APLAC T067

CHEMICAL ANALYSIS OF THE COMPONENTS IN STAINLESS STEEL PROFICIENCY TESTING SCHEME

Final Report

August, 2009

Contents

Summary of results

1. This report summarizes the results for the APLAC T067 proficiency testing scheme on the determination of the components in stainless steel. This scheme covered a series of tests on stainless steel.

2. A total of 70 laboratories from 33 different economies participated in the proficiency testing scheme. 67 laboratories submitted their results in time, thus were included in the statistical analysis.

3. Assigned value and standard deviation are determined by robust analysis according to ISO 13528:2005. The z-score is used as the numerical indicator to assess individual participant's performance in the scheme.

4. Results of participants are summarized as follows:

Performance Achieved	**Number of Participants (Percentage)**							
	C	**Si**	**Mn**	**P**	**S**	**Cr**	**Ni**	**Ti**
$\lvert z \rvert \leqslant 2$	60 (91%)	55 (86%)	60 (91%)	50 (79%)	57 (89%)	52 (80%)	59 (91%)	49 (83%)
$2 < \lvert z \rvert < 3$	4 (6%)	3 (5%)	4 (6%)	1 (2%)	4 (6%)	6 (9%)	1 (2%)	4 (7%)
$\lvert z \rvert \geqslant 3$	2 (3%)	6 (9%)	2 (3%)	12 (19%)	3 (5%)	7 (11%)	5 (8%)	6 (10%)
Total	66 (100%)	64 (100%)	66 (100%)	63 (100%)	64 (100%)	65 (100%)	65 (100%)	59 (100%)

1. Introduction

1.1 This report summarizes the results for the APLAC T067 proficiency testing scheme on the determination of the components in stainless steel. The scheme was organized by the China National Accreditation Service for Conformity Assessment (CNAS) in collaboration with the China NIL Research Centre for Proficiency Testing, under the auspices of Asia-Pacific Laboratory Accreditation Cooperation (APLAC).

1.2 Stainless steels are one of the common materials in metallurgy, machinery, railway, aviation and other fields. The elements such as carbon, silicon, manganese, phosphorus, sulphur, chromium, nickel and titanium in stainless steel are routine analysis items for most laboratories. This scheme covered the analysis of 8 elements mentioned above.

1.3 A total of 70 laboratories participated in the proficiency testing scheme. 67 laboratories submitted their results in time. Lab 16 and Lab 69 failed to submit their results. Lab 36 submitted their results 24 days later than the deadline, thus their results were not included in the statistical analysis.

1.4 Each participant was confidentially assigned with a unique laboratory code which is used throughout the scheme.

2. Objectives

2.1 The main objective of the scheme was to evaluate the performance of participating laboratories in the analysis for the content of C, Si, Mn, P, S, Cr, Ni, Ti by means of inter-laboratory comparison.

2.2 Test results from participants are evaluated according to the statistical techniques outlined in ISO 13528:2005 “Statistical methods for use in proficiency testing by interlaboratory comparisons”. The z-score is used as a numerical indicator to assess individual participant’s performance in the scheme.

3. Test Material

3.1 Sample preparation: Samples discs of 36mm diameter and 12mm thickness were used in this proficiency testing scheme.

3.2 Prior to the distribution of the samples, 10 discs of samples were tested by spark discharge atomic emission spectrometry for all the 8 elements in repeatability condition. 10 samples were selected from the parts of top, tail and equally divided points of mother bar length. The homogeneity testing report indicated that the prepared samples were of good homogeneity, thus ensured that any deviation occurred in the proficiency testing scheme was not due to the difference between samples. (APPENDIX I)

3.3 Laboratories were requested to perform the test according to the "INSTRUCTION" and to record their results on the "RESULTS SHEET", both of which were distributed to participants with the samples in December, 2008. (APPENDIX IV & V)

3.4 All AB were requested to read the "Instructions to Accreditation Bodies" and to redirect the sample(s) and the attached documents to their nominated laboratories as soon as possible.

