

Report No. 1090

**Metal Alloys Proficiency Testing
Program**

Round 34

Low Alloy Steel

August 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.

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1. FOREWORD

This report summarises the results of a proficiency testing program on the chemical analysis of metal alloys. It constitutes the thirty 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).

The program was conducted in May 2018 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 11 laboratories received samples, comprising:
 - 8 Australian participants; and
 - 3 overseas participants, including:
 - Egypt, Ethiopia and Qatar

Of these 11 laboratories, 8 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.

Please note that a target coefficient of variation (CV) has been used for Nickel and Molybdenum.

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	0.1910	0.0041
Manganese	11	0.7430	0.0095
Phosphorus	11	0.0110	0.0015
Sulfur	11	0.0250	0.0014
Silicon	11	0.3055	0.0067
Copper	9	0.0035	0.0004
Nickel	9	0.0030	0.0026
Chromium	11	0.0380	0.0020
Molybdenum	10	0.0010	0.0003
Vanadium	9	0.0020	0.0009
Cobalt	7	0.0030	0.0011

5. PTA AND TECHNICAL ADVISER'S COMMENTS

Carbon

The results for Carbon were very good with the exception of laboratory code 8. It is likely that an error in calibration lead to this high result. A high result such as this can lead to a sample being assessed incorrectly as it is out of specification. The top of the Carbon range for 1021 is 0.23%. Similarly, if there is a bias of +0.02% Carbon, a sample which is 0.16% and out of specification will be reported erroneously as 0.18% which is within specification.

Manganese

The results for Manganese were very good with the obvious exception of the result for laboratory code 5 which suggests an error in calibration for this element at this level.

Phosphorus

The results for Phosphorus were very good.

Sulfur

The results for Sulfur were satisfactory with the exception of the result for laboratory code 4. The calibration status of this laboratory's instrument is doubtful.

Silicon

The results for Silicon were very good.

Copper

With the exception of laboratory code 11, the results for Copper were satisfactory.

Chromium

The results for Chromium were very good.

Molybdenum

At this level, all results are considered to be satisfactory.

Cobalt

An upper limit for this element is not normally specified. The reported results are satisfactory with the exception of laboratory code 4. This laboratory's ability to quantify low levels of Cobalt is questionable.

Vanadium

The results for Vanadium were very good. At this level, Vanadium would normally be reported as <0.01%.

Variations within and between laboratories

Most results have been generated by AES arc/spark. Replicates within laboratories are very good with the exception of the Cobalt results for laboratory code 4.

Variation between methods

Most laboratories reported results generated by atomic emission spectroscopy. One laboratory used LECO (C & S), photometry for Phosphorus and Silicon and atomic absorption spectrometry for the remainder.

Possible sources of error

When using AES arc/spark it is vital that the calibration status of the instrument is checked before analysing unknowns, and adjusted if necessary. A certified reference material should be run in parallel with all analyses, regardless of the technique employed.

Measurement Uncertainties

The Measurement Uncertainties were unexceptionable.

This is a common alloy and becomes a worthwhile addition to laboratories 'libraries' of certified reference materials. It can be used to confirm the calibration status of instruments and the accuracy of reported results.

Analysis of this alloy should be within the scope of laboratories accredited in the field of Metals and Alloys - Iron and Steel. It is still important that results, particularly for the salient elements, but also for the residual elements, are as accurate as possible. This is necessary when a particular heat (batch) of steel needs to be identified. Therefore, confidence in the calibration status of instruments is vital.

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	8
Manganese	5
Phosphorus	-
Sulfur	4, 6
Silicon	-
Copper	-
Nickel	-
Chromium	-
Molybdenum	-
Vanadium	-
Cobalt	4

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

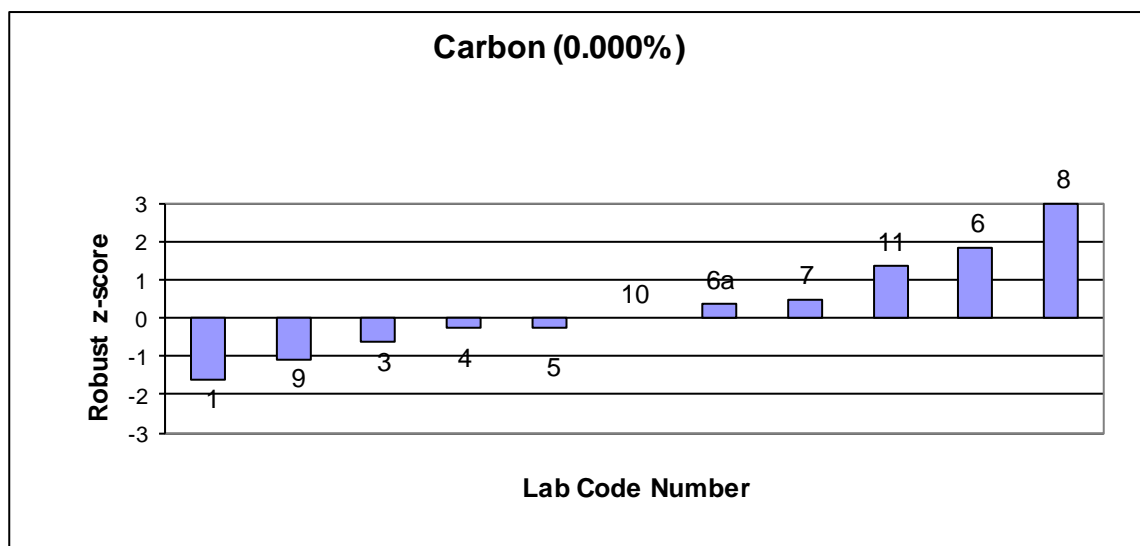
Carbon (0.000%)

