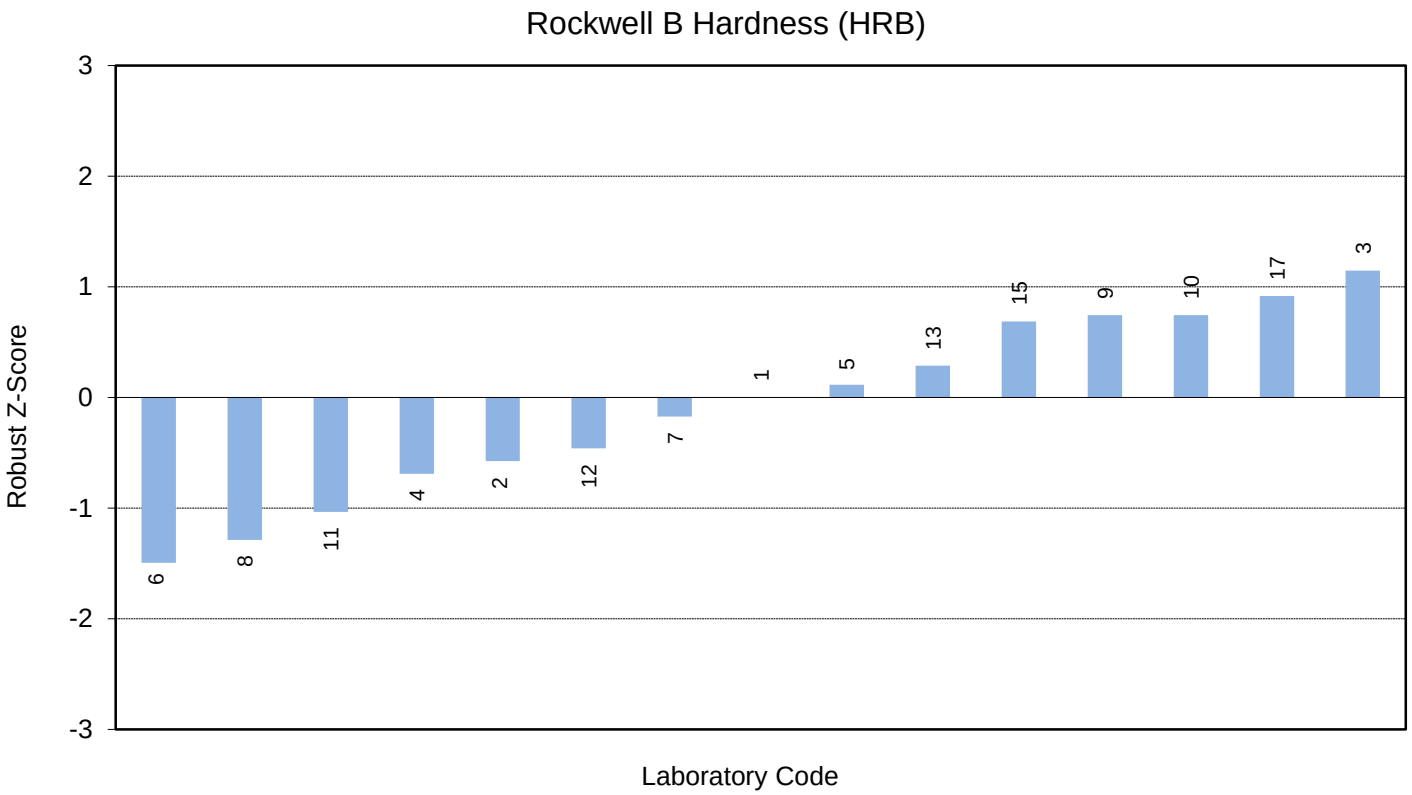
Summary Statistics

Statistic	Average Result
Number of Results	15
Median	95.50
Normalised IQR	1.74
Uncertainty (Median)	0.56
Robust CV	1.8%
Minimum	92.9
Maximum	97.5
Range	4.6

Notes:

1. The results for all test methods were pooled for analysis.
2. Summary statistics and z-scores have been calculated for the average results reported.

A3.2


Rockwell B Hardness (HRB)
Robust Z-Score
3
2
1
0
-1
-2
-3
6
8
11
4
2
12
7
1
5
13
15
9
10
17
3
Laboratory Code

Section A4

Methods Used and Surface Preparation

A4.1

Methods Used

Lab Code	Brinell Hardness	Vickers Hardness	Rockwell B Hardness
1	ASTM A370	AS 1817.1 - 2003	ASTM E18
2	AS 1816.1 - 2007	-	AS 1815.1 - 2007
3	ISO 6506-1	ISO 6507-1	ISO 6508-1
4	ISO 6506-1: 2004	ISO 6507-1: 2005	ISO 6508-1: 2015
5	AS 1816.1	AS 1817.1	AS 1815.1
6	AS 1816.1 - 2007	AS 1817.1	AS 1815.1
7	AS 1816	AS 1817	AS 1815
8	ASTM E10	ASTM E384	ASTM E18
9	AS 1816.1 / ISO 6506	AS 1817.1 / ISO 6507	AS 1815.1
10	-	AS 1817.1	AS 1815.1
11	ISO 6506-1	ISO 6507-1	ISO 6508-1
12	AS 1816.1	-	AS 1815.1
13	-	AS 1817.1	AS 1815.1
14	AS 1816 - 2007	AS 1817 - 2003	-
15	AS	AS	AS
16	AS 1816 - 2007	AS 1817 - 2003	-
17	AS 1816.1	AS 1817.1	AS 1815.1

