



Report No. 1063

**Metal Alloys Proficiency Testing
Program**

Round 33

Low Alloy Steel

February 2018

Acknowledgments

PTA wishes to gratefully acknowledge the technical assistance provided for this program by Mr W Ting from Universal Scientific Laboratory Pty Ltd, along with the supply of the samples.

© Copyright Proficiency Testing Australia, 2018

PO Box 7507 SILVERWATER NSW 2128, Australia

CONTENTS

1. FOREWORD	1
2. FEATURES OF THE PROGRAM.....	1
3. FORMAT OF THE APPENDICES	2
4. STATISTICAL DESIGN OF THE PROGRAM	2
5. PTA AND TECHNICAL ADVISER'S COMMENTS.....	5
6. OUTLIER RESULTS	7
7. REFERENCES	7

APPENDIX A – Results and Data Analysis

Carbon.....	A1
Manganese.....	A2
Phosphorus.....	A3
Sulfur.....	A4
Silicon.....	A5
Copper.....	A6
Nickel.....	A7
Chromium.....	A8
Molybdenum.....	A9
Vanadium.....	A10
Cobalt.....	A11

APPENDIX B – Homogeneity and Stability Testing

Sample Preparation and Homogeneity Testing.....	B1
Stability Testing.....	B2

APPENDIX C – Documentation

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

1. FOREWORD

This report summarises the results of a proficiency testing program on the chemical analysis of metal alloys. It constitutes the thirty third round of an ongoing series of programs.

The program was conducted in November 2017 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 Mrs K Cividin and the Technical Adviser was Mr W Ting from Universal Scientific Laboratory. This report was authorised by Mr P Briggs, PTA General Manager.

2. FEATURES OF THE PROGRAM

(a) Participants were provided with one low alloy steel disc sample.

(b) A total of 10 laboratories received samples, comprising:

- 7 Australian participants; and

- 3 overseas participants, including:

- Korea, Singapore and the United Kingdom

Of these 10 laboratories, 9 submitted their results by the due date.

(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, ten 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 two laboratories reported more than one set of results and, therefore, their code numbers (with letter) may 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. 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 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 7.

3. FORMAT OF THE APPENDICES

- (a) Appendix A contains the analysis of results reported by laboratories for the sample by all methods pooled. 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 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 "§".

The table on page 7 summarises the outlier results detected.

(b) Results Tables and Summary Statistics

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

For Nickel, Vanadium and Cobalt, no statistical analysis was conducted as the results were not normally distributed. Please note that a target coefficient of variation (CV) has been used for Carbon.

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

Where a statistical analysis has been conducted, a list of summary statistics appears at the bottom of the table 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.

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

TABLE A: SUMMARY STATISTICS

Test	No. of Results	Median	Normalised IQR
Carbon	11	0.4640	0.0086
Manganese	11	0.6700	0.0146
Phosphorus	11	0.0105	0.0013
Sulfur	11	0.0280	0.0020
Silicon	11	0.2390	0.0037
Copper	11	0.2130	0.0024
Nickel	11	N/A	N/A
Chromium	11	0.1680	0.0048
Molybdenum	11	0.0210	0.0019
Vanadium	10	N/A	N/A
Cobalt	6	N/A	N/A

N/A - Not Applicable

5. PTA AND TECHNICAL ADVISER'S COMMENTS

The alloy tested was similar to AS 1442 [2] (1045 Medium Tensile Carbon Steel bar) which is widely used and should therefore have been within the scope of most laboratories. Chromium, copper, nickel and molybdenum are most likely impurities, however, accurate analysis of these elements is important when assessing the heat treatability of steel. Accurate analysis of all elements in the steel is likewise important for identifying the heat (batch) of steel. Most laboratories have reported results generated by AES = Arc Spark and it is important that the calibration status of the instrument is established before analysis commences. This is achieved by analysing one or more Certified Reference Materials (CRMs) and/or appropriate type standards.

Carbon

Overall, the results were satisfactory.

Manganese

Overall, the results were satisfactory.

Phosphorus

Overall, the results were satisfactory. While the results for laboratory code 7 were considered acceptable, they may have a problem if attempting to identify a particular batch of steel.

Sulfur

The results were satisfactory. Results for laboratory codes 4 and 8 appeared to have a bias due to calibration.

Silicon

In general the results were satisfactory. The outliers would be acceptable in most situations.

Copper

In general the results were satisfactory. The results for laboratory code 8 suggest that their instrument was not calibrated for copper above 0.2%.

Chromium

With the exception of the results for laboratory code 7, these results were satisfactory.

Molybdenum

Overall, the results were satisfactory.

Variations within and between laboratories

In general, the variation within laboratories was minimal. Variations between laboratories were primarily due to calibration or calibration status issues.

Variation between methods

Most results appear to have been generated by AES Arc/spark. With the exception of the outliers, there was no appreciable variation between methods.

Measurement Uncertainties

These were unexceptionable and low.