Lab Code	Result 1	Result 2	Average	MU	Robust Z-score	Technique
1	0.182	0.187	0.185	0.013	-1.59	1
3	0.189	0.188	0.189	0.010	-0.61	6
4	0.190	0.190	0.190	0.016	-0.25	1
5	0.190	0.190	0.190	0.005	-0.25	1
6	0.199	0.198	0.199	0.016	1.84	1
6a	0.195	0.190	0.193	0.016	0.37	1
7	0.193	0.193	0.193	0.001	0.49	1
8	0.210	0.209	0.210	0.007	4.54	§ 1
9	0.183	0.190	0.187	0.010	-1.10	1
10	0.191	0.191	0.191	0.013	0.00	1
11	0.197	0.196	0.197	0.005	1.35	1

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

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

No. of Results	11
Median	0.1910
Norm IQR	0.0041
Uncertainty of the Median	0.0015
Robust CV	2.1%
Min	0.185
Max	0.210
Range	0.025



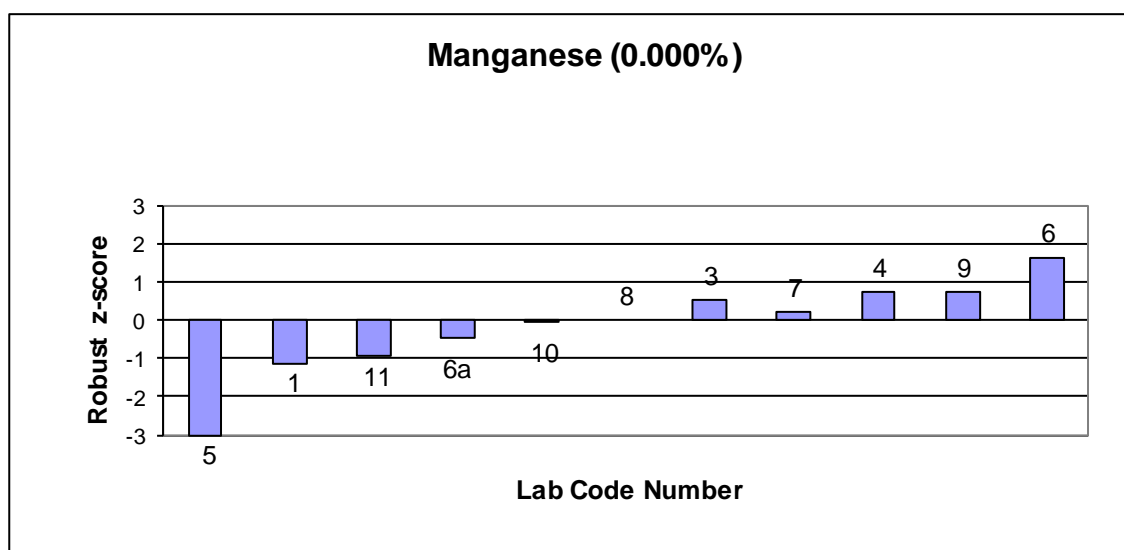
Manganese (0.000%)

Lab Code	Result 1	Result 2	Average	MU	Robust Z-score	Technique
1	0.733	0.731	0.732	0.026	-1.16	1
3	0.748	0.748	0.748	0.01	0.53	3
4	0.750	0.750	0.750	0.033	0.74	1
5	0.690	0.690	0.690	0.015	-5.61 §	1
6	0.756	0.761	0.759	0.024	1.64	1
6a	0.742	0.735	0.739	0.024	-0.48	1
7	0.745	0.745	0.745	0.002	0.21	1
8	0.737	0.749	0.743	0.021	0.00	1
9	0.750	0.750	0.750	0.02	0.74	1
10	0.743	0.742	0.743	0.018	-0.05	1
11	0.733	0.735	0.734	0.0064	-0.95	1

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

Technique: 1 AES - Arc/spark (Atomic Emission Spectroscopy - Arc/Spark)
3 AAS (Atomic Absorption Spectrometry)