4. Test Required

4.1 Participants were required to determine the content of C, Si, Mn, P, S, Cr, Ni, Ti in the test sample according to their preferable test methods (could be accredited, in-house, modified, etc.), which were normally implemented to test their customer samples. However, it was strongly suggested to implement the international or national consensus standards. It was requested that a copy of the full text of analysis method (except ISO Standard) be provided to NIL for technical comments in the Final Report.

4.2 Participants were asked to report results according to the Instructions. The significant digits recommended are as follows: XX.XX%, X.XX%, 0.XXX%, 0.0XXX%.

5. Statistical Evaluation

5.1 Participants' test results

Test results received from participants are presented in Table II to IX.

5.2 Performance evaluation

5.2.1 According to Algorithm A in Annex C of ISO 13528:2005, the data are sorted into ascending order, by:

$x_1, x_2, \ldots, x_i, \ldots x_p$

Denote the robust average and robust standard deviation of these data by x* and s*.

Calculate the initial values for x* and s* as:

x*= median of x_i (i=1, 2, …p)

s*= 1.483 median of $|x_i - x^*|$ (i=1, 2, …p)

Update the values of x* and s* as follows. Calculate:

$\delta = 1.5\ s^*$

For each x_i (i=1, 2, …p), calculate:

$$x_i^* = \begin{cases} x^* - \delta, & \text{if } x_i < x^* - \delta \\ x^* + \delta, & \text{if } x_i > x^* + \delta \\ x_i, & otherwise \end{cases}$$

Calculate the new values of x* and s* from:

$$x_i^* = \sum x_i^* \Big/ p$$

$$s^* = 1.134 \sqrt{\sum (x_i^* - x^*)^2 / (p-1)}$$

where the summation is over i.

The robust estimates x* and s* are derived by an iterative calculation, i.e. by updating the values of x* and s* several times using the modified data, until the process converges. Convergence is assumed when there is no change from one iteration to the next in the significant figure of the robust standard deviation and the robust average specified in the Instructions for laboratories.

When the assigned valued is derived as a robust average, the standard uncertainty of the assigned value X is estimated as:

$u_X = 1.25 \times s^* / \sqrt{p}$

where s^* is the robust standard deviation;

p is the number of results.

When the confidence level is 95%, and the coverage factor k=2, the expanded uncertainty is calculated as $U=2u_X$.

5.2.2 Performance of each participant was evaluated by means of a performance index, z-score, which is calculated as:

$$z = \frac{x_i - X}{s}$$

Where x_i is the reported mean of individual participant;

X is the assigned value from robust average according to ISO 13528:2005;

s is the standard deviation from robust standard deviation according to ISO 13528:2005.

5.2.3 The z-score is normally interpreted as follows:

$|z| \leqslant 2$ Satisfactory

$2 < |z| < 3$ Questionable

$|z| \geqslant 3$ Unsatisfactory

5.2.4 Participants with $|z| \geq 3$ should thoroughly investigate their results and report to their AB. Participants with a z-score in the range $2 < |z| < 3$ are encouraged to review their results.

5.2.5 Graphical Displays: In addition to tables of the results and z-score, and summary statistics, the ordered z-score histograms are included in the report. On these charts each laboratory's z-score is shown in order of magnitude, and marked with its code number of the lab. From these charts each laboratory can readily compare its performance relative to the other laboratories.

6. Results

6.1 An interim report was issued to participants in early May 2009. Participants were requested to check the correctness of their submitted data and to inform the organizer of any mistakes found before May 15, 2009. No correction was made in this scheme and the results in the interim report for all laboratories remain unchanged in this report.