With the exception of the obvious and discounted outliers, the results were satisfactory. With laboratories increasingly reliant upon AES Arc/spark, it is critical that appropriate CRMs are used to confirm test results, and that laboratory operatives observe the appropriate protocols for this technique. Similarly, confidence in results generated by LECO/infrared, photometry, AAS and AES - ICP must be established at the time of analysis.

It is very important that the calibration status of instruments is verified by running one or more CRMs or type standards before generating results for certification. CRMs from previous PTA proficiency programs would be suitable for this use.

Metrological Traceability and Measurement Uncertainty of Assigned Values

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

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 and is presented as part of the summary statistics for each element.

Analysis of Results by Method Groups

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.

6. OUTLIER RESULTS

Laboratories reporting outlier results by pooled methods analysis are listed in the following table:

TABLE B: SUMMARY OF STATISTICAL OUTLIERS

Test	Laboratory Code No.
Carbon	-
Manganese	-
Phosphorus	-
Sulfur	-
Silicon	4, 7, 7a, 8
Copper	8, 9
Nickel	N/A
Chromium	7
Molybdenum	-
Vanadium	N/A
Cobalt	N/A

N/A - Not Applicable

7. REFERENCES

- [1] *Guide to Proficiency Testing Australia*, 2016 (This document can be found on the PTA website, www.pta.asn.au)
- [2] *AS1442-2007 Carbon steels and carbon-manganese steels-Hot rolled bars and semifinished products.*

APPENDIX A

Results and Data Analysis

Carbon.....	A1
Manganese.....	A2
Phosphorus.....	A3
Sulfur.....	A4
Silicon.....	A5
Copper.....	A6
Nickel.....	A7
Chromium.....	A8
Molybdenum.....	A9
Vanadium.....	A10
Cobalt.....	A11

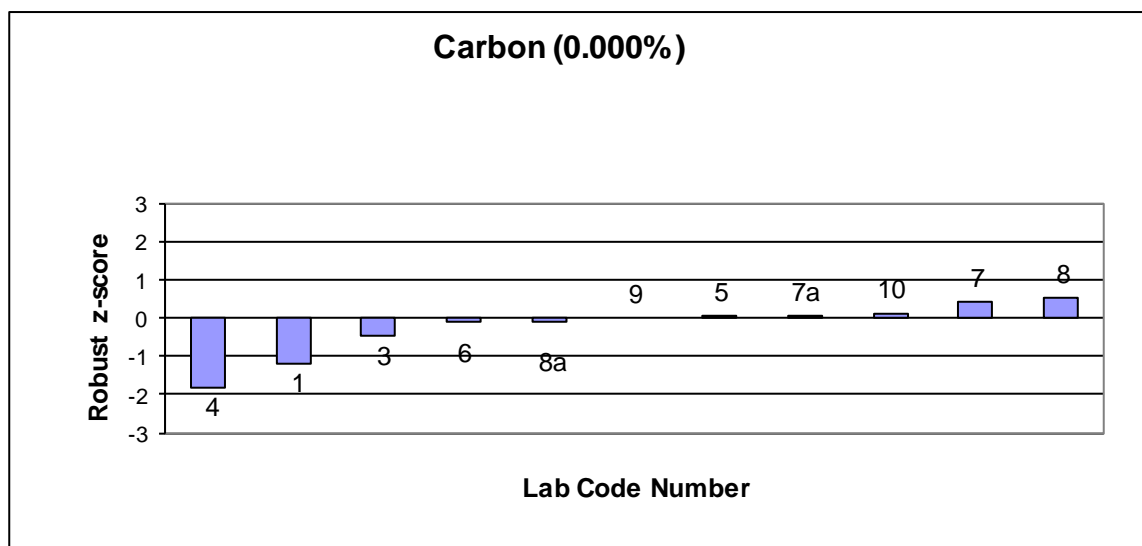
Carbon (0.000%)

Lab Code	Result 1	Result 2	Average	MU	Robust Z-score	Technique
1	0.453	0.454	0.454	0.01	-1.22	6
3	0.460	0.460	0.460	0.020	-0.46	1
4	0.448	0.449	0.449	0.020	-1.80	1
5	0.465	0.464	0.465	0.003	0.06	1
6	0.462	0.464	0.463	0.001	-0.12	1
7	0.468	0.467	0.468	0.002	0.41	1
7a	0.464	0.465	0.465	0.002	0.06	1
8	0.471	0.466	0.469	0.012	0.52	1
8a	0.464	0.462	0.463	0.003	-0.12	1
9	0.465	0.463	0.464	0.018	0.00	6
10	0.465	0.465	0.465	0.011	0.12	1

* Please note that a target CV has been used for this test

Technique: 1 AES - Arc/spark (Atomic Emission Spectroscopy - Arc/Spark)
6 LECO/OES

No. of Results	11
Median	0.4640
Norm IQR	0.0086
Uncertainty of the Median	0.0033
Robust CV *	1.9%
Min	0.449
Max	0.469
Range	0.020

