

Report No. 841

Metal Alloys Proficiency Testing

Round 25

Free Machining Alloy Steel

February 2014

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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 twenty-fifth round of an ongoing series of programs.

The program was conducted in November 2013 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 Advisor was Mr W Ting from Universal Scientific Laboratory Pty Ltd. This report was authorised by Ms W Fajloun, PTA Quality Coordinator.

2. FEATURES OF THE PROGRAM

- (a) Participants were provided with one stainless steel disc sample.
- (b) A total of 12 laboratories received samples, comprising:
 - 6 Australian participants; and
 - 6 overseas participants, including:
 - Singapore, Iran and Hong Kong.
- (c) Laboratories were provided with the *Instructions to Participants* and *Results Sheet* (see Appendix C). Laboratories were requested to perform the tests according to their routine methods and to record their results on the *Results Sheet*.
- (d) Prior to sample distribution, a number of randomly selected samples were analysed for homogeneity. Based on the results of this testing (see Appendix B), the homogeneity of the samples was established.
- (e) Each laboratory was randomly allocated a unique code number for the program to ensure confidentiality of results. Reference to each laboratory in this report is by code number only.
- (f) Results (as reported by participants) with corresponding summary statistics (i.e. number of results, median, uncertainty of the median, normalised interquartile range, robust coefficient of variation, minimum, maximum and range) are presented in Appendix A (for each of the analyses performed). Measurement Uncertainty (MU) is also presented where supplied by participants. Please note that this information is presented for information purposes only and has not been used for the formal evaluation of results.
- (g) A robust statistical approach, using z-scores, was utilised to assess laboratories' testing performance (see Section 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, 2012* (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 samples. This section contains the following for each determinant:
 - a table of results and calculated z-scores;
 - a list of summary statistics;
 - 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 "§".

- (b) Results Tables and Summary Statistics

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

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

A list of summary statistics appears at the bottom of each of the tables of results and consists of:

- the number of results for that test/sample (*No. of Results*);
- the median of these results, i.e. the middle value (*Median*);
- the uncertainty of the median;
- the normalised interquartile range of the results (*Normalised IQR*);
- the robust coefficient of variation, expressed as a percentage (*Robust CV*) - i.e. $100 \times \text{Normalised IQR} / \text{Median}$;
- the minimum and maximum laboratory results; and
- the range (*Maximum - Minimum*).

The median is a measure of the centre of the data.

The normalised IQR is a measure of the spread of the results. It is calculated by multiplying the interquartile range (IQR) by 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).

Please see reference [1] for further details on these robust summary statistics.

(c) Ordered Z-score Charts

On these charts each laboratory's robust z-score is shown, in order of magnitude, and is marked with its code number. From these charts, each laboratory can readily compare its performance relative to the other laboratories. These charts contain solid lines at +3.0 and -3.0, so that outliers are clearly identifiable as those laboratories whose "bar" extends beyond these "cut-off" lines. The y-axis of these charts has been limited, so very large z-scores appear to extend beyond the chart boundary.

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

TABLE A: SUMMARY STATISTICS

Test	No. of Results	Median	Normalised IQR
Carbon	12	0.0523	0.0063
Manganese	12	1.3903	0.0725
Phosphorus	12	0.0608	0.0041
Sulfur	10	0.3800	0.1093
Silicon	10	0.0240	0.0039
Copper	12	n/a	n/a
Nickel	12	0.0350	0.0039
Chromium	12	0.0290	0.0041
Molybdenum	12	0.0092	0.0028
Cobalt	4	n/a	n/a
Vanadium	10	0.0030	0.0032

Note:

1. No summary statistics are provided for copper as an initial statistical analysis showed that the spread of results was not normal.
2. Statistical analysis has not been performed for cobalt due to the small number of results returned.

5. PTA AND TECHNICAL ADVISOR'S COMMENTS

The sample used in this round was a resulfurised and rephosphorised free machining steel, similar to AS 1442 1214 which is still widely used in Australia. Therefore, accredited laboratories should have been competent in the analysis of this material. Manganese has a large number of peak emission wavelengths and there is often an inflating interference on higher (>0.15%) sulfur contents and vice versa. It may be difficult to select wavelengths for manganese and sulfur which do not give rise to interference and yet have sufficient sensitivity for the application. When higher sulfur steels are to be analysed, it is necessary to either apply a correction for sulfur and manganese, or calibrate to include a range of higher sulfur steels. It may also be necessary to vary the analytical parameters, specifically increasing the pre-integration time. Manganese is also known to interfere with phosphorus but the amount of phosphorus in this alloy is insufficiently high to have an effect. If using ICP techniques, the same applies regarding wavelengths and the

best approach is to expel sulfur in the digestion stage (see comment for manganese and sulfur).

Carbon

The results were very good with the exception of laboratory code 13. The result for laboratory code 8 was also considered low in comparison to the other two LECO results.

Manganese

The spread of results indicated that the sulfur-manganese interference had not been taken into account by laboratory codes 8 and 12. Results >1.4% (laboratory codes 2, 3, 7 and 13) would probably have been boosted by sulfur. The remaining results show good correlation.