6.2 Summary of laboratories with satisfactory, questionable and unsatisfactory results

Result	Lab code	Sum	Percentage（%）
Labs with all results of $\|z\| \leqslant 2$	01,02,03,05,06,08,11, 12,13,14,15,20,21,22, 24,28,30,37,39,40,41, 45,46,49,51,52,53,55, 57,60,62,65,67,68	34	50.7
Labs with results of $2 < \|z\| < 3$	26,29,31,38, 44,47,61	7	10.4
Labs with result of $\|z\| \geqslant 3$	04,07,09,10,17,18,19, 23,25,27,32,33,34,35, 42,43,48,50,54,56,58, 59,63,64,66,70	26	38.8

6.3 Summary statistics of z-score

Lab code	z-score								Questionable	Unsatisfactory
	C	Si	Mn	P	S	Cr	Ni	Ti		
1	0.75	0.50	1.00	-0.50	0.00	-0.83	1.08	/	0	0
2	0.25	-0.31	0.67	0.50	0.50	0.83	1.23	0.11	0	0
3	0.25	0.75	0.67	0.00	0.50	0.25	0.23	-0.05	0	0
4	0.00	-0.69	-1.33	6.00§	-2.00	1.08	1.77	/	0	1
5	-1.00	-0.56	0.00	0.00	-1.50	-0.58	0.15	-1.95	0	0
6	0.75	0.06	-1.00	-0.50	-1.00	0.83	-0.62	-0.47	0	0
7	-2.25#	-3.06§	-1.00	-3.50§	2.50#	0.25	-0.23	4.37§	2	3
8	0.25	1.31	0.33	0.50	-0.50	0.92	0.23	0.32	0	0
9	1.00	-1.38	0.00	0.00	-0.50	6.83§	-1.31	0.84	0	1
10	0.25	-5.25§	1.00	0.00	0.00	-0.08	0.85	0.37	0	1
11	0.25	-0.88	0.00	0.00	0.50	-0.17	0.38	-0.21	0	0
12	-1.00	1.25	1.00	0.00	0.00	0.00	0.08	0.26	0	0
13	0.75	0.44	0.33	0.50	-0.50	0.00	0.38	0.11	0	0
14	-0.75	-0.06	0.33	0.50	-0.50	0.08	0.77	0.53	0	0
15	/	/	0.00	/	/	/	/	0.68	0	0
17	-0.75	-0.25	0.67	0.00	1.00	8.08§	-0.31	-0.11	0	1
18	-0.25	0.81	-2.67#	/	/	-0.50	-0.69	-3.32§	1	1
19	0.25	-1.50	-2.00	-3.50§	-1.00	-13.25§	-0.31	-2.05#	1	2
20	-2.00	0.69	-1.00	-2.00	1.00	0.00	-1.08	-0.68	0	0
21	-0.50	0.06	-0.67	0.50	-1.50	1.08	0.77	1.74	0	0
22	-0.75	-0.31	1.00	1.50	1.50	-0.17	0.62	-0.84	0	0
23	0.50	8.00§	2.00	-1.00	0.50	12.67§	7.23§	0.63	0	3
24	-0.50	-1.69	-0.33	-0.50	-1.00	-1.17	0.00	0.89	0	0
25	0.25	0.19	-0.67	1.50	-0.50	-3.33§	-0.85	0.42	0	1
26	1.00	0.38	-0.33	2.50#	-0.50	-1.75	-0.38	/	1	0
27	0.50	-7.56§	-5.33§	0.00	0.50	-1.58	-7.00§	-6.05§	0	4
28	-1.25	0.38	-1.00	-1.00	0.00	-0.33	-0.54	0.63	0	0
29	0.50	2.13#	0.67	0.50	0.00	-0.58	-1.00	-0.63	1	0
30	0.50	0.13	1.00	0.50	1.00	0.08	0.08	0.58	0	0
31	-0.25	2.31#	1.33	0.50	-1.00	1.25	0.46	-2.05#	2	0
32	1.00	-1.81	1.33	3.00§	4.00§	-3.92§	-9.08§	13.32§	0	5
33	2.50#	-0.75	-1.67	3.50§	4.50§	2.33#	-2.31#	0.53	3	2
34	-3.25§	-1.44	-0.33	0.50	-1.00	-0.58	-1.46	1.05	0	1
35	-1.00	0.06	2.67#	5.00§	3.00§	1.08	-0.62	-1.95	1	2
37	0.50	-0.06	-0.33	-1.00	-0.50	-0.25	0.46	0.00	0	0

(Cont'd)