No. of Results	11
Median	0.7430
Norm IQR	0.0095
Uncertainty of the Median	0.0036
Robust CV	1.3%
Min	0.690
Max	0.759
Range	0.069

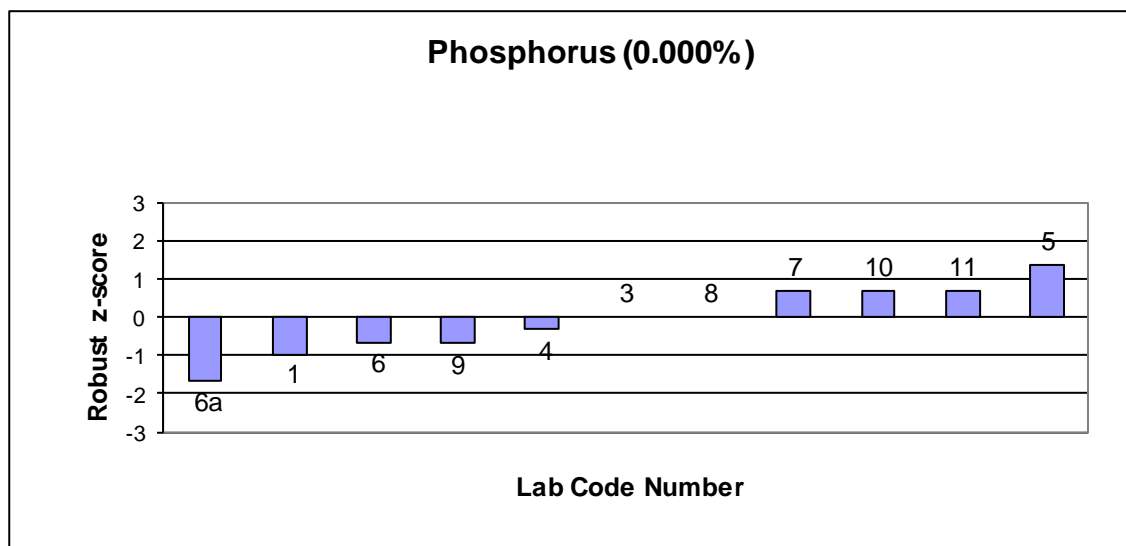


Phosphorus (0.000%)

Lab Code	Result 1	Result 2	Average	MU	Robust Z-score	Technique
1	0.01	0.009	0.010	0.003	-1.01	1
3	0.011	0.011	0.011	0.005	0.00	5
4	0.01	0.011	0.011	0.002	-0.34	1
5	0.013	0.013	0.013	0.0009	1.35	1
6	0.01	0.01	0.010	0.005	-0.67	1
6a	0.009	0.008	0.009	0.005	-1.69	1
7	0.012	0.012	0.012	0.001	0.67	1
8	0.011	0.011	0.011	0.001	0.00	1
9	0.01	0.01	0.010	0.001	-0.67	1
10	0.012	0.012	0.012	0.0025	0.67	1
11	0.012	0.012	0.012	0.0013	0.67	1

Technique: 1 AES - Arc/spark (Atomic Emission Spectroscopy - Arc/Spark)
5 Photometric

No. of Results	11
Median	0.0110
Norm IQR	0.0015
Uncertainty of the Median	0.0006
Robust CV	13.5%
Min	0.009
Max	0.013
Range	0.005



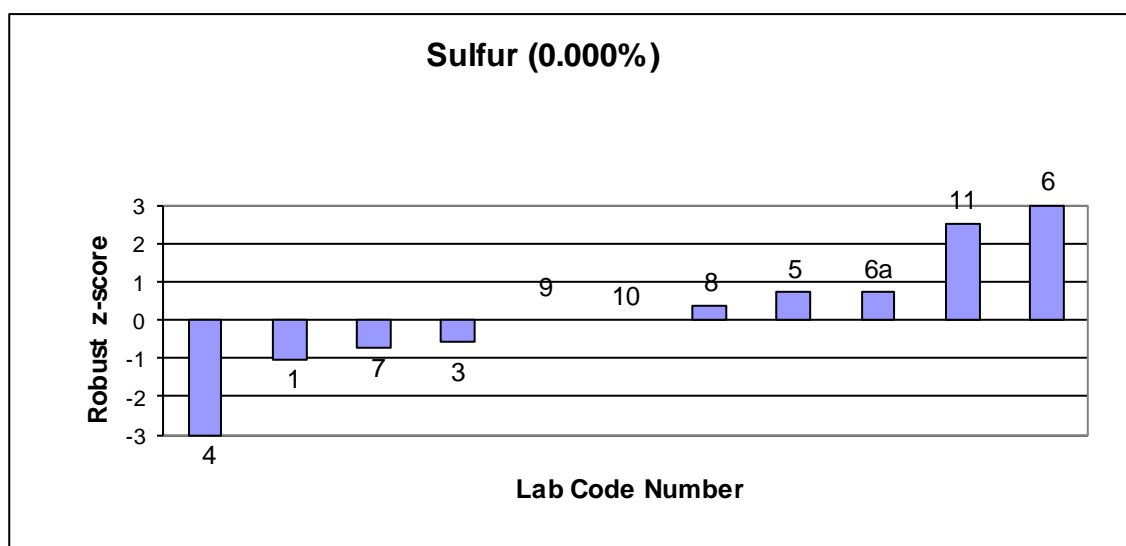
Sulfur (0.000%)

