REPORT NO. 1122

Impact Testing of Metals

Proficiency Testing Program

Round 4

January 2019

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 impact properties of metals. It constitutes the fourth 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 November 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 15 laboratories participated in the program, one of which did not return results for inclusion in the final report. Laboratories from the following countries received samples:

7	AUSTRALIA
3	NEW ZEALAND
2	SAUDI ARABIA
1	BAHRAIN
1	HONG KONG
1	THAILAND

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 70 mm × 60 mm × 12 mm. The sample was to be cut into three Charpy V-notch test pieces. The thickness of each Charpy V-notch sample to be tested was recommended to be 10 mm, however, other thicknesses could be used. Impact tests were to be prepared with the major axis of the test piece in the same direction as the principle direction of rolling (*i.e.* longitudinal direction).

(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), 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 three sections (A1-A3).

Sections A1-A2 contain the analysis of the results reported by laboratories for their Charpy testing. The majority of the participating laboratories performed their Charpy testing with the major axis of the test piece in the longitudinal direction. However, some laboratories performed their Charpy testing with the major axis of the test piece in the transverse direction. The results for the test pieces that were prepared using a longitudinal orientation were analysed separately from the test pieces that were prepared using a transverse orientation.

Section A1 contains the analysis of the results submitted by the participants that used a longitudinal orientation to prepare their test pieces. Section A2 contains the analysis of the results submitted by the participants that used a transverse orientation to prepare their test pieces. These sections contain, where appropriate:

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 A3 contains information on the methods used by the participants, the sample preparations performed and the fracture assessment.

(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 < |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	Orientation	Summary Statistics	Average Result
Indicated Absorbed Energy (J)	Longitudinal	Number of Results	12
		Median	104.0
		Normalised IQR	7.4
		Uncertainty (Median)	2.7
	Transverse	Number of Results	7
		Median	40.0
		Normalised IQR	1.8
		Uncertainty (Median)	0.9

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

Test	Orientation	Outliers (Laboratory Code No.)
Indicated Absorbed Energy	Longitudinal	15
	Transverse	-

Notes:

1. The results for all test methods were pooled for analysis.
2. Summary statistics were calculated for the average Charpy value reported.
3. The summary statistics and z-scores for the Charpy V-notch samples that were prepared using a transverse orientation were calculated by including results that were obtained from testing by ARL Laboratory Services Pty Ltd (see Appendix B).

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 are reported in Tables A and B on the previous page. Complete details of the statistical analyses appear in Appendix A.

6.1 Return rate

Fourteen of the 15 laboratories (93%) that participated in the program submitted results for inclusion in the final report.

The return rate was as follows:

- Samples prepared using a longitudinal orientation 12 out of 14 86%
- Samples prepared using a transverse orientation 2 out of 14 14%

6.2 Performance summary

Statistical outliers were reported by one of the 14 laboratories (7%) that returned results for this round of the program. For comparison, there were no statistical outliers reported by any of the participants in Round 3 of this program (see Report No. 1061 for more details).

6.3 Sample Preparation and the Instructions to Participants

The original version of the *Instructions to Participants* contained an error, as it requested that tests be prepared with the major axis of the test piece in the transverse direction and that the V-notch for each test sample be made on the surface perpendicular to the principle direction of rolling. These instructions were contradictory. Upon being informed of the error by one of the participants, a new version of the instructions was sent to all the participants. A copy of these revised instructions can be found in Appendix C.

Homogeneity testing was performed by ARL Laboratory Services Pty Ltd for samples prepared in both the longitudinal and transverse directions (see Appendix B), in case any of the participants followed the original instructions and prepared their samples in the transverse direction.

While 12 of the participants submitted results that were comparable to the homogeneity results obtained by ARL Laboratory Services Pty Ltd for samples prepared in a longitudinal orientation, two participants (codes 5 and 13) submitted results that were comparable with the homogeneity results obtained by ARL Laboratory Services Pty Ltd for samples prepared in a transverse orientation.