Sulfur

The high result for laboratory code 8 suggested an inappropriate calibration standard. The high results for laboratory codes 5 and 12 indicated possible manganese interference, and the results for laboratory codes 2, 4 and 13 suggest that the calibrated range for sulfur was exceeded by this sample.

Phosphorus

These results were satisfactory.

Silicon

With the exception of the two outliers (laboratory codes 13 and 14), these results were quite good.

Nickel

These results were good. The first replicate for laboratory code 3 appears to be incorrect.

Chromium

The results were good with the exception of the outlier (laboratory code 13).

Molybdenum

At this level, all the results, excluding the outlier identified for laboratory code 13, were regarded as satisfactory.

Cobalt

An upper impurity level for this element is not specified for this type of steel. At this very low level the results were satisfactory.

Vanadium

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. Laboratory code 3 shows unacceptable variations between replicates for carbon, manganese and nickel. As previously stated, variations in manganese and sulfur are most likely due to a restricted calibration range (sulfur) and cross interference.

Variations between methods

Most laboratories have reported results generated by atomic emission spectroscopy. With the exception of some results for manganese and sulfur, the figures lined up reasonably well against those derived from LECO or AES-ICP.

As mentioned above, some laboratories appeared to have been outside calibrated ranges (sulfur), or not cognisant of the potential interference between manganese and sulfur. Good basic laboratory practice would include running a certified reference material (CRM) or a sample of known composition and acceptable homogeneity at the same time as the analysis of unknowns. Participating laboratories now have an appropriate CRM.

Most of the measurement uncertainties (MU) appeared to be acceptable with the exception of the MU reported by laboratory code 4.

As stated, the sample used was unusually high in sulfur. For future programs involving a similar alloy, it is suggested that participating laboratories be informed of the approximate content of sulfur (and manganese) before commencing analysis.

This sample tested should have been within the scope of laboratories accredited in the field of Metals and Alloys - Iron and Steel. It was of concern that some laboratories reported results outside their calibrated ranges and/or did not allow for the inter-element effects described above. The small number of participants was also disappointing.

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 in Appendix A.

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 are listed in the following table:

TABLE B: SUMMARY OF STATISTICAL OUTLIERS

Test	Laboratory Code No.
Carbon	13
Manganese	8, 12
Phosphorus	-
Sulfur	8
Silicon	13, 14
Copper	n/a
Nickel	2
Chromium	13
Molybdenum	13
Cobalt	n/a
Vanadium	-

Note: Statistical analysis has not been performed for copper due to the results not being normally distributed or for cobalt due to the small number of results returned.

7. REFERENCE

- [1] *Guide to Proficiency Testing Australia*, 2012 (This document can be found on the PTA website, www.pta.asn.au)

APPENDIX A

Results and Data Analysis

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

Carbon (0.000%)

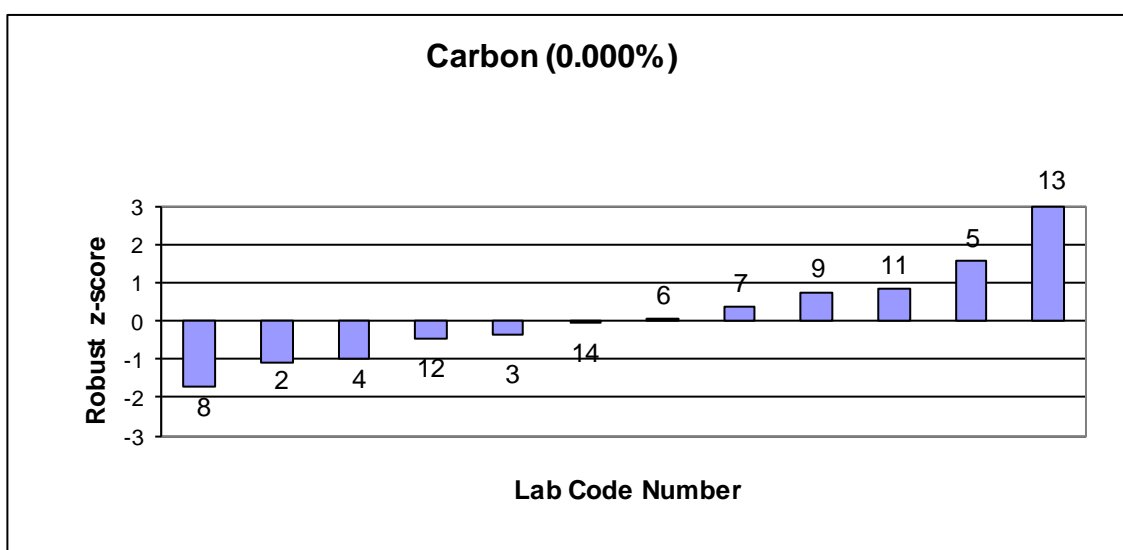
Lab Code	Result 1	Result 2	Average	MU	Robust Z-score	Technique
2	0.046	0.045	0.046	0.003	-1.08	1
3	0.045	0.055	0.050	0.006	-0.37	1
4	0.046	nr	0.046	0.072	-1.00	1
5	0.061	0.063	0.062	0.002	1.54	1
6	0.0523	0.0529	0.053	0.002	0.05	6
7	0.055	0.054	0.055	0.006	0.35	1
8	0.040	0.043	0.042	nr	-1.71	6
9	0.054	0.060	0.057	0.0097	0.75	1
11	0.057	0.058	0.058	nr	0.83	6
12	0.051	0.048	0.050	0.015	-0.44	1
13	0.080	0.083	0.082	0.003	4.63 §	1
14	0.052	0.052	0.052	0.002	-0.05	1