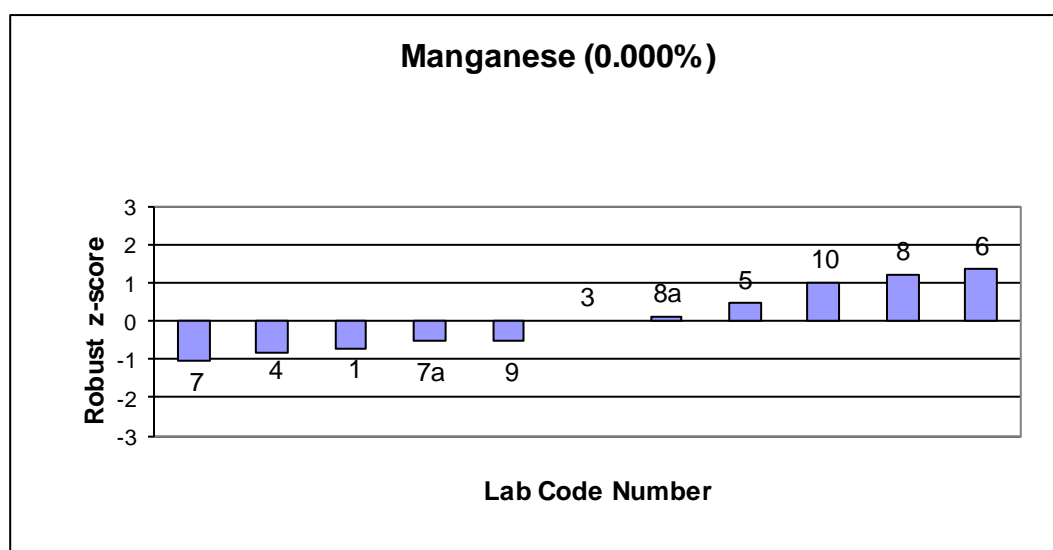


Manganese (0.000%)

Lab Code	Result 1	Result 2	Average	MU	Robust Z-score	Technique
1	0.660	0.659	0.660	0.01	-0.72	3
3	0.670	0.670	0.670	0.02	0.00	1
4	0.658	0.658	0.658	0.024	-0.82	1
5	0.675	0.678	0.677	0.003	0.44	1
6	0.691	0.688	0.690	0.004	1.33	1
7	0.652	0.657	0.655	0.005	-1.06	1
7a	0.661	0.663	0.662	0.003	-0.55	1
8	0.679	0.696	0.688	0.02	1.20	1
8a	0.673	0.670	0.672	0.004	0.10	1
9	0.655	0.670	0.663	0.023	-0.51	2
10	0.684	0.685	0.685	0.017	0.99	1

Technique: 1 AES - Arc/spark (Atomic Emission Spectroscopy - Arc/Spark)
 2 AES - ICP (Atomic Emissions Spectroscopy - Inductively Coupled Plasma)
 3 AAS (Atomic Absorption Spectrometry)

No. of Results	11
Median	0.6700
Norm IQR	0.0146
Uncertainty of the Median	0.0055
Robust CV	2.2%
Min	0.655
Max	0.690
Range	0.035

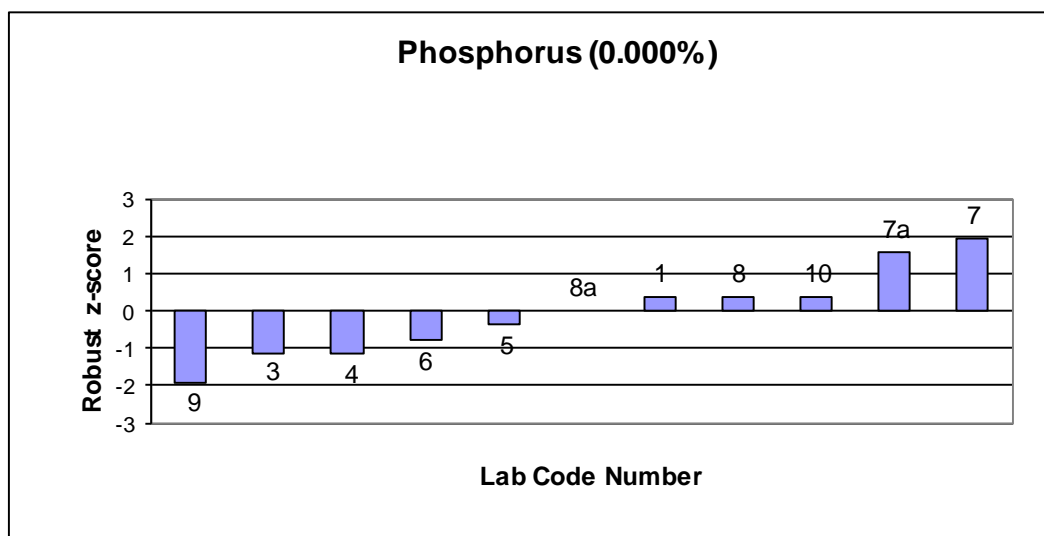


Phosphorus (0.000%)