The results submitted by the participants in this round of the program are separated in Appendix A into those that were obtained using a longitudinal orientation for preparing the test pieces and those that were obtained using a transverse orientation for preparing the test pieces. The z-scores obtained by laboratory codes 5 and 13, using a transverse orientation, were calculated by including results that were obtained from the homogeneity testing by ARL Laboratory Services Pty Ltd.

6.4 Longitudinal Orientation Results

Of the 12 laboratories that used a longitudinal orientation for preparing their test pieces, eight tested using the AS 1544.2 method. Two laboratories tested using the ISO 148-1 method. One laboratory tested using the BS EN 10045-1 and ISO 148-1 methods. One laboratory used the ASTM E23 method (see Appendix A3 for more details).

In order for methods to be grouped for analysis, PTA requires at least 11 sets of results from the same method group. As there were less than 11 results submitted for each method, reliable conclusions cannot be drawn from analysing grouped methods on this occasion. Therefore, results from all method groups have been pooled for analysis.

For all methods pooled, the median and standard error of the longitudinal orientation results for indicated absorbed energy was 104.0 ± 2.7 J.

The robust CV for the longitudinal orientation results for this round was 7.1%.

Laboratory code 15 reported an outlier for the longitudinal orientation results, while laboratory code 10 obtained an absolute z-score between 2.0 and 3.0.

Laboratory code 10 reported an average of 88.56 J, which was low, compared to the median of 104.0 J, and resulted in a z-score of -2.08. Such a low average result may be due to a number of factors, including but not limited to: improper sizing of the test samples (outside of the allowable tolerances); the test samples not being conditioned properly; the test machine and equipment not being calibrated and performance checks not being carried out appropriately.

Almost all standards and guidelines on Charpy impact testing suggest carrying out tests at a maximum of 80% of the machine nominal capacity. This is because high level vibration and impact damages on the machine could adversely affect its sensitivity and accuracy. This could explain why laboratory code 15 reported an average of 149 J on a machine with Nominal Striking Energy of 150 J, which resulted in a z-score of 6.07. Frictional and loss checks / tests should be carried out on testing machines regularly to detect any abnormalities with the testing machines.

Ten laboratories reported measurement uncertainties associated with their Charpy results, for samples prepared in a longitudinal orientation.

6.5 Transverse Orientation Results

Of the two laboratories that used a transverse orientation for preparing their test pieces, one tested using the ISO 148-1 method and one tested using the ASTM A370 method (see Appendix A3 for more details).

ARL Laboratory Services Pty Ltd also prepared five sets of Charpy V-notch test pieces that were prepared in a transverse orientation. ARL Laboratory Services Pty Ltd performed their testing on these samples using AS 1544.2.

In order to assess the results of the two laboratories that tested in a transverse orientation, the summary statistics and z-scores were calculated by including the results that were obtained from the testing by ARL Laboratory Services Pty Ltd (see Appendix B). Once again, since there were less than 11 results submitted for each method, results from all method groups have been pooled for analysis for the transverse orientation results.

The median and standard error of the transverse orientation results for indicated absorbed energy was 40.0 ± 0.9 J.

The robust CV for the transverse orientation results for this round was 4.5%.

There were no outliers reported for the transverse orientation results.

Laboratory code 13 reported an average result of 36.56 J, which was low, compared to the median of 40.0 J. This resulted in a z-score of -1.91 (a satisfactory result). The low result reported by this laboratory may have been due to not applying any cooling medium (instead using the ambient air temperature of 21 °C, as reported). While a testing temperature of 21 °C is completely acceptable, as tolerance on test temperatures are usually at ± 1 °C, applying a cooling medium to achieve the desired temperature of 22 °C may have helped this laboratory obtain a result closer to the median.

One laboratory reported a measurement uncertainty for their Charpy results, for samples prepared in a transverse orientation.

6.6 Measurement Uncertainty

Of the 14 participants that reported results in this round, eleven laboratories (79%) reported estimates of the measurement uncertainty associated with their results. The variation between the estimates of measurement uncertainty this round ranged from not reporting at all, to reported numerical values, to one laboratory that reported percentage values.

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

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

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

6.7 General Comments

The overall performance of the participating laboratories in this round of Charpy impact testing is commendable, with only one outlier result.