nr = no result

§ = an outlier result i.e. |z-score| ≥ 3.0

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

No. of Results	12
Median	0.0523
Norm IQR	0.0063
Uncertainty of the Median	0.0023
Robust CV	12.0%
Min	0.042
Max	0.082
Range	0.040



Manganese (0.000%)

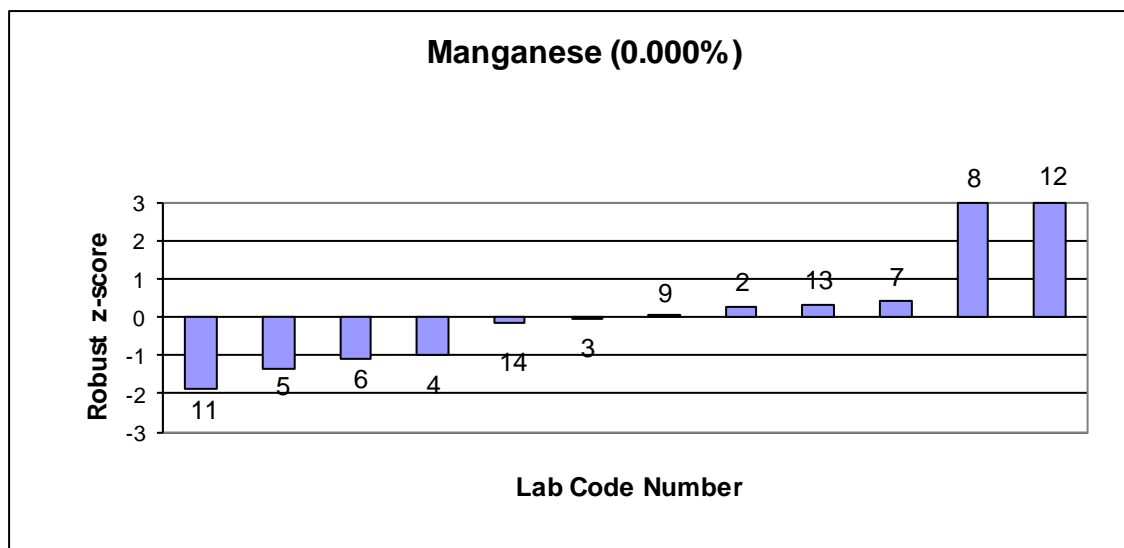
Lab Code	Result 1	Result 2	Average	MU	Robust Z-score	Technique
2	1.403	1.417	1.410	0.036	0.27	1
3	1.456	1.324	1.390	0.07	0.00	1
4	1.320	nr	1.320	0.05	-0.97	1
5	1.284	1.303	1.294	0.021	-1.34	1
6	1.314	1.310	1.312	0.05	-1.08	2
7	1.435	1.407	1.421	0.03	0.42	1
8	1.665	1.616	1.641	nr	3.45 §	6
9	1.385	1.396	1.391	0.014	0.00	1
11	1.262	1.243	1.253	nr	-1.90	2
12	1.670	1.649	1.660	0.032	3.72 §	1
13	1.429	1.399	1.414	0.029	0.33	1
14	1.370	1.390	1.380	0.018	-0.14	1

nr = no result

§ = 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 Emission Spectroscopy - Inductively Coupled Plasma)
 6 LECO

No. of Results	12
Median	1.3903
Norm IQR	0.0725
Uncertainty of the Median	0.0262
Robust CV	5.2%
Min	1.253
Max	1.660
Range	0.407