Lab Code	Result 1	Result 2	Average	MU	Robust Z-score	Technique
1	0.011	0.011	0.011	0.005	0.39	5
3	0.009	0.009	0.009	0.001	-1.16	1
4	0.009	0.009	0.009	0.003	-1.16	1
5	0.01	0.01	0.010	0.0002	-0.39	1
6	0.009	0.01	0.010	0.001	-0.77	1
7	0.013	0.013	0.013	0.0002	1.93	1
7a	0.012	0.013	0.013	0.001	1.54	1
8	0.011	0.011	0.011	0.001	0.39	1
8a	0.011	0.01	0.011	0.001	0.00	1
9	0.009	0.007	0.008	0.001	-1.93	2
10	0.011	0.011	0.011	0.002	0.39	1

Technique: 1 AES - Arc/spark (Atomic Emission Spectroscopy - Arc/Spark)
 2 AES - ICP (Atomic Emissions Spectroscopy - Inductively Coupled Plasma)
 5 Photometric

No. of Results	11
Median	0.0105
Norm IQR	0.0013
Uncertainty of the Median	0.0005
Robust CV	12.4%
Min	0.008
Max	0.013
Range	0.005

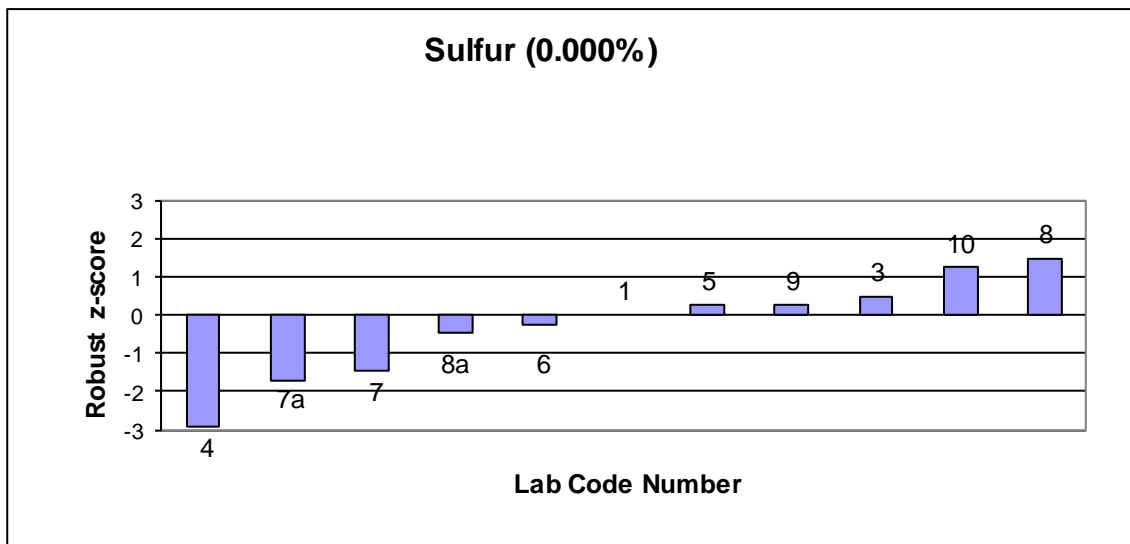


Sulfur (0.000%)

Lab Code	Result 1	Result 2	Average	MU	Robust Z-score	Technique
1	0.028	0.028	0.028	0.005	0.00	6
3	0.029	0.029	0.029	0.002	0.49	1
4	0.022	0.022	0.022	0.004	-2.94	1
5	0.028	0.029	0.0285	0.001	0.25	1
6	0.027	0.028	0.0275	0.001	-0.25	1
7	0.025	0.025	0.025	0.001	-1.47	1
7a	0.024	0.025	0.0245	0.001	-1.72	1
8	0.032	0.03	0.031	0.004	1.47	1
8a	0.027	0.027	0.027	0.001	-0.49	1
9	0.028	0.029	0.0285	0.003	0.25	6
10	0.03	0.031	0.0305	0.0056	1.23	1

Technique: 1 AES - Arc/spark (Atomic Emission Spectroscopy - Arc/Spark)
6 LECO/OES

No. of Results	11
Median	0.0280
Norm IQR	0.0020
Uncertainty of the Median	0.0008
Robust CV	7.3%
Min	0.022
Max	0.031
Range	0.009