With the provided test instructions and samples, there was some confusion with the orientation / direction of the test sample to be used with some of the participants. However, this is not uncommon in routine work. The participating laboratories should treat these programs as routine. Therefore, if any questions arise, as they sometimes do, the laboratory should contact PTA for further clarification.

Proficiency testing programs are designed and implemented considering all types of situations that may arise. For each Charpy impact testing program, PTA has access to data for analysis from ARL Laboratory Services Pty Ltd (a NATA accredited laboratory) on a range of conditions, such as sub-size test results, different orientation test results and tests at different temperatures. This is so all the returned test results can be analysed, irrespective of incorrectly carrying out the Charpy impact tests at different temperatures, thicknesses or orientations.

For the next round of this program, sub-size specimens of thickness 7.5 mm may be used. Participants will be provided with 12 mm sized samples and a 7.5 mm thickness will be recommended. If there is any restriction by some of the participating laboratories, they could test at 10 mm standard size.

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 1544.2: 2003 Methods for impact tests on metals – Charpy V-notch*.

4. *AS 1544.5: 2003 Methods for impact tests on metals – Assessment of fracture surface appearance of steel.*

5. *AS/NZS 3678: 2016 Structural steel – Hot-rolled plates, floorplates and slabs.*

6. *AS/NZS 3679.1: 2016 Structural steel – Hot-rolled bars and sections.*

7. *ISO 148-1: 2016: Metallic materials – Charpy pendulum impact test – Part 1: Test method.*

8. *BS EN 10045-1: 1990 Charpy impact test on metallic materials. Test method (V- and U-notches).*

9. *ASTM A370 – Standard Test Methods and Definitions for Mechanical Testing of Steel Products.*

10. *ASTM E23 – Standard Test Methods for Notched Bar Impact Testing of Metallic Materials*.

APPENDIX A

Summary of Results

Section A1

Indicated Absorbed Energy – Longitudinal Orientation

A1.1

Indicated Absorbed Energy (J) – Longitudinal Orientation

Lab Code	Temp. (^{o}C)	Test 1	Test 2	Test 3	Average	MU (±)	Z-Score
1	23	99	100	101	100	2	-0.54
2	22.0	101	104	107	104	-	0.00
3	22	106	101	105	104	2.5	0.00
4	22	114	116	115	115	8%	1.48
6	22	106	101	96	101	0.268	-0.40
7	22	108	110	111	110	0.1927	0.81
8	22	117	113	109	113	5	1.21
10	22.1	88.0	88.7	89.0	88.56	-	-2.08
11	21.6	103	105	106	104.67	1.53	0.09
12	22	104	100	106	103	11	-0.13
14	21	99	96	95	97	2	-0.94
15	22	149	149	149	149	1	6.07 **§**