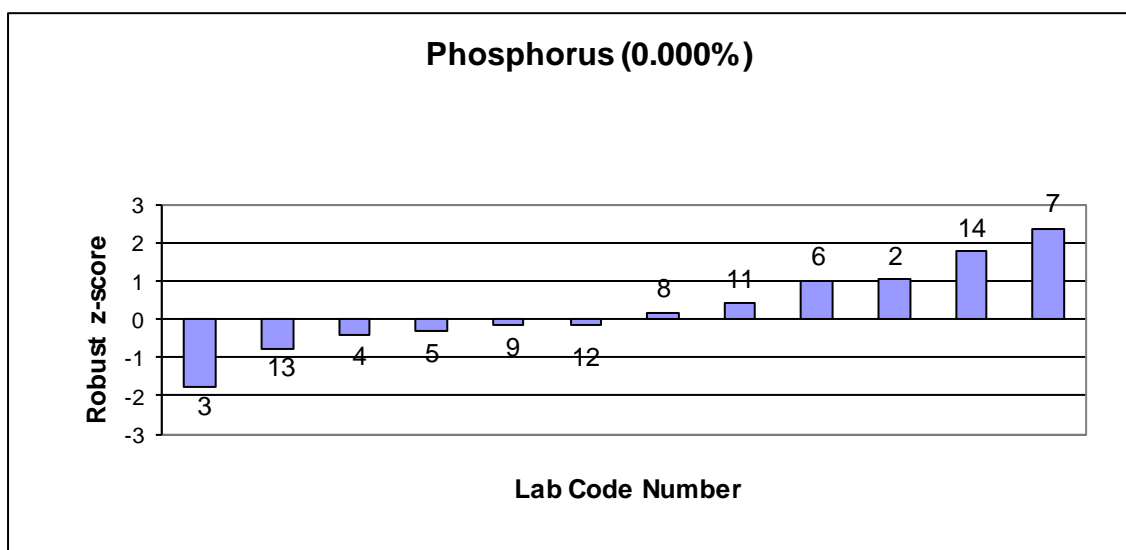
Phosphorus (0.000%)

Lab Code	Result 1	Result 2	Average	MU	Robust Z-score	Technique
2	0.062	0.068	0.065	0.005	1.03	1
3	0.052	0.055	0.054	0.003	-1.75	1
4	0.059	nr	0.059	0.506	-0.42	1
5	0.060	0.059	0.060	0.002	-0.30	1
6	0.0648	0.0651	0.065	0.005	1.01	5
7	0.071	0.070	0.071	0.006	2.35	1
8	0.062	0.061	0.062	nr	0.18	6
9	0.060	0.060	0.060	0.001	-0.18	1
11	0.065	0.060	0.063	nr	0.42	2
12	0.060	0.060	0.060	0.002	-0.18	1
13	0.056	0.059	0.058	0.004	-0.78	1
14	0.070	0.066	0.068	0.003	1.75	1

nr = no result

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

No. of Results	12
Median	0.0608
Norm IQR	0.0041
Uncertainty of the Median	0.0015
Robust CV	6.8%
Min	0.054
Max	0.071
Range	0.017



Sulfur (0.000%)

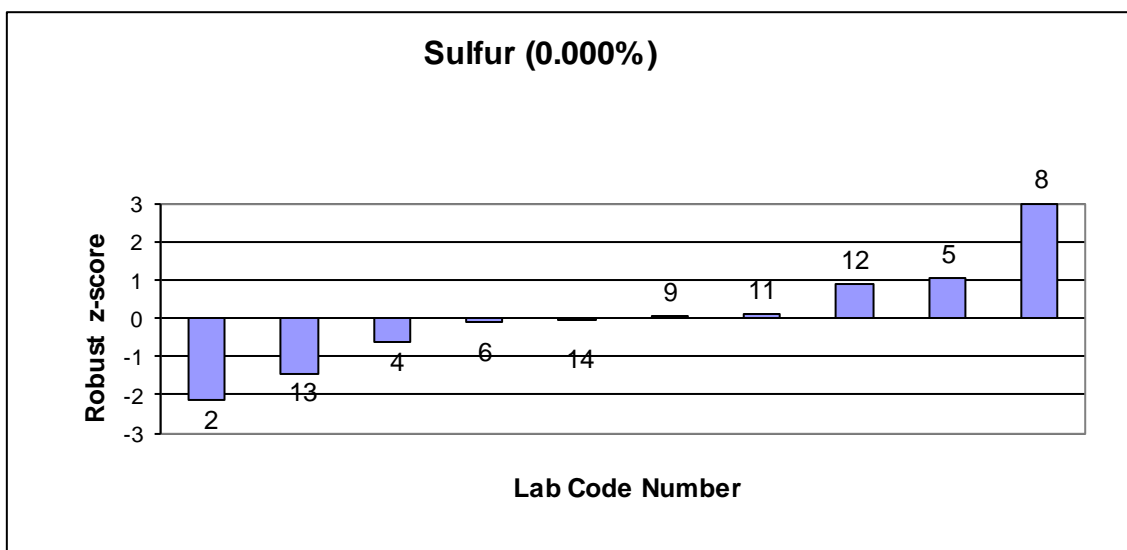
Lab Code	Result 1	Result 2	Average	MU	Robust Z-score	Technique
2	0.145	0.146	0.146	0.009	-2.15	1
4	0.313	nr	0.313	0.215	-0.61	1
5	0.490	0.497	0.494	0.039	1.04	1
6	0.371	0.370	0.371	0.01	-0.09	6
8	0.885	nr	0.885	nr	4.62 §	6
9	0.383	0.386	0.385	0.004	0.04	6
11	0.389	0.393	0.391	nr	0.10	6
12	0.479	0.475	0.477	0.006	0.89	1
13	0.232	0.212	0.222	0.020	-1.45	1
14	0.374	0.377	0.376	0.002	-0.04	6

nr = no result

§ = an outlier result i.e. |z-score| ≥ 3.0

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

No. of Results	10
Median	0.3800
Norm IQR	0.1093
Uncertainty of the Median	0.0433
Robust CV	28.8%
Min	0.146
Max	0.885
Range	0.740