Lab code	z-score								Questionable	Unsatisfactory
	C	Si	Mn	P	S	Cr	Ni	Ti		
38	1.25	0.00	-1.00	0.50	2.50#	-0.33	-0.85	-1.58	1	0
39	0.75	0.38	0.00	-1.50	-1.50	-0.75	0.31	0.68	0	0
40	-0.25	-0.13	0.00	0.50	-1.00	0.33	0.46	0.26	0	0
41	0.25	-0.50	-0.67	-0.50	0.50	-0.17	0.08	0.26	0	0
42	0.25	0.06	-0.33	-3.50§	0.50	0.33	1.69	-1.79	0	1
43	1.50	0.19	-0.67	-3.50§	-0.50	-2.83#	1.08	0.00	1	1
44	2.25#	-0.13	-1.33	0.00	0.50	1.33	0.69	-0.95	1	0
45	-0.25	-0.63	-0.33	1.00	0.00	1.67	-0.46	0.00	0	0
46	0.50	0.25	0.00	1.50	0.50	-0.42	0.92	0.16	0	0
47	-0.75	2.38#	0.00	-1.50	0.00	0.00	-0.23	/	1	0
48	0.50	0.50	-1.00	-3.50§	0.00	0.67	0.38	/	0	1
49	-0.50	0.06	-0.33	-0.50	-0.50	-0.42	0.54	0.68	0	0
50	-1.25	1.69	2.67#	4.00§	1.50	0.33	-0.38	-0.95	1	1
51	-0.25	0.44	-2.00	1.00	0.00	-0.42	1.31	/	0	0
52	-0.25	-0.13	0.33	-0.50	0.50	0.00	-0.77	0.37	0	0
53	-1.00	1.31	-1.00	0.50	-1.00	0.67	-0.15	-1.95	0	0
54	-1.25	-1.63	0.67	-0.50	-1.00	2.33#	-4.31§	0.00	1	1
55	0.75	0.50	1.33	-0.50	-0.50	0.50	-0.62	-1.89	0	0
56	0.75	0.88	1.33	-3.50§	0.50	0.58	-1.69	-2.63#	1	1
57	-0.50	0.69	-0.33	-1.00	1.50	-0.50	1.08	0.16	0	0
58	0.50	0.25	0.33	0.50	0.50	1.67	0.54	-5.63§	0	1
59	-2.25#	-3.69§	2.33#	-1.00	-1.00	5.17§	-0.54	-2.74#	3	2
60	-0.50	/	/	/	0.50	/	/	/	0	0
61	0.25	-2.00	1.33	0.50	0.50	-2.33#	-0.54	-0.74	1	0
62	-0.75	-0.25	0.33	1.00	0.00	0.17	0.23	0.32	0	0
63	0.25	3.81§	-0.33	-4.00§	-1.50	-2.58#	1.62	0.16	1	2
64	-0.50	1.81	0.00	1.00	-2.50#	-0.42	-5.62§	1.05	1	1
65	-0.75	-1.13	0.33	-1.00	-0.50	0.58	-1.38	0.47	0	0
66	1.75	0.00	0.33	0.00	2.50#	0.00	0.69	5.68§	1	1
67	0.75	0.81	-0.67	0.50	0.00	-0.17	0.77	1.21	0	0
68	-0.50	-1.00	-0.67	0.50	-1.50	-0.92	-0.69	1.89	0	0
70	6.50§	/	-3.33§	/	/	-2.58#	0.69	/	1	2
Questionable	**4**	**3**	**4**	**1**	**4**	**6**	**1**	**4**	**27**	**-**
Unsatisfactory	**2**	**6**	**2**	**12**	**3**	**7**	**5**	**6**	**-**	**43**

Note: The value marked with '§' is unsatisfactory, which is of $|z| \geq 3$;

The value marked with '#' is questionable , which is of $2 < |z| < 3$.