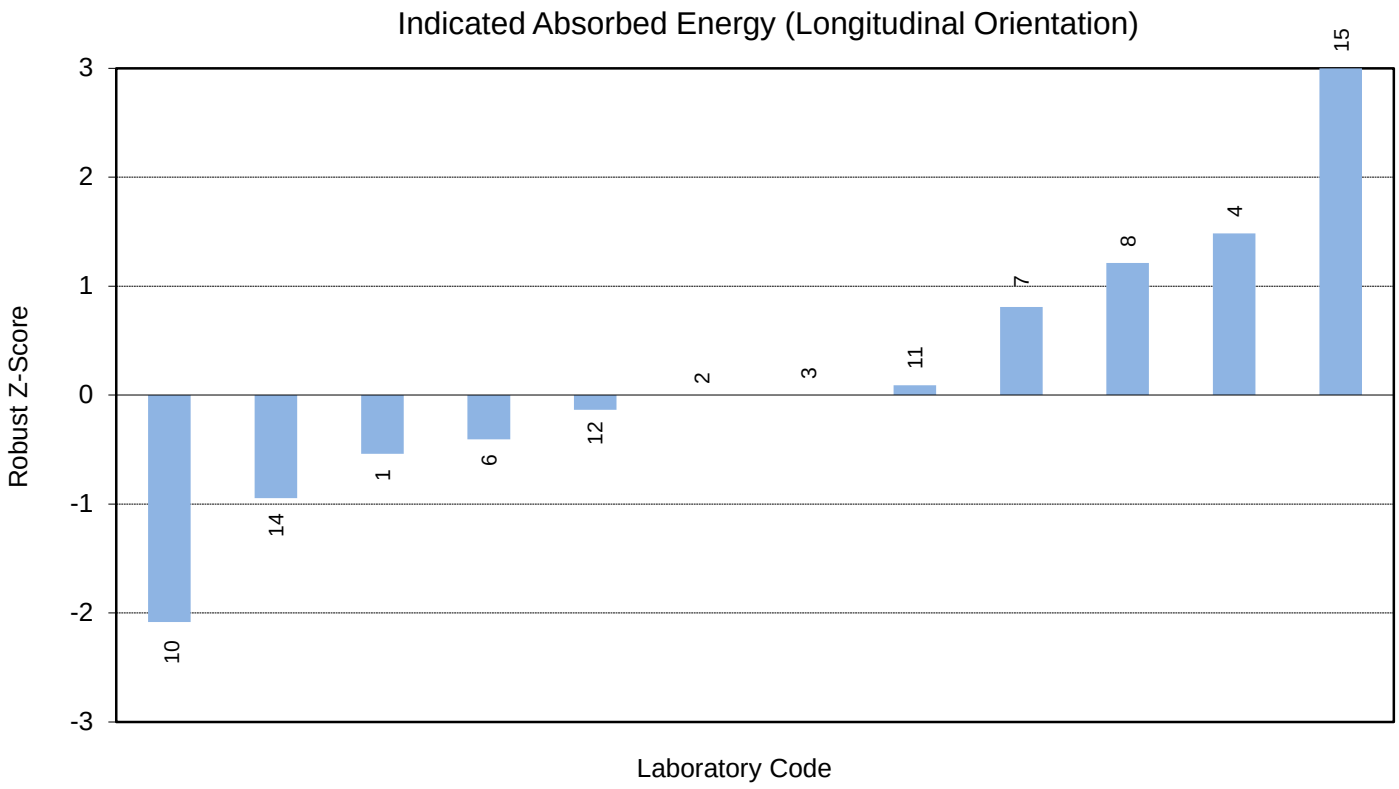
Summary Statistics

Statistic	Average Result
Number of Results	12
Median	104.0
Normalised IQR	7.4
Uncertainty (Median)	2.7
Robust CV	7.1%
Minimum	89
Maximum	149
Range	60

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


Indicated Absorbed Energy (Longitudinal Orientation)
Robust Z-Score
3
2
1
0
-1
-2
-3
10
14
1
6
12
2
3
11
7
8
4
15
Laboratory Code

Section A2

Indicated Absorbed Energy – Transverse Orientation

Indicated Absorbed Energy (J) – Transverse Orientation

Lab Code	Temp. (^{o}C)	Test 1	Test 2	Test 3	Average	MU (±)	Z-Score
5	22	43	42	42	42	13	1.11
13	21	36.38	35.73	37.57	36.56	-	-1.91