Silicon (0.000%)

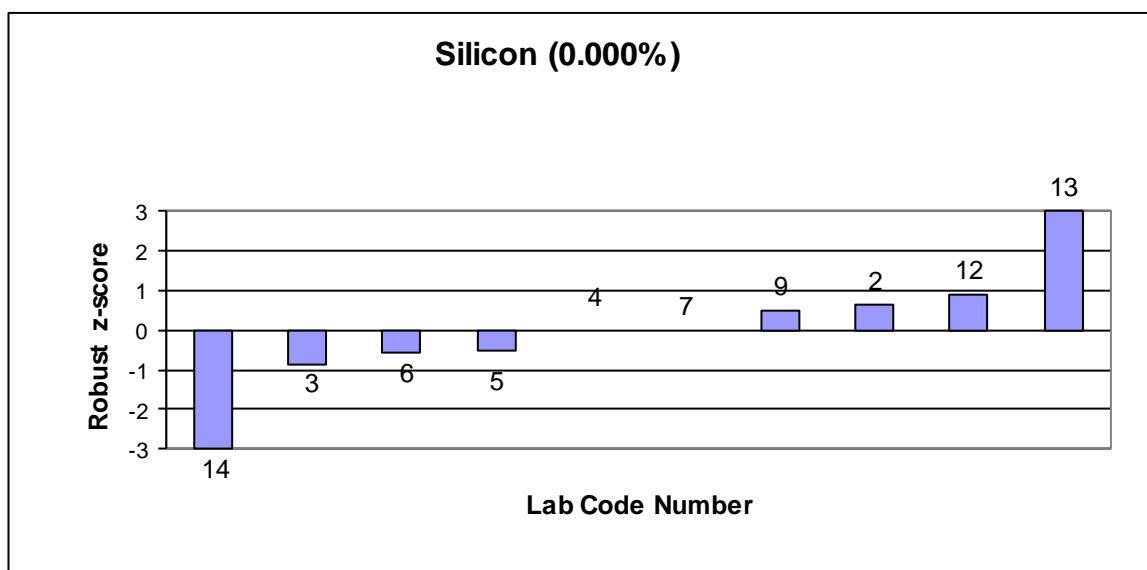
Lab Code	Result 1	Result 2	Average	MU	Robust Z-score	Technique
2	0.025	0.028	0.027	0.003	0.64	1
3	0.018	0.023	0.021	0.003	-0.89	1
4	0.024	nr	0.024	0.025	0.00	1
5	0.022	0.022	0.022	0.001	-0.51	1
6	0.0219	0.0215	0.022	0.005	-0.59	2
7	0.024	0.024	0.024	0.002	0.00	1
9	0.026	0.026	0.026	0.0002	0.51	1
12	0.028	0.027	0.028	0.018	0.89	1
13	0.038	0.036	0.037	0.003	3.31 §	1
14	0.010	0.010	0.010	0.0006	-3.57 §	1

nr = no result

§ = an outlier result i.e. |z-score| ≥ 3.0

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

No. of Results	10
Median	0.0240
Norm IQR	0.0039
Uncertainty of the Median	0.0016
Robust CV	16.4%
Min	0.010
Max	0.037
Range	0.027



Copper (0.000%)

Lab Code	Result 1	Result 2	Average	MU	Technique
2	0.038	0.035	0.037	0.004	1
3	0.041	0.033	0.037	0.008	1
4	0.045	nr	0.045	0.029	1
5	0.045	0.046	0.046	0.001	1
6	0.0416	0.0419	0.042	0.005	2
7	0.044	0.043	0.044	0.002	1
8	0.037	0.035	0.036	nr	nr
9	0.038	0.038	0.038	0.0003	1
11	0.044	0.044	0.044	nr	nr
12	0.043	0.043	0.043	0.003	1
13	0.024	0.010	0.017	0.014	1
14	0.044	0.045	0.045	0.0006	1

nr = no result

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

Note: The above results are provided for information purposes only. The results were not normally distributed and therefore no statistical analysis could be performed.

Nickel (0.000%)