6.4 Assigned values and its standard uncertainty

Elements	C	Si	Mn	P	S	Cr	Ni	Ti
Assigned value (%)	0.069	0.619	1.19	0.027	0.015	17.87	8.78	0.397
Standard deviation	0.004	0.016	0.03	0.002	0.002	0.12	0.13	0.019
Standard uncertainty	0.001	0.003	0.01	0.001	0.001	0.02	0.02	0.003
No. of labs	66	64	66	63	64	65	65	59

6.5 Summary of the methods used for each element

Element	Analytical Method	No. of labs	Method Code
C	Combustion-infrared Absorption Method	20	C-1
	Gas-volumetric Method	1	C-2
	Optical Emission Spectrometric Method	45	C-3
Si	Gravimetry Method	5	Si-1
	ICP-AES Method	5	Si-2
	Spectrophotometric Method	3	Si-3
	Optical Emission Spectrometric Method	46	Si-4
	Atomic Absorption Spectroscopic Method	2	Si-5
	X-ray Fluorescence Method	3	Si-6
Mn	Atomic Absorption Spectroscopic Method	6	Mn-1
	ICP-AES Method	9	Mn-2
	Spectrophotometric Method	1	Mn-3
	Optical Emission Spectrometric Method	46	Mn-4
	X-ray Fluorescence Method	4	Mn-5
P	Spectrophotometric Method	7	P-1
	Optical Emission Spectrometric Method	45	P-2
	ICP-AES Method	6	P-3
	X-ray Fluorescence Method	4	P-4
	Titration Method	1	P-5
S	Combustion-infrared Absorption Method	18	S-1
	Gas-volumetric Method	3	S-2
	Optical Emission Spectrometric Method	43	S-3

(Cont'd)

Cr	Atomic Absorption Spectroscopic Method	3	Cr-1
	ICP-AES Method	5	Cr-2
	Titration Method	6	Cr-3
	Optical Emission Spectrometric Method	48	Cr-4
	X-ray Fluorescence Method	3	Cr-5
Ni	Atomic Absorption Spectroscopic Method	3	Ni-1
	ICP-AES Method	5	Ni-2
	Gravimetric Method	5	Ni-3
	Optical Emission Spectrometric Method	48	Ni-4
	X-ray Fluorescence Method	3	Ni-5
	Titration Method	1	NI-6
Ti	ICP-AES Method	9	Ti-1
	Spectrophotometric Method	1	Ti-2
	Optical Emission Spectrometric Method	43	Ti-3
	X-ray Fluorescence Method	3	Ti-4
	Atomic Absorption Spectroscopic Method	3	Ti-5

6.6 Comparisons for the robust averages calculated from the different methods between corresponding assigned values

Element	Methods Code	No. of labs	Robust Average %	Robust Standard Deviation	Assigned value %	Standard Deviation
C	Inf (C-1)	20	0.070	0.003	0.069	0.004
	OES(C-3)	45	0.069	0.004		
Si	OES(Si-4)	46	0.621	0.015	0.619	0.016
Mn	ICP-AES(Mn-2)	9	1.21	0.03	1.19	0.03
	OES(Mn-4)	46	1.19	0.03		
P	OES(P-2)	45	0.027	0.003	0.027	0.002
S	Inf(S-1)	18	0.015	0.001	0.015	0.002
	OES(S-3)	43	0.015	0.003		
Cr	OES(Cr-4)	48	17.87	0.11	17.87	0.12
Ni	OES(Ni-4)	48	8.76	0.12	8.78	0.13
Ti	ICP-AES(Ti-1)	9	0.397	0.012	0.397	0.019
	OES(Ti-3)	43	0.394	0.024		

7. Comments

7.1 AAS and ICP-AES method are suitable for testing Cr and Ni of lower content but maybe not for higher content. In this scheme, when the two methods are adopted to test Cr and Ni, relatively big errors may come into being.

7.2 It is shown in 6.6 that for each element, the robust average and robust standard deviation calculated from the different method were fairly consistent with the corresponding assigned value and standard deviation.