Lab Code	Result 1	Result 2	Average	MU	Robust Z-score	Technique
1	0.023	0.024	0.0235	0.005	-1.06	1
3	0.024	0.0244	0.0242	0.005	-0.57	6
4	0.015	0.016	0.0155	0.003	-6.74 §	1
5	0.028	0.024	0.026	0.0004	0.71	1
6	0.029	0.03	0.0295	0.006	3.19 §	1
6a	0.027	0.025	0.026	0.006	0.71	1
7	0.024	0.024	0.024	0.001	-0.71	1
8	0.024	0.027	0.0255	0.003	0.35	1
9	0.025	0.025	0.025	0.004	0.00	1
10	0.024	0.026	0.025	0.004	0.00	1
11	0.028	0.029	0.0285	0.0031	2.48	1

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

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

No. of Results	11
Median	0.0250
Norm IQR	0.0014
Uncertainty of the Median	0.0005
Robust CV	5.6%
Min	0.016
Max	0.030
Range	0.014

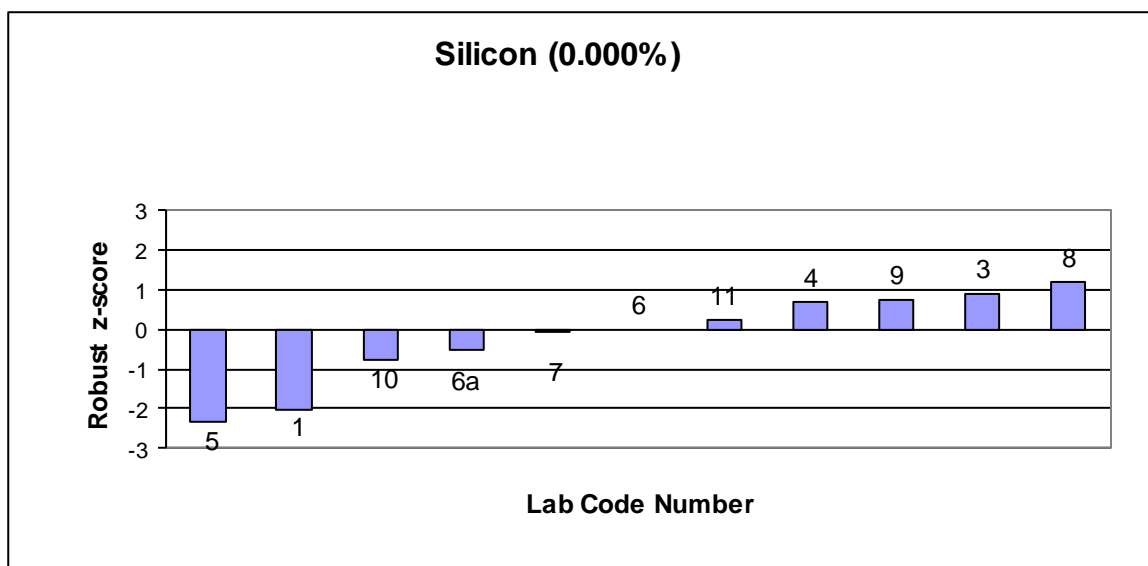


Silicon (0.000%)

Lab Code	Result 1	Result 2	Average	MU	Robust Z-score	Technique
1	0.294	0.29	0.2920	0.005	-2.02	1
3	0.31	0.313	0.3115	0.01	0.90	5
4	0.31	0.31	0.3100	0.016	0.67	1
5	0.29	0.29	0.2900	0.02	-2.32	1
6	0.305	0.306	0.3055	0.015	0.00	1
6a	0.303	0.301	0.3020	0.015	-0.52	1
7	0.304	0.306	0.3050	0.002	-0.07	1
8	0.311	0.316	0.3135	0.007	1.20	1
9	0.311	0.31	0.3105	0.02	0.75	1
10	0.302	0.299	0.3005	0.012	-0.75	1
11	0.307	0.307	0.3070	0.038	0.22	1

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

No. of Results	11
Median	0.3055
Norm IQR	0.0067
Uncertainty of the Median	0.0025
Robust CV	2.2%
Min	0.290
Max	0.314
Range	0.024