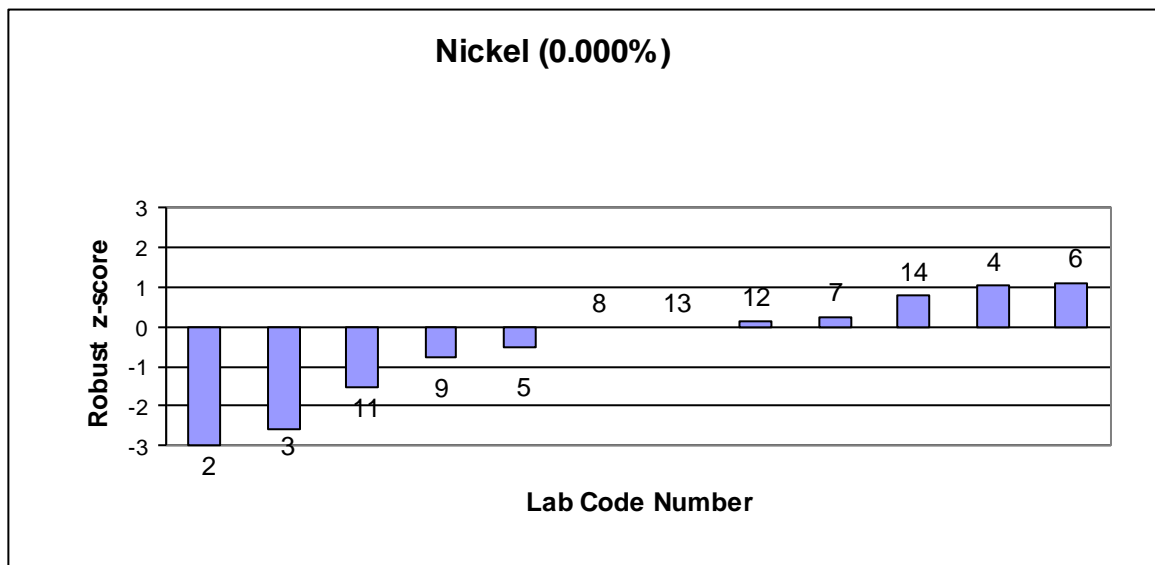
Lab Code	Result 1	Result 2	Average	MU	Robust Z-score	Technique
2	0.021	0.021	0.021	0.002	-3.60 §	1
3	0.018	0.032	0.025	0.012	-2.57	1
4	0.039	nr	0.039	0.035	1.03	1
5	0.033	0.033	0.033	0.001	-0.51	1
6	0.0392	0.0391	0.039	0.005	1.07	2
7	0.036	0.036	0.036	0.003	0.26	1
8	0.035	0.035	0.035	nr	0.00	6
9	0.032	0.032	0.032	0.0005	-0.77	1
11	0.029	0.029	0.029	nr	-1.54	2
12	0.036	0.035	0.036	0.006	0.13	1
13	0.036	0.034	0.035	0.002	0.00	1
14	0.038	0.038	0.038	0.0003	0.77	1

nr = no result

§ = an outlier result i.e. |z-score| ≥ 3.0

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

No. of Results	12
Median	0.0350
Norm IQR	0.0039
Uncertainty of the Median	0.0014
Robust CV	11.1%
Min	0.021
Max	0.039
Range	0.018



Chromium (0.000%)

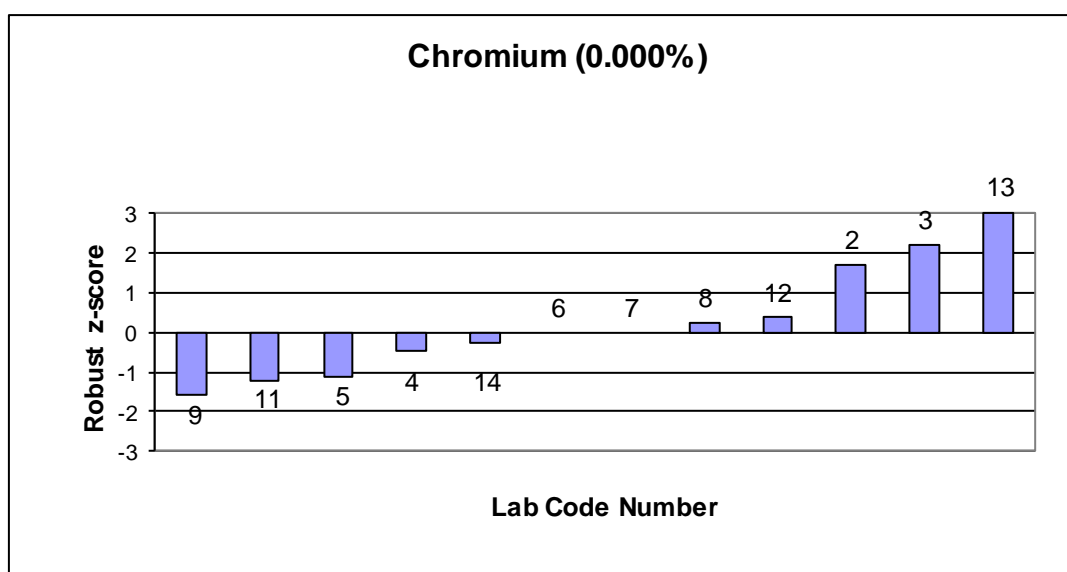
Lab Code	Result 1	Result 2	Average	MU	Robust Z-score	Technique
2	0.036	0.036	0.036	0.001	1.72	1
3	0.038	0.038	0.038	0.001	2.21	1
4	0.027	nr	0.027	0.045	-0.49	1
5	0.025	0.024	0.025	0.001	-1.10	1
6	0.0293	0.0287	0.029	0.005	0.00	2
7	0.030	0.028	0.029	0.003	0.00	1
8	0.032	0.028	0.030	nr	0.25	6
9	0.022	0.023	0.023	0.0003	-1.59	1
11	0.024	0.024	0.024	nr	-1.23	2
12	0.031	0.030	0.031	0.004	0.37	1
13	0.169	0.164	0.167	0.005	33.72 §	1
14	0.028	0.028	0.028	0.0002	-0.25	1

nr = no result

§ = 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 Emission Spectroscopy - Inductively Coupled Plasma)
 6 Other