7.3 The requirements on the evaluation of measurement uncertainty were specified in the ISO/IEC 17025 for testing and calibration laboratories. In this scheme, 49 laboratories have submitted data of expanded uncertainty. whether expanded uncertainty U or a standard uncertainty u is given in the GUM and EURACHEM / CITAC Guide CG 4 Quantifying Uncertainty in Analytical Measurement, in which it is seldom necessary to give more than two significant digits for the uncertainty and results should be rounded to be consistent with the uncertainty given. In this scheme, there are only 9 of 49 participants (accounting for 18.37%) reported correct number of significant digits. A few participants reported expanded uncertainty as 0, which is invalid. The uncertainty evaluation methods must be in conformity with GUM and EURACHEM / CITAC Guide CG 4 so that a valid and suitable evaluation can be made. This will contribute to the further enhancement of the test level of the laboratories.

8. Remarks

Efforts and supports from all AB and participants to this scheme are gratefully noted. Participants are welcome to forward any comments on this PT to the following information:

Prof. Wang Haizhou,

President of China NIL Research Center for Proficiency Testing

Address: China NIL Research Center for Proficiency Testing

Box 14, No. 76 Xueyuan South Road, Beijing 100081, P. R. China

Tel: +86 10 62185713

Fax : +86 10 62181163

E-mail: nil@analysis.org.cn

9. References

[1] ISO/IEC GUIDE 43-1:1997, “Proficiency testing by interlaboratory comparisons – Part 1: Development and operation of proficiency testing schemes”.

[2] ISO 13528:2005, “Statistical methods for use in proficiency testing by interlaboratory comparisons”.

[3] ISO-Guide to the Expression of Uncertainty in Measurement.

[4] EURACHEM/CITAC Guide CG 4, “Quantifying Uncertainty in Analytical Measurement”.

Results of C

Table I Results and Statistical Analysis for C

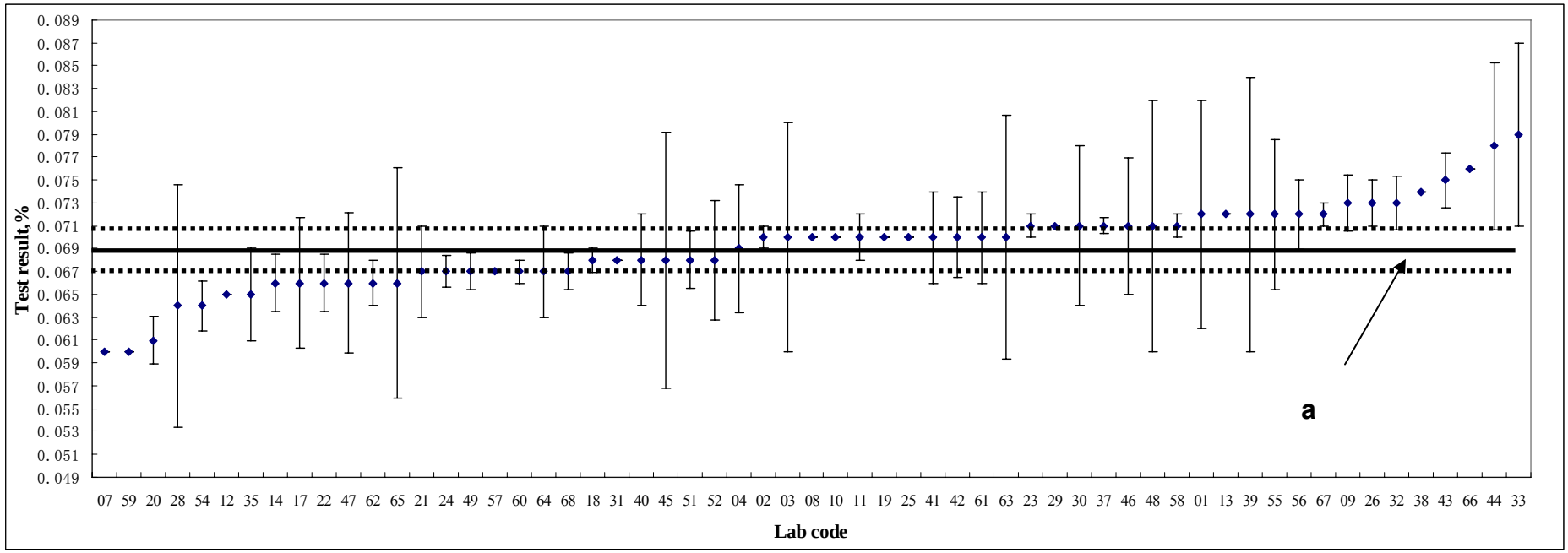
Lab Code	BX 07-1# w_C/ %	Expanded Uncertainty (k=2), %	z-score	Method Code
01	0.072	0.010	0.75	C-1
02	0.070	0.001	0.25	C-1
03	0.070	0.01	0.25	C-2
04	0.069	0.0056	0.00	C-1
05	0.065	0.014	-1.00	C-3
06	0.072	9.14	0.75	C-3
07	0.060	/	-2.25#	C-3
08	0.070	/	0.25	C-1
09	0.073	0.00242	1.00	C-1
10	0.070	/	0.25	C-1
11	0.070	0.002	0.25	C-1
12	0.065	/	-1.00	C-3
13	0.072	/	0.75	C-1
14	0.066	0.0025	-0.75	C-3
17	0.066	0.0057	-0.75	C-1
18	0.068	0.001093	-0.25	C-3
19	0.070	/	0.25	C-3
20	0.061	0.0021	-2.00	C-3
21	0.067	0.004	-0.50	C-3
22	0.066	0.00253	-0.75	C-1
23	0.071	0.001	0.50	C-1
24	0.067	0.0014	-0.50	C-3
25	0.070	/	0.25	C-3
26	0.073	0.002	1.00	C-3
27	0.071	14	0.50	C-1
28	0.064	0.0106	-1.25	C-3
29	0.071	/	0.50	C-3
30	0.071	0.007	0.50	C-3
31	0.068	/	-0.25	C-3
32	0.073	0.0023	1.00	C-3
33	0.079	0.008	2.50#	C-3
34	0.056	/	-3.25§	C-3
35	0.065	0.004	-1.00	C-3
37	0.071	0.0007	0.50	C-1
38	0.074	/	1.25	C-3
39	0.072	0.012	0.75	C-3
40	0.068	0.0040	-0.25	C-3
41	0.070	0.004	0.25	C-3
42	0.070	0.0035	0.25	C-3