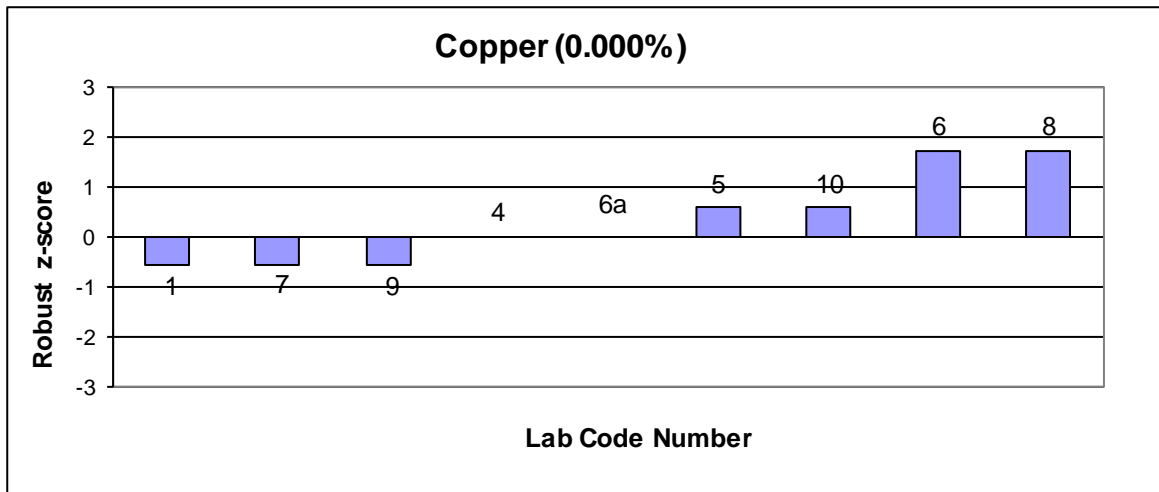
Copper (0.000%)

Lab Code	Result 1	Result 2	Average	MU	Robust Z-score	Technique
1	0.003	0.003	0.003	0.001	-0.57	1
4	0.004	0.003	0.004	0.002	0.00	1
5	0.004	0.004	0.004	0.002	0.57	1
6	0.005	0.005	0.005	0.013	1.72	1
6a	0.004	0.003	0.004	0.003	0.00	1
7	0.003	0.003	0.003	0.001	-0.57	1
8	0.005	0.005	0.005	0.0002	1.72	1
9	0.003	0.003	0.003	0.0004	-0.57	1
10	0.004	0.004	0.004	0.0003	0.57	1
11	<0.021	<0.021	n/a	0.0075	n/a	1

n/a = not applicable

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

No. of Results	9
Median	0.0035
Norm IQR	0.0009
Uncertainty of the Median	0.0004
Robust CV	25.0%
Min	0.003
Max	0.005
Range	0.002



Nickel (0.000%)

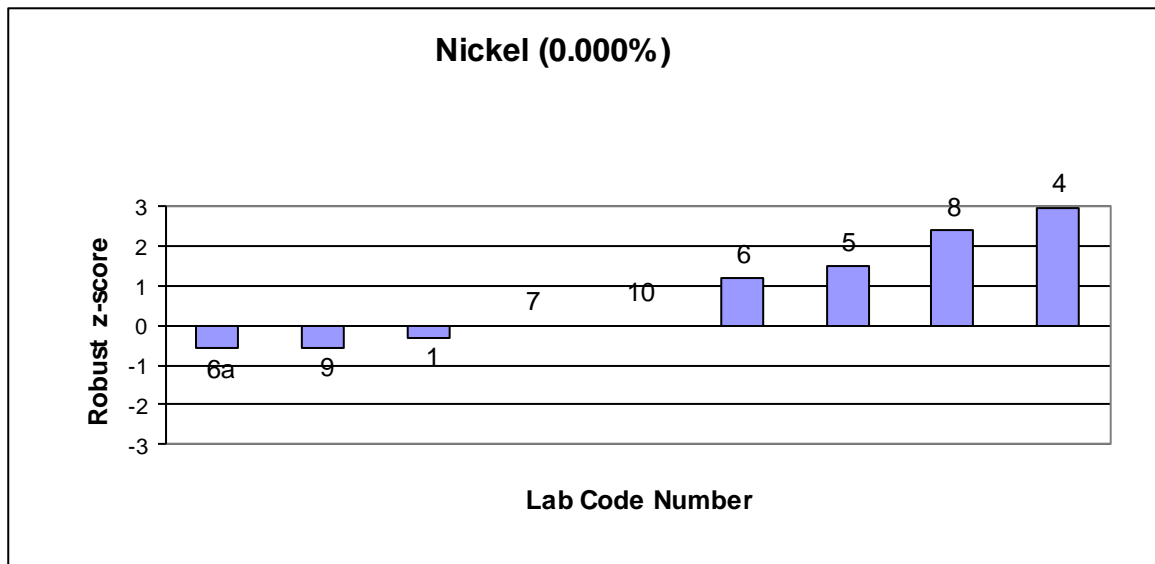
Lab Code	Result 1	Result 2	Average	MU	Robust Z-score	Technique
1	0.002	0.003	0.003	0.001	-0.30	1
4	0.008	0.008	0.008	0.027	2.98	1
5	0.006	0.005	0.006	0.011	1.49	1
6	0.005	0.005	0.005	0.018	1.19	1
6a	0.002	0.002	0.002	0.002	-0.60	1
7	0.003	0.003	0.003	0.002	0.00	1
8	0.007	0.007	0.007	0.001	2.38	1
9	0.002	0.002	0.002	0.000	-0.60	1
10	0.003	0.003	0.003	0.001	0.00	1
11	<0.020	<0.020	n/a	0.021	n/a	1