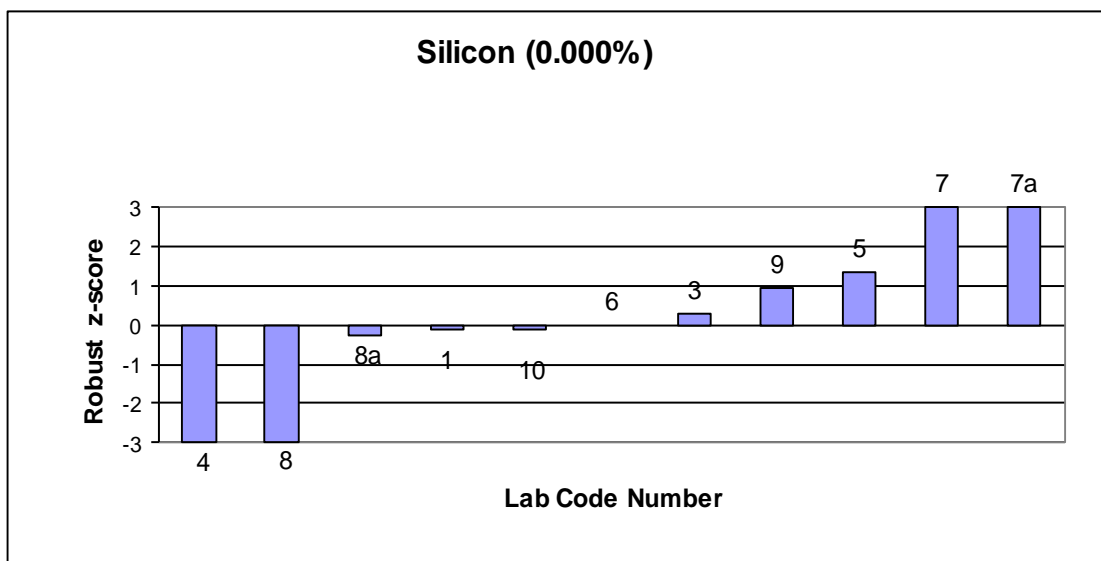
Silicon (0.000%)

Lab Code	Result 1	Result 2	Average	MU	Robust Z-score	Technique
1	0.237	0.24	0.239	0.01	-0.13	5
3	0.24	0.24	0.240	0.01	0.27	1
4	0.221	0.222	0.222	0.014	-4.72 §	1
5	0.244	0.244	0.244	0.002	1.35	1
6	0.241	0.237	0.239	0.006	0.00	1
7	0.249	0.252	0.251	0.004	3.10 §	1
7a	0.255	0.253	0.254	0.002	4.05 §	1
8	0.227	0.227	0.227	0.004	-3.24 §	1
8a	0.239	0.237	0.238	0.003	-0.27	1
9	0.245	0.24	0.243	0.012	0.94	2
10	0.239	0.238	0.239	0.0156	-0.13	1

§ = an outlier result i.e. $|z\text{-score}| \geq 3.0$

Technique: 1 AES - Arc/spark (Atomic Emission Spectroscopy - Arc/Spark)
 2 AES - ICP (Atomic Emissions Spectroscopy - Inductively Coupled Plasma)
 5 Photometric

No. of Results	11
Median	0.2390
Norm IQR	0.0037
Uncertainty of the Median	0.0014
Robust CV	1.6%
Min	0.222
Max	0.254
Range	0.033



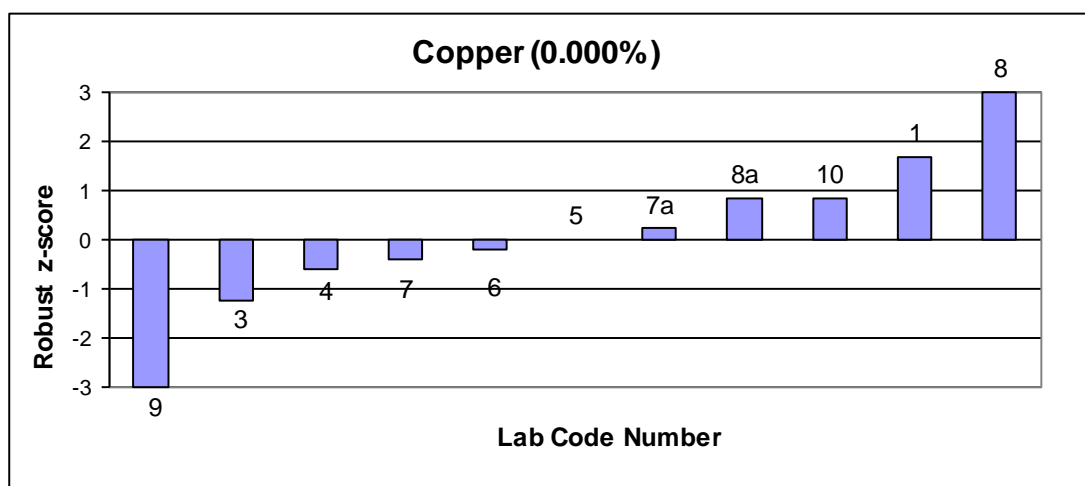
Copper (0.000%)