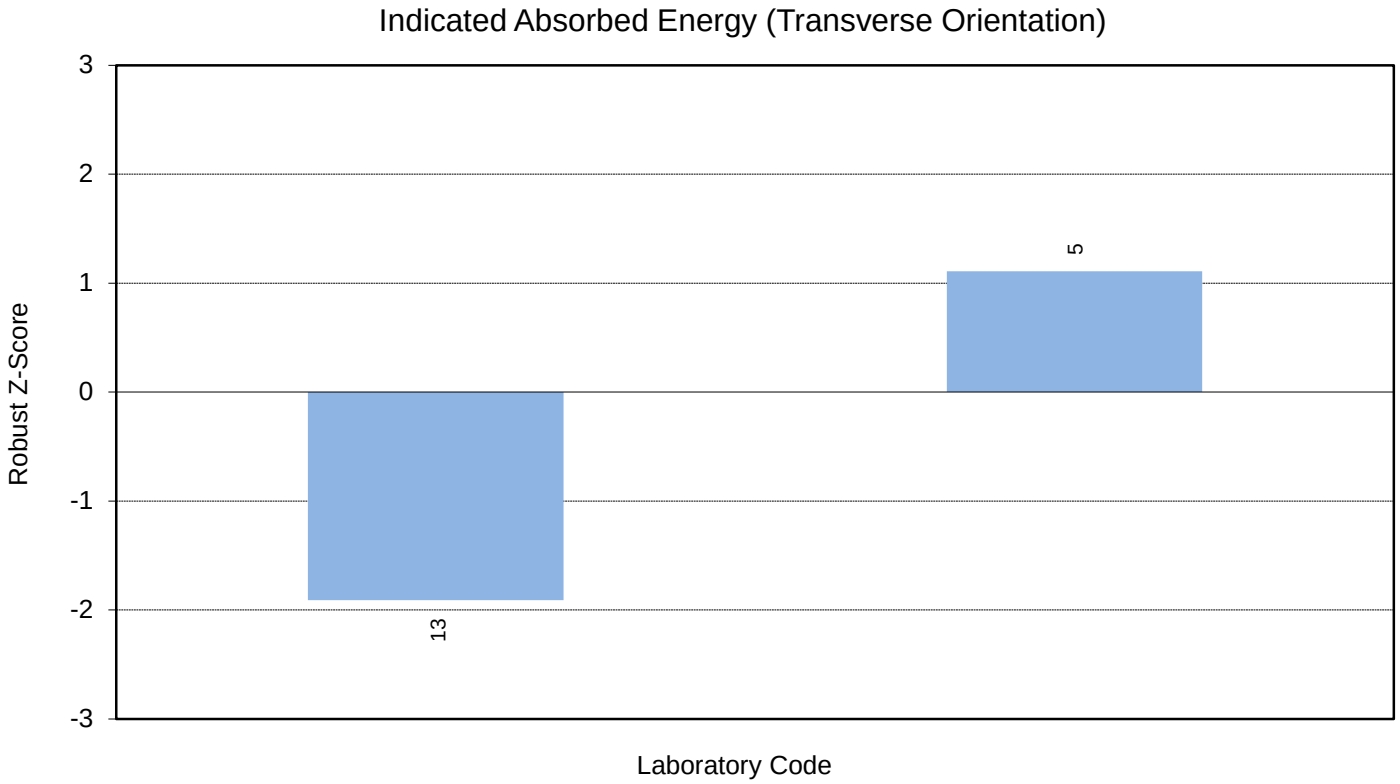
Summary Statistics

Statistic	Average Result
Number of Results	7
Median	40.0
Normalised IQR	1.8
Uncertainty (Median)	0.9
Robust CV	4.5%
Minimum	37
Maximum	42
Range	5

Notes:

1. The summary statistics and z-scores were calculated by including results that were obtained from testing by ARL Laboratory Services Pty Ltd (see Appendix B).
2. The results for all test methods were pooled for analysis.
3. Summary statistics and z-scores have been calculated for the average results reported.

A2.2


Indicated Absorbed Energy (Transverse Orientation)
Robust Z-Score
3
2
1
0
-1
-2
-3
13
5
Laboratory Code

Section A3

Methods Used, Sample Preparation and Fracture Assessment

A3.1

Methods Used and Sample Preparation

Lab Code	Length (mm)	Width (mm)	Thickness (mm)	Ambient Temp. (°C)
1	54.91, 54.90, 54.91	9.89, 10.01, 9.89	10.07, 10.07, 10.07	23
2	54.72	10.03	10.01	22
3	55	10	10	21
4	55.10, 55.15, 55.10	10.02, 10.01, 10.01	9.98, 10.00, 9.99	23
5	54.93, 54.92, 54.89	9.99, 9.98, 9.98	9.95, 9.95, 9.95	25
6	55.00	10.00	10.00	24
7	55	10	10	21
8	55.00, 54.99, 54.99	9.94, 9.94, 9.94	10.02, 10.02, 10.01	22
10	54.92	10.02	10.01	25.1
11	54.77	9.97	9.96	21.0
12	55.03	9.73	10.06	19
13	55.01, 54.96, 54.92	10.01, 10.01, 10.01	10.00, 10.00, 10.00	21
14	55	10	10	21
15	55.08	9.99	9.99	22