No. of Results	12
Median	0.0290
Norm IQR	0.0041
Uncertainty of the Median	0.0015
Robust CV	14.1%
Min	0.023
Max	0.167
Range	0.144



Molybdenum (0.000%)

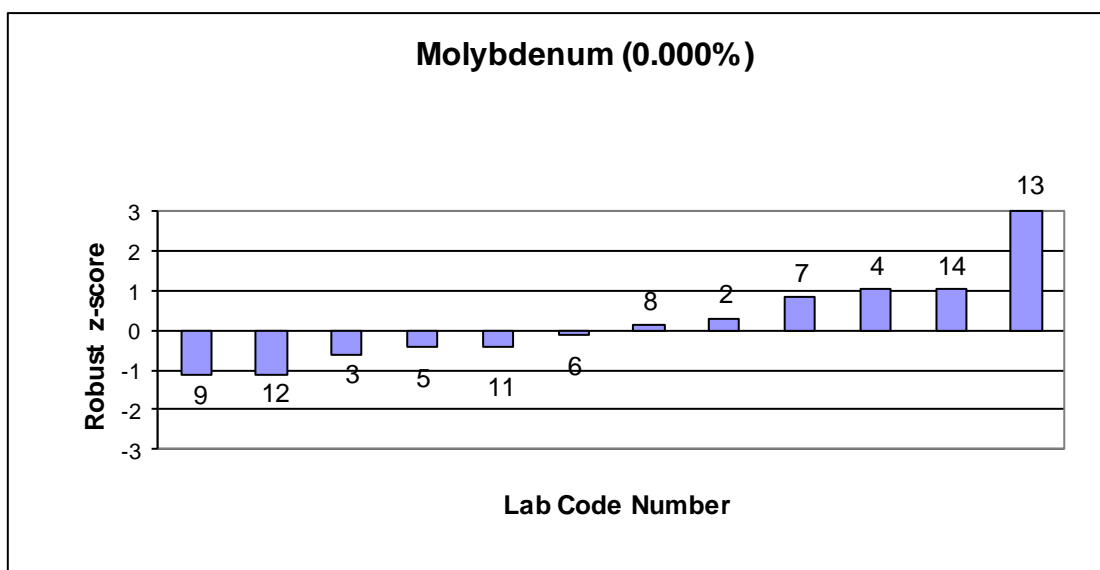
Lab Code	Result 1	Result 2	Average	MU	Robust Z-score	Technique
2	0.010	0.010	0.010	0.001	0.30	1
3	0.008	0.007	0.008	0.002	-0.60	1
4	0.012	nr	0.012	0.022	1.02	1
5	0.008	0.008	0.008	0.0000	-0.42	1
6	0.0087	0.0090	0.009	0.001	-0.12	2
7	0.012	0.011	0.012	0.002	0.84	1
8	0.011	0.008	0.010	nr	0.12	6
9	0.006	0.006	0.006	0.0003	-1.14	1
11	0.008	0.008	0.008	nr	-0.42	2
12	0.006	0.006	0.006	0.002	-1.14	1
13	0.025	0.025	0.025	0	5.69 §	1
14	0.011	0.013	0.012	0.0002	1.02	1

nr = no result

§ = 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 Emission Spectroscopy - Inductively Coupled Plasma)
 6 Other

No. of Results	12
Median	0.0092
Norm IQR	0.0028
Uncertainty of the Median	0.0010
Robust CV	30.3%
Min	0.006
Max	0.025
Range	0.019



Cobalt (0.000%)

Lab Code	Result 1	Result 2	Average	MU	Technique
2	0.003	0.003	0.003	0.005	1
4	0.005	nr	0.005	0.08	1
6	0.0036	0.0035	0.004	0.001	2
14	0.004	0.004	0.004	0.0001	1

nr = no result

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

Note: Statistical analysis has not been performed due to the small number of results returned.