n/a = not applicable

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

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

No. of Results	9
Median	0.0030
Norm IQR	0.0026
Uncertainty of the Median	0.0011
Robust CV	56.0%
Min	0.002
Max	0.008
Range	0.006

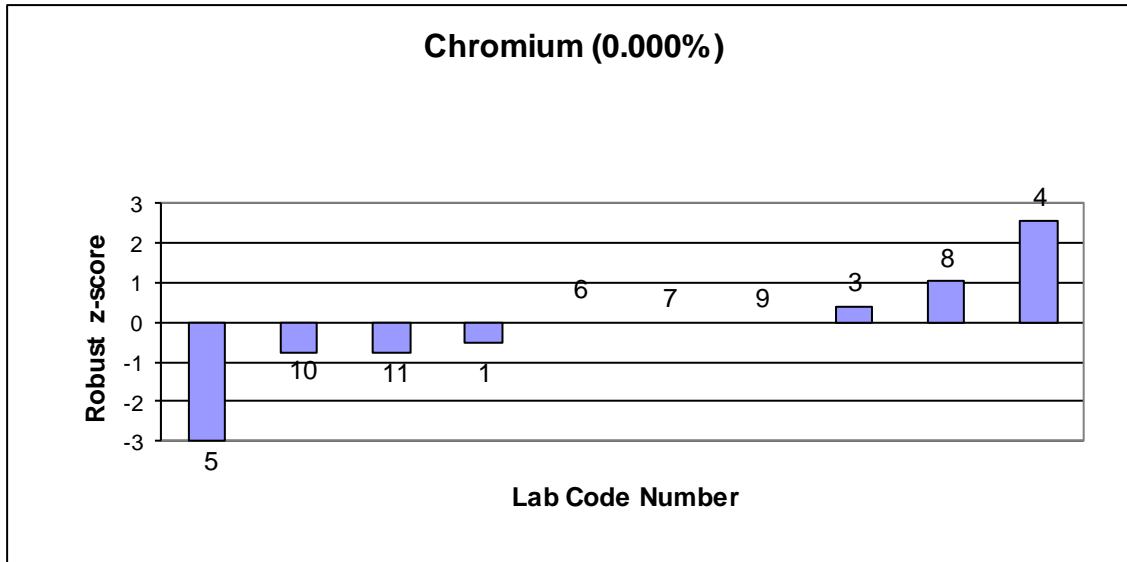


Chromium (0.000%)

Lab Code	Result 1	Result 2	Average	MU	Robust Z-score	Technique
1	0.037	0.037	0.0370	0.006	-0.51	1
3	0.039	0.039	0.0388	0.005	0.41	3
4	0.044	0.042	0.0430	0.024	2.55	1
5	0.032	0.033	0.0325	0.004	-2.80	1
6	0.038	0.038	0.0380	0.018	0.00	1
6a	0.043	0.043	0.0430	0.018	2.55	1
7	0.038	0.038	0.0380	0.005	0.00	1
8	0.040	0.040	0.0400	0.001	1.02	1
9	0.038	0.038	0.0380	0.003	0.00	1
10	0.036	0.037	0.0365	0.0073	-0.76	1
11	0.036	0.037	0.0365	0.0232	-0.76	1

Technique: 1 AES - Arc/spark (Atomic Emission Spectroscopy - Arc/Spark)
 3 AAS (Atomic Absorption Spectrometry)

No. of Results	11
Median	0.0380
Norm IQR	0.0020
Uncertainty of the Median	0.0007
Robust CV	5.2%
Min	0.033
Max	0.043
Range	0.011



Molybdenum (0.000%)