Lab Code	Result 1	Result 2	Average	MU	Robust Z-score	Technique
1	0.218	0.216	0.217	0.01	1.66	3
3	0.21	0.21	0.210	0.01	-1.25	1
4	0.211	0.212	0.212	0.014	-0.62	1
5	0.213	0.213	0.213	0.001	0.00	1
6	0.211	0.214	0.213	0.004	-0.21	1
7	0.216	0.208	0.212	0.009	-0.42	1
7a	0.214	0.213	0.214	0.002	0.21	1
8	0.242	0.242	0.242	0.001	12.04	1
8a	0.215	0.215	0.215	0.001	0.83	1
9	0.202	0.206	0.204	0.01	-3.74	2
10	0.215	0.215	0.215	0.0072	0.83	1

§ = an outlier result i.e. $|z\text{-score}| \geq 3.0$

Technique: 1 AES - Arc/spark (Atomic Emission Spectroscopy - Arc/Spark)
 2 AES - ICP (Atomic Emissions Spectroscopy - Inductively Coupled Plasma)
 3 AAS (Atomic Absorption Spectrometry)

No. of Results	11
Median	0.2130
Norm IQR	0.0024
Uncertainty of the Median	0.0009
Robust CV	1.1%
Min	0.204
Max	0.242
Range	0.038



Nickel (0.000%)

Lab Code	Result 1	Result 2	Average	MU	Technique
1	0.095	0.096	0.095	0.005	3
3	0.098	0.098	0.098	0.006	1
4	0.093	0.093	0.093	0.009	1
5	0.100	0.101	0.101	0.001	1
6	0.102	0.096	0.099	0.008	1
7	0.080	0.080	0.080	0.002	1
7a	0.076	0.079	0.078	0.001	1
8	0.097	0.097	0.097	0.001	1
8a	0.094	0.095	0.095	0.001	1
9	0.089	0.090	0.090	0.006	2
10	0.099	0.099	0.099	0.019	1

Technique: 1 AES - Arc/spark (Atomic Emission Spectroscopy - Arc/Spark)
2 AES - ICP (Atomic Emissions Spectroscopy - Inductively Coupled Plasma)
3 AAS (Atomic Absorption Spectrometry)

No statistical analysis was performed as results were not normally distributed.

Chromium (0.000%)

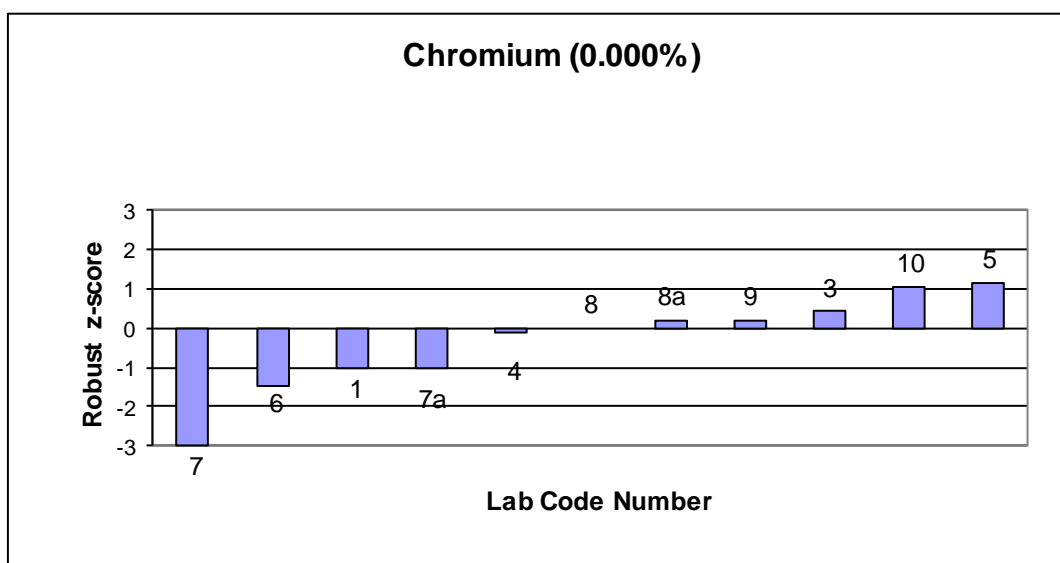
Lab Code	Result 1	Result 2	Average	MU	Robust Z-score	Technique
1	0.163	0.163	0.163	0.01	-1.04	3
3	0.170	0.170	0.170	0.01	0.42	1
4	0.167	0.168	0.168	0.012	-0.10	1
5	0.173	0.174	0.174	0.001	1.14	1
6	0.162	0.160	0.161	0.003	-1.45	1
7	0.150	0.150	0.150	0.002	-3.74	1
7a	0.164	0.162	0.163	0.003	-1.04	1
8	0.168	0.168	0.168	0.001	0.00	1
8a	0.169	0.169	0.169	0.003	0.21	1
9	0.169	0.169	0.169	0.009	0.21	2
10	0.173	0.173	0.173	0.0096	1.04	1

§ = an outlier result i.e. $|z\text{-score}| \geq 3.0$

Technique: 1 AES - Arc/spark (Atomic Emission Spectroscopy - Arc/Spark)
 2 AES - ICP (Atomic Emissions Spectroscopy - Inductively Coupled Plasma)
 3 AAS (Atomic Absorption Spectrometry)