A3.2

Methods Used and Sample Preparation

Lab Code	Standard	Machine Nominal Striking Energy (J)	Conditioning Medium
1	BS EN 10045-1: 1990, BS EN ISO 148-1: 2016	300	Air
2	AS 1544.2	450	Liquid methylated spirits
3	AS/NZS 1544.2	250	Liquid
4	AS 1544.2: 2003	300	Liquid
5	ISO 148-1: 2016	300	Liquid
6	ISO 148-1	450	Liquid
7	ISO 148-1	300	Ethanol (liquid medium)
8	AS 1544.2	300	n/a
10	ASTM E23	300	Liquid
11	AS 1544.2, AS 1544.5	300	Methylated spirits
12	AS 1544.2	300	Liquid
13	ASTM A370	300	Ambient
14	AS 1544.2	300	None
15	AS 1544.2	150	Air

Lab Code	Fracture Assessment
1	Test piece 1: 30% shear; Test piece 2: 34% shear; Test piece 3: 34% shear.
2	All 100% fibrous.
3	25% crystalline, 75% fibrous.
4	All samples 100% fibrous shear, unaided visual assessment.
5	Test piece 1: 15% shear; Test piece 2: 20% shear; Test piece 3: 20% shear.
6	100% fibrosity observed.
7	100% fibrous structure at fracture surface.
8	100% fibrosity.
10	-
11	Almost 100% fibrosity.
12	All 3 samples 100% fibrous.
13	Sample 1: 100% fibrosity; sample 2: 100% fibrosity; sample 3: 100% fibrosity.
14	100% fibrous fracture.
15	60% fibrosity - 40% crystallinity.

Lab Code	Cooling Method
1	Samples were conditioned in laboratory room temperature.
2	Agitated methylated spirits.
3	The desired temperature has been obtained by using a very little amount of warm water.
4	Agitated liquid bath.
5	Cool bath and ethanol.
6	Silicon oil (KRYO-85) following ISO 148-1.
7	Samples are kept in liquid ethanol for 10 minutes (minimum). Samples are picked from ethanol medium pot and placed in impact machine to complete testing before 5 seconds.
8	Ambient.
10	Cooled in water bath for 12 minutes at 22 °C.
11	Continuously agitated methylated spirits, c/v cooling freezer.
12	Cooled in ethanol where the cooling unit was set to the desired temperature.
13	None.
14	None.
15	Stabilised at ambient temperature of 22 °C.

Lab Code	Additional Comments
1	Wire Electrical Discharge Machining (WEDM) is used to prepare the samples.
2	Nil.
3	Systematic error due to temperature variation while transferring the test piece from the medium to the machine may have some effects on the obtained results.
4	-
5	Surface roughness.
6	Specimens machined on CNC machine (Kondia A-6) meeting tolerances of ISO 148-1.
7	-
8	The 2 mm V-notch was milled. The sample was cleaned with ethanol.
10	Samples prepared by sectioning on band saw machine as per direction and further milled and ground to finish dimensions. V-notch by Mechanised Broaching machine.
11	Snow grind 4 surfaces, notched and milled to length.
12	The sample had to be cut differently to our daily process because we did not have a means to clamp it. It would be helpful if samples sent to us can at least be double this length.
13	None.
14	-
15	n/a.

APPENDIX B

Homogeneity Testing

HOMOGENEITY TESTING

Before the samples were distributed to participants, eight randomly selected samples were chosen for homogeneity testing. These samples were cut into three Charpy V-notch test pieces each. The samples were prepared with the major axis of the test piece in the longitudinal direction.

Another five samples were cut into three Charpy V-notch test pieces each. The samples were prepared with the major axis of the test piece in the transverse direction. The results from testing these samples were also checked for homogeneity.

The samples were prepared and tested by ARL Laboratory Services Pty Ltd. Each Charpy V-notch test piece was 55 mm × 10 mm × 10 mm. The test temperature was 22 °C. All testing was performed using AS 1544.2.