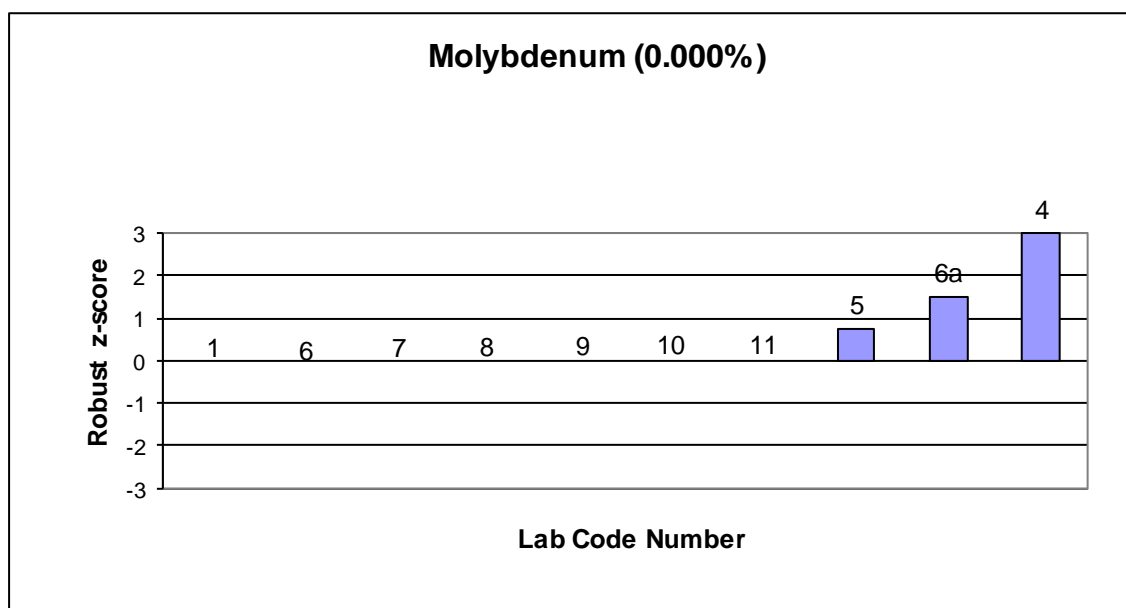
Lab Code	Result 1	Result 2	Average	MU	Robust Z-score	Technique
1	0.001	0.001	0.001	0.001	0.00	1
4	0.003	0.003	0.003	0.015	2.99	1
5	0.001	0.002	0.002	0.005	0.75	1
6	0.001	0.001	0.001	0.019	0.00	1
6a	0.002	0.002	0.002	0.002	1.49	1
7	0.001	0.001	0.001	0.001	0.00	1
8	0.001	0.001	0.001	0.0005	0.00	1
9	0.001	0.001	0.001	0.001	0.00	1
10	0.001	0.001	0.001	0.0005	0.00	1
11	0.001	0.001	0.001	0.0031	0.00	1

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

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

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

No. of Results	10
Median	0.0010
Norm IQR	0.0003
Uncertainty of the Median	0.0001
Robust CV	67.0%
Min	0.001
Max	0.003
Range	0.002



Cobalt (0.000%)

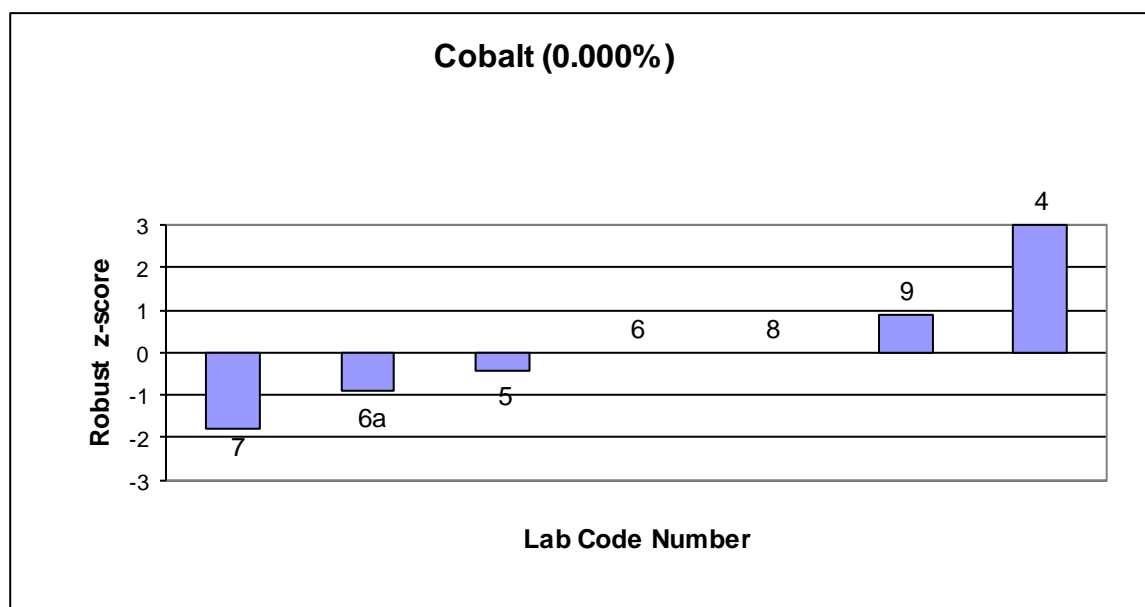
Lab Code	Result 1	Result 2	Average	MU	Robust Z-score	Technique
4	0.014	0.011	0.0125	0.005	8.44 §	1
5	0.003	0.002	0.0025	nr	-0.44	1
6	0.003	0.003	0.003	0.002	0.00	1
6a	0.002	0.002	0.002	0.002	-0.89	1
7	0.001	0.001	0.001	0.001	-1.78	1
8	0.003	0.003	0.003	0.0003	0.00	1
9	0.004	0.004	0.004	0.001	0.89	1
11	<0.003	<0.003	n/a	0.0089	n/a	1