No. of Results	11
Median	0.1680
Norm IQR	0.0048
Uncertainty of the Median	0.0018
Robust CV	2.9%
Min	0.150
Max	0.174
Range	0.024

Please note that a target CV has been used to calculate the z-scores

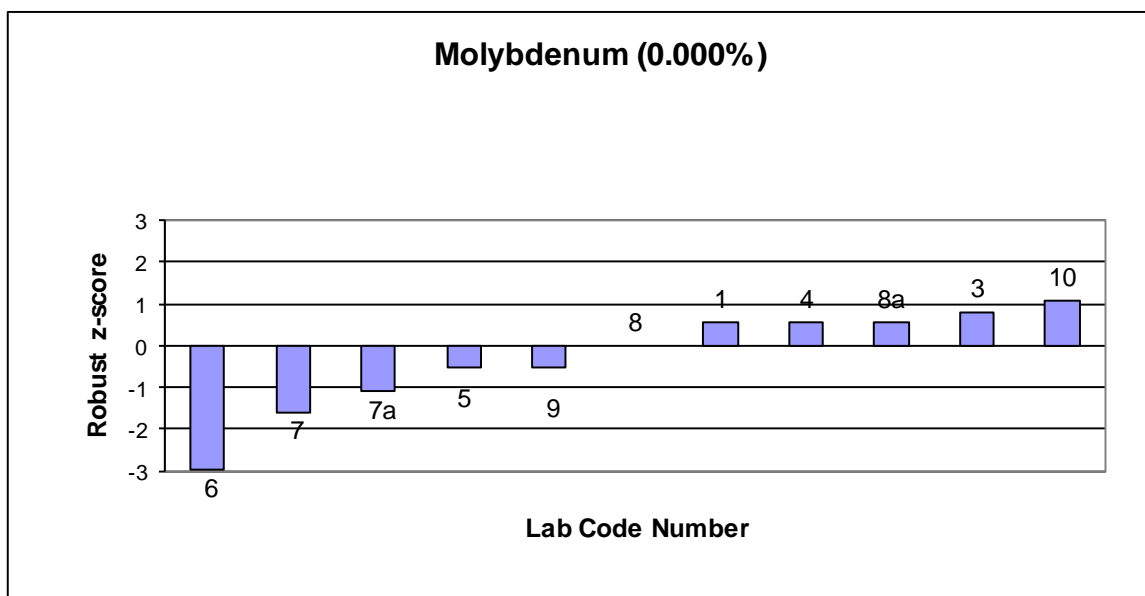


Molybdenum (0.000%)

Lab Code	Result 1	Result 2	Average	MU	Robust Z-score	Technique
1	0.022	0.022	0.022	0.005	0.54	3
3	0.022	0.023	0.023	0.002	0.81	1
4	0.022	0.022	0.022	0.004	0.54	1
5	0.020	0.020	0.020	0.0003	-0.54	1
6	0.016	0.015	0.016	0.001	-2.97	1
7	0.018	0.018	0.018	0.0002	-1.62	1
7a	0.019	0.019	0.019	0.001	-1.08	1
8	0.021	0.021	0.021	0.001	0.00	1
8a	0.022	0.022	0.022	0.001	0.54	1
9	0.020	0.020	0.020	0.002	-0.54	2
10	0.023	0.023	0.023	0.006	1.08	1

Technique: 1 AES - Arc/spark (Atomic Emission Spectroscopy - Arc/Spark)
 2 AES - ICP (Atomic Emissions Spectroscopy - Inductively Coupled Plasma)
 3 AAS (Atomic Absorption Spectrometry)

No. of Results	11
Median	0.0210
Norm IQR	0.0019
Uncertainty of the Median	0.0007
Robust CV	8.8%
Min	0.016
Max	0.023
Range	0.008



Vanadium (0.000%)

Lab Code	Result 1	Result 2	Average	MU	Technique
3	0.003	0.003	0.003	0.001	1
4	0.002	0.002	0.002	0.001	1
5	0.002	0.002	0.002	0.0001	1
6	0.002	0.002	0.002	0.000	1
7	0.006	0.006	0.006	0.0002	1
7a	0.005	0.005	0.005	0.001	1
8	0.003	0.003	0.003	0.001	1
8a	0.002	0.002	0.002	0.001	1
9	0.002	0.002	0.002	0.001	2
10	0.003	0.003	0.003	0.0006	1

Technique: 1 AES - Arc/spark (Atomic Emission Spectroscopy - Arc/Spark)
2 AES - ICP (Atomic Emissions Spectroscopy - Inductively Coupled Plasma)

No statistical analysis was performed as results were not normally distributed.