The results of the homogeneity testing are displayed below:

Homogeneity Testing Results

Indicated Absorbed Energy (J)

Longitudinal Orientation

Test 1	Test 2	Test 3	Average
108	110	112	110.0
115	106	110	110.3
104	98	102	101.3
105	112	113	110.0
114	107	106	109.0
105	101	103	103.0
108	111	112	110.3
108	112	110	110.0

Transverse Orientation

Test 1	Test 2	Test 3	Average
38	40	42	40.0
37	38	41	38.7
38	39	39	38.7
39	40	43	40.7
38	41	43	40.7

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

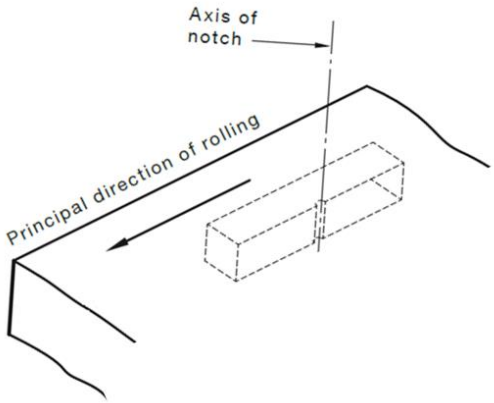
Impact Testing Of Metals Proficiency Testing Program Round 4, November 2018

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 program consists of a steel sample, approximately 70 mm x 60 mm x 12 mm. This sample is to be cut into three Charpy V-notch test pieces.

2) Each Charpy test piece needs to be fully prepared for testing. This preparation may include further cutting of the test piece, creating of the V-notches and further cleaning of the test piece to remove any scale, oil, grease, dirt, etc. before cooling the test pieces until the desired test temperature is achieved. The principle direction of rolling of the test piece is marked with an arrow. Impact test samples shall be prepared with the major axis of the test piece in the direction of the arrow. The axis of the notch shall be perpendicular to the direction of the arrow (rolling surface of the plate). For further clarification, a photograph of the orientation of the test samples is provided below, excerpted from AS/NZS 3678: 2016 Figure 1.



3) The thickness of each Charpy V-notch sample to be tested is recommended to be 10 mm. However, other thicknesses may be used. The sizing chosen for the Charpy test samples must be recorded on the Results Sheet.

4) Each Charpy test piece should be treated as a routine laboratory sample. All testing, recording and reporting is to be performed in accordance with your routine test methods, but testing in accordance with AS 1544.2 – *Methods for impact tests on metals – Charpy V-notch* (2003) or ISO 148-1: *Metallic materials – Charpy pendulum impact test – Part 1: Test method* (2016) are the preferred test methods.

5) Charpy testing is to be performed at 22 ± 2 °C.

6) Please use the attached Results Sheet to record and report your results to Proficiency Testing Australia. Please also report the method used for testing (*e.g.* AS 1544.2, ISO 148-1, etc.).

7) Report only one result per test piece. For each test piece, results are to be reported to the accuracy and in the units indicated on the Results Sheet.

8) 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.

9) 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 $k \approx 2$).

10) 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 **Monday 26 November 2018**. Results reported later than this date may not be analysed in the final report.

C2.1

PROFICIENCY TESTING AUSTRALIA

Impact Testing Of Metals Proficiency Testing Program
Round 4, November 2018

RESULTS SHEET

Laboratory Code: ☐

Test Temp. (nearest 1 ºC)	Indicated Absorbed Energy (nearest 1 J)					Standard (AS, ISO, etc.)
	Test Piece 1	Test Piece 2	Test Piece 3	Average	MU (±)	

Sample Preparation					
Test Piece Length (nearest 0.01 mm)	Test Piece Width (nearest 0.01 mm)	Test Piece Thickness (nearest 0.01 mm)	Ambient Temp. (nearest 1 ºC)	Nominal Striking Energy of the Machine (nearest 1 J)	Conditioning Medium (gas, liquid, etc.)

Please comment on the percentage assessment of the fractured surface (*e.g.* 10% fibrosity, 90% crystallinity, etc.).

……

.....……

Please comment on the method of cooling.

.....……

.....……

Please report any factors that may have influenced the results as well as any additional comments about the sample preparation.

.....……

.....……

.....……

Print Name: _____Signature & Date: _____

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