Table I Results and Statistical Analysis for C (Cont'd)

Lab Code	BX 07-1# w_C/ %	Expanded Uncertainty (k=2) , %	z-score	Method Code
43	0.075	0.0024	1.50	C-1
44	0.078	0.0073	2.25#	C-3
45	0.068	0.0112	-0.25	C-3
46	0.071	0.0060	0.50	C-3
47	0.066	0.0061	-0.75	C-3
48	0.071	0.011	0.50	C-3
49	0.067	0.0016	-0.50	C-3
50	0.064	0.019	-1.25	C-3
51	0.068	0.0025	-0.25	C-1
52	0.068	0.0052	-0.25	C-3
53	0.065	8.2	-1.00	C-3
54	0.064	0.0022	-1.25	C-3
55	0.072	0.0066	0.75	C-3
56	0.072	0.003	0.75	C-3
57	0.067	/	-0.50	C-3
58	0.071	0.001	0.50	C-3
59	0.060	/	-2.25#	C-3
60	0.067	0.0010	-0.50	C-1
61	0.070	0.004	0.25	C-1
62	0.066	0.002	-0.75	C-1
63	0.070	0.0107	0.25	C-3
64	0.067	0.004	-0.50	C-3
65	0.066	0.0101	-0.75	C-1
66	0.076	/	1.75	C-3
67	0.072	0.001	0.75	C-1
68	0.067	0.00158	-0.50	C-3
70	0.095	/	6.50§	C-3
No. of results	66			
Assigned value	0.069			
Standard deviation	0.004			
Standard uncertainty	0.001			
Minimum	0.056			
Maximum	0.095			
Range	0.039			

Note: The value marked with "§" is unsatisfactory, which is of $|z| \geq 3$; the value marked with "#" is questionable, which is of $2 < |z| < 3$.