Cobalt (0.000%)

Lab Code	Result 1	Result 2	Average	MU	Technique
3	0.010	0.010	0.010	0.001	1
5	0.007	0.007	0.007	0.0001	1
6	0.001	0.001	0.001	0.000	1
8a	0.007	0.007	0.007	0.001	1
9	0.001	0.001	0.001	0.001	2
10	0.009	0.009	0.009	0.0068	1

Technique: 1 AES - Arc/spark (Atomic Emission Spectroscopy - Arc/Spark)
2 AES - ICP (Atomic Emissions Spectroscopy - Inductively Coupled Plasma)

No statistical analysis was performed as results were not normally distributed.

APPENDIX B

Homogeneity and Stability Testing

Sample Preparation and Homogeneity Testing.....	B1
Stability Testing.....	B2

Sample Preparation and Homogeneity

The samples were supplied by Universal Scientific Laboratory Pty Ltd.

Eight discs were selected and tested for each element and the results are shown in the following table:

Carbon	Sulfur	Phosphorus	Silicon
0.4480	0.0269	0.0137	0.440
0.4520	0.0280	0.0141	0.433
0.4520	0.0282	0.0140	0.435
0.4500	0.0284	0.0143	0.438
0.4590	0.0285	0.0138	0.436
0.4580	0.0291	0.0136	0.438
0.4560	0.0289	0.0138	0.439
0.4530	0.0272	0.0140	0.440
0.454	0.028	0.014	0.437
0.004	0.001	0.000	0.003
0.82%	2.10%	1.33%	0.59%
Manganese	Chromium	Nickel	Copper
0.660	0.177	0.095	0.210
0.656	0.174	0.094	0.209
0.660	0.175	0.096	0.211
0.657	0.176	0.094	0.209
0.658	0.176	0.095	0.212
0.658	0.175	0.094	0.213
0.660	0.177	0.095	0.214
0.660	0.175	0.094	0.211
0.66	0.18	0.09	0.211
0.0125	0.0005	0.0004	0.0004
0.25%	0.53%	0.78%	0.88%
Molybdenum			
0.018			
0.018			
0.019			
0.018			
0.019			
0.019			
0.018			
0.018			
0.02			
0.001			
4.12%			

Analysis of this data indicated that the samples were sufficiently homogenous and, therefore, any results later identified as outliers could not be attributed to sample variability.

Stability Testing

Due to the nature of the samples it was not considered necessary to perform stability testing.

APPENDIX C

Documentation

Instructions to Participants	C1
Results Sheet	C2



Proficiency Testing Australia

Proficiency Testing Program Metal Alloys (Round 33) – November 2017

INSTRUCTIONS TO PARTICIPANTS

Please read instructions carefully **BEFORE** commencing testing.

1. For this round each participant will be supplied with one steel disc.
2. Participants are asked to test the percentage composition (in duplicate) for each sample for the following elements:
Carbon, Manganese, Phosphorus, Sulfur, Silicon, Copper, Nickel, Chromium, Molybdenum, Cobalt and Vanadium. If the analysis of any element is not possible, please note this on the results sheet. Please be advised that the initial measurement recorded is to be noted as “Result 1” and the following measurement is to be recorded as “Result 2” on the results sheet.
3. These tests are to be conducted by the methods used routinely in your laboratory. The sample should be treated as a routine sample.
4. Results are to be reported as a % to three decimal places. **Do not report any values as “<”**. The method used for each test should also be noted.
5. For each test note the appropriate technique code no. on the Results Sheet:
 1. AES – Arc/Spark (Atomic Emission Spectroscopy – Arc\Spark)
 2. AES – ICP (Atomic Emission spectroscopy – Inductively Coupled Plasma)
 3. AAS (Atomic Absorption Spectrometry)
 4. Gravimetric
 5. Photometric
 6. Other (please specify)
6. Laboratories are also requested to calculate and report an estimate of measurement uncertainty (MU) for each reported measurement result. All estimates of measurement uncertainty must be given as a 95% confidence interval (coverage factor $k \approx 2$)
7. Testing may commence as soon as samples are received. All laboratories are asked to return their results by **Friday 1st December 2017** to:

Karen Cividin
Proficiency Testing Australia
PO Box 7507
Silverwater NSW 2128
AUSTRALIA
Phone: +61 2 9736 8295 Fax: +61 2 9743 6664
8. To allow for the confidential treatment of your results in the final report, you have been allocated a code number which appears on your results sheet.



Proficiency Testing Australia

**Proficiency Testing Program
Metal Alloys (Round 33) – November 2017**

RESULTS SHEET

Date sample was received: _____

Lab Code:

TEST (report % to three decimal places)	SAMPLE		MU (\pm)	Technique Code No.
	Result 1	Result 2		
Carbon				
Sulfur				
Phosphorus				
Silicon				
Manganese				
Chromium				
Nickel				
Copper				
Molybdenum				
Vanadium				
Cobalt				

Signed: _____

Date: _____

Please return no later than **Friday 1st December 2017**, to

*Karen Cividin, Proficiency Testing Australia
PO Box 7507, Silverwater NSW 2128
phone: +61 2 9736 8295, fax: +61 9743 6664*

- End of Report -