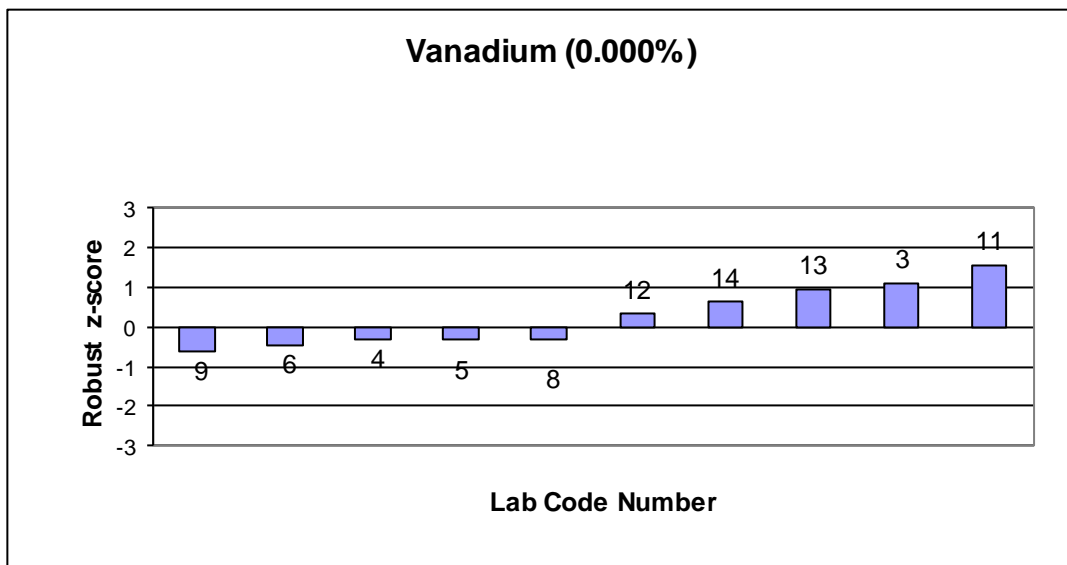
Vanadium (0.000%)

Lab Code	Result 1	Result 2	Average	MU	Robust Z-score	Technique
3	0.007	0.006	0.007	0.001	1.09	1
4	0.002	nr	0.002	0.25	-0.31	1
5	0.002	0.002	0.002	0.000	-0.31	1
6	0.0014	0.0015	0.001	0.001	-0.48	2
8	0.002	0.002	0.002	nr	-0.31	6
9	0.001	0.001	0.001	0.001	-0.63	1
11	0.008	0.008	0.008	nr	1.56	2
12	0.004	0.004	0.004	0.003	0.31	1
13	0.005	0.007	0.006	0.002	0.94	1
14	0.004	0.006	0.005	0.0001	0.63	1

nr = no result

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

No. of Results	10
Median	0.0030
Norm IQR	0.0032
Uncertainty of the Median	0.0013
Robust CV	106.7%
Min	0.001
Max	0.008
Range	0.007



APPENDIX B

Homogeneity and Stability Testing

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

Sample Preparation and Homogeneity Testing

The samples were supplied by Universal Scientific Laboratory Pty Ltd.

Ten discs were selected and tested for each element and the results are shown in the following tables:

Sample	Carbon	Sulfur	Phosphorus	Silicon	Manganese	Chromium
1	0.0522	0.366	0.0481	0.0208	1.31	0.0289
2	0.0522	0.370	0.0499	0.0208	1.30	0.0297
3	0.0526	0.371	0.0500	0.0199	1.32	0.0297
4	0.0528	0.374	0.0500	0.0201	1.32	0.0300
5	0.0524	0.372	0.0502	0.0199	1.32	0.0288
6	0.0521	0.371	0.0500	0.0215	1.32	0.0289
7	0.0529	0.374	0.0509	0.0216	1.33	0.0297
8	0.0526	0.375	0.0481	0.0216	1.30	0.0289
9	0.0521	0.371	0.0499	0.0197	1.29	0.0295
10	0.0531	0.374	0.0502	0.0199	1.32	0.0287
Average	0.0525	0.372	0.0496	0.0206	1.313	0.0293
SD	0.0004	0.0027	0.0008	0.0008	0.0125	0.0005
CV	0.68	0.71	1.65	3.77	0.95	1.65

Sample	Nickel	Copper	Molybdenum	Vanadium	Cobalt
1	0.0319	0.0386	0.0091	0.0014	0.0039
2	0.0316	0.0383	0.0087	0.0014	0.0038
3	0.0315	0.0377	0.0089	0.0013	0.0038
4	0.0316	0.0374	0.0088	0.0014	0.0038
5	0.0320	0.0382	0.0092	0.0014	0.0038
6	0.0320	0.0377	0.0092	0.0014	0.0038
7	0.0317	0.0375	0.0090	0.0014	0.0038
8	0.0318	0.0381	0.0092	0.0014	0.0039
9	0.0320	0.0315	0.0090	0.0013	0.0038
10	0.0320	0.0383	0.0091	0.0014	0.0038
Average	0.0318	0.0379	0.0090	0.0014	0.0038
SD	0.0002	0.0004	0.0002	0.0000	0.0000
CV	0.62	1.10	1.94	3.06	1.10

Analysis of this data indicated that the samples were sufficiently homogeneous 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.....	C3



Proficiency Testing Australia

Proficiency Testing Program

Metal Alloys (Round 25) – October 2013

INSTRUCTIONS TO PARTICIPANTS

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

1. For this round each participant will be supplied with one stainless 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 to return their results by **Friday 22nd November 2013** to:

C2

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 25) – October 2013

RESULTS SHEET

Date sample was received: _____

Lab Code:

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

Signed: _____

Date: _____

Please return no later than **Friday 22nd November 2013** to:
 Karen Cividin
 Proficiency Testing Australia
 PO Box 7507, Silverwater NSW 2128
 phone: +61 2 9736 8295, fax: +61 9743 6664

- End of Report -