A4.2

Surface Preparation

Lab Code	Preparation Details
1	Test surface was ground by surface grinder. For HV10, test surface polish to 1400 grit wet/dry.
2	Face in lathe then linished.
3	Surface grinding was done on the test surface to obtain a smooth area.
4	The surface of the sample has been polished.
5	Ground flat and polished to a mirror finish.
6	Surface ground and polished using wet & dry / water paper to 2500 grit.
7	Polished to P1200 grit wet & dry paper.
8	Finish surface grinding on both surfaces.
9	Polished from #80 grit to #600 grit.
10	Wet ground sample using 120 grit, 240 grit, 400 grit, 800 grit and 1200 grit. Then diamond polished on 6 micron and finished on 1 micron.
11	Polished surface of the sample to 600 grit.
12	Faced on lathe then cleaned with emery.
13	Water-cooled surface grinding and polished the surface using fine sand paper to mirror finish.
14	Milling machined surface, SiC ground: P120, P320. Diamond polish 3µ, 1µ.
15	Test surface polished to 2000 grit using SiC abrasive papers. Surface was then etched with 10% nital solution.
16	Surface grind both surfaces to make parallel and polish.
17	Ground and polished to 1 micron surface finish.

APPENDIX B

Homogeneity Testing

HOMOGENEITY TESTING

Before the samples were distributed to participants, eight randomly selected samples were tested for homogeneity by ARL Laboratory Services Pty Ltd. Eight hardness measurements were made around the inner edge of the testing area, while another eight hardness measurements were made around the outer edge of the testing area, for each of the eight samples, for each hardness test. The results of the homogeneity testing are displayed below:

Homogeneity Testing Results

Brinell HBW 10/3000

Sample No.	Inner Average	Outer Average	Overall Average
7	209	210	210
8	210	212	211
15	208	212	210
18	209	212	211
26	209	212	210
27	207	211	209
35	207	212	209
39	206	211	209

Vickers HV 10

Sample No.	Inner Average	Outer Average	Overall Average
7	216	225	221
8	217	226	221
15	215	225	220
18	217	223	220
26	215	227	221
27	215	224	219
35	215	222	219
39	214	224	219

B1.2

Rockwell B HRB

Sample No.	Inner Average	Outer Average	Overall Average
7	94.6	95.7	95.2
8	95.6	97.1	96.3
15	94.6	96.6	95.6
18	93.7	94.9	94.3
26	94.7	96.1	95.4
27	94.9	96.1	95.5
35	94.5	96.1	95.3
39	95.0	96.5	95.7

Analysis of the homogeneity testing data indicated that the samples were sufficiently homogeneous for the program and, therefore, any participant results identified as outliers cannot be attributed to sample variability.

APPENDIX C

Instructions to Participants
and
Results Sheet

PROFICIENCY TESTING AUSTRALIA

Hardness Testing Of Metals Proficiency Testing Program Round 14, June 2018

Instructions to Participants

To ensure that the results of this program can be analysed correctly, participants are asked to adhere carefully to these instructions.

1) The sample for this hardness testing program consists of a steel sample, approximately 60 mm in diameter and 30 mm thick. The sample has a number labelled on the circumference.

2) The sample is to be tested for Brinell, Vickers and Rockwell 'B' hardness. The samples contain two grooves. The testing area is to be between these grooves. Participants may wish to improve the surface to provide a better testing surface.

3) The sample should be treated as a routine laboratory sample. All testing, recording and reporting is to be performed in accordance with your routine test methods.

4) Please use the attached Result Sheet to record and report your results to Proficiency Testing Australia. Please also report the method used for testing (*e.g.* AS 1816.1, ISO 6506.1, etc. for Brinell hardness testing, AS 1817.1, ISO 6507.1, etc. for Vickers hardness testing, AS 1815.1, ISO 6508.1, etc. for Rockwell HRB hardness testing).

5) Do not discard the hardness test sample until you have received the final report. You may be asked to carry out a retest or to return the sample to Proficiency Testing Australia for retesting at the laboratory that performed the homogeneity tests.

6) For this program, your laboratory has been allocated the code number on the attached Results Sheet. All reference to your laboratory in reports associated with this program will be via this code number, thus ensuring the confidentiality of your results.

7) Laboratories are also requested to calculate and report an estimate of uncertainty of measurement for each reported measurement result. All estimates of uncertainty of measurement must be given as a 95% confidence interval (coverage factor $k \approx 2$).

8) Return the Results Sheet, either by mail, email or facsimile, to:

Mark Bunt
Proficiency Testing Australia
PO Box 7507
Silverwater NSW 2128
AUSTRALIA

Telephone: + 61 2 9736 8397 (1300 782 867)
Fax: +61 2 9743 6664
Email: mbunt@pta.asn.au

All results should arrive at the above address by no later than **Friday 22 June 2018**. Results reported later than this date may not be analysed in the final report.

C2.1

PROFICIENCY TESTING AUSTRALIA

Hardness Testing Of Metals Proficiency Testing Program

Round 14, June 2018

RESULTS SHEET

Laboratory Code: ☐

Sample I.D.	Scale	Report to nearest	Test Temp ºC	Results					Standard (AS, ISO, etc.)
				Test 1	Test 2	Test 3	Average	MU (±)	
	Brinell (/ /) (mm/kg/s)	1 BHN							
	HV ( ) Insert load used	1 HV							
	HRB	0.1 HRB							

Did you carry out surface preparation on the obverse surfaces of the samples for the hardness tests? Yes / No

If Yes, please give details of preparation.

……

……

……

……

……

……

Print Name: _____

Signature: _____

Date: _____

-----End of Report-----