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

n/a = not applicable

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

No. of Results	7
Median	0.0030
Norm IQR	0.0011
Uncertainty of the Median	0.0005
Robust CV	37.5%
Min	0.001
Max	0.013
Range	0.012



Vanadium (0.000%)

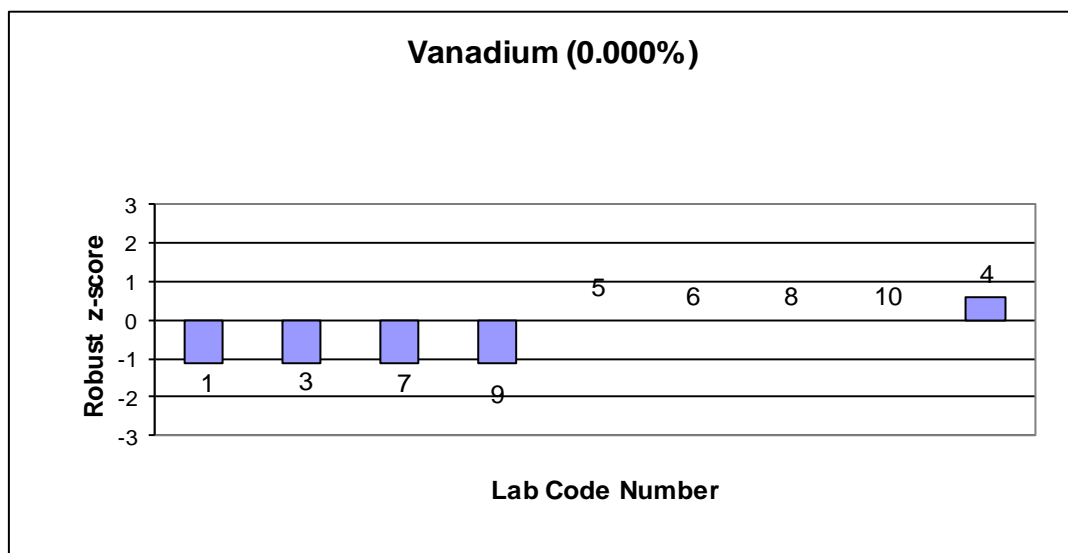
Lab Code	Result 1	Result 2	Average	MU	Robust Z-score	Technique
1	0.001	0.001	0.001	0.001	-1.14	1
3	0.001	0.001	0.001	0.001	-1.14	nr
4	0.003	0.002	0.003	0.018	0.57	1
5	0.002	0.002	0.002	0.0005	0.00	1
6	0.002	0.002	0.002	0.001	0.00	1
6a	0.003	0.003	0.003	0.001	1.14	1
7	0.001	0.001	0.001	0.001	-1.14	1
8	0.002	0.002	0.002	0.0004	0.00	1
9	0.001	0.001	0.001	0.001	-1.14	1
10	0.002	0.002	0.002	0.002	0.00	1
11	<0.005	<0.005	n/a	0.0022	n/a	1

nr = not reported

n/a = not applicable

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

No. of Results	9
Median	0.0020
Norm IQR	0.0009
Uncertainty of the Median	0.0004
Robust CV	43.7%
Min	0.001
Max	0.003
Range	0.002



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
	0.189	0.024	0.009
	0.187	0.025	0.009
	0.188	0.025	0.009
	0.191	0.024	0.009
	0.188	0.025	0.009
	0.188	0.024	0.009
	0.189	0.025	0.009
	0.190	0.025	0.009
Average	0.189	0.025	0.009
STD	0.001	0.000	0.000
CV	0.47%	3.00%	2.68%
	Silicon	Manganese	Chromium
	0.277	0.732	0.038
	0.276	0.730	0.038
	0.275	0.739	0.038
	0.277	0.734	0.038
	0.276	0.733	0.038
	0.273	0.732	0.038
	0.278	0.739	0.038
	0.274	0.736	0.038
Average	0.276	0.734	0.038
STD	0.002	0.000	0.000
CV	0.60%	0.48%	0.00%

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 Program
Metal Alloys (Round 34) – May 2018**

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 8th June 2018** 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 Program
Metal Alloys (Round 34) – May 2018**

RESULTS SHEET

Date sample was received: _____

Lab Code:

TEST (report % to three decimal places)	SAMPLE		MU (±)	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 8th June 2018**, to:

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

- End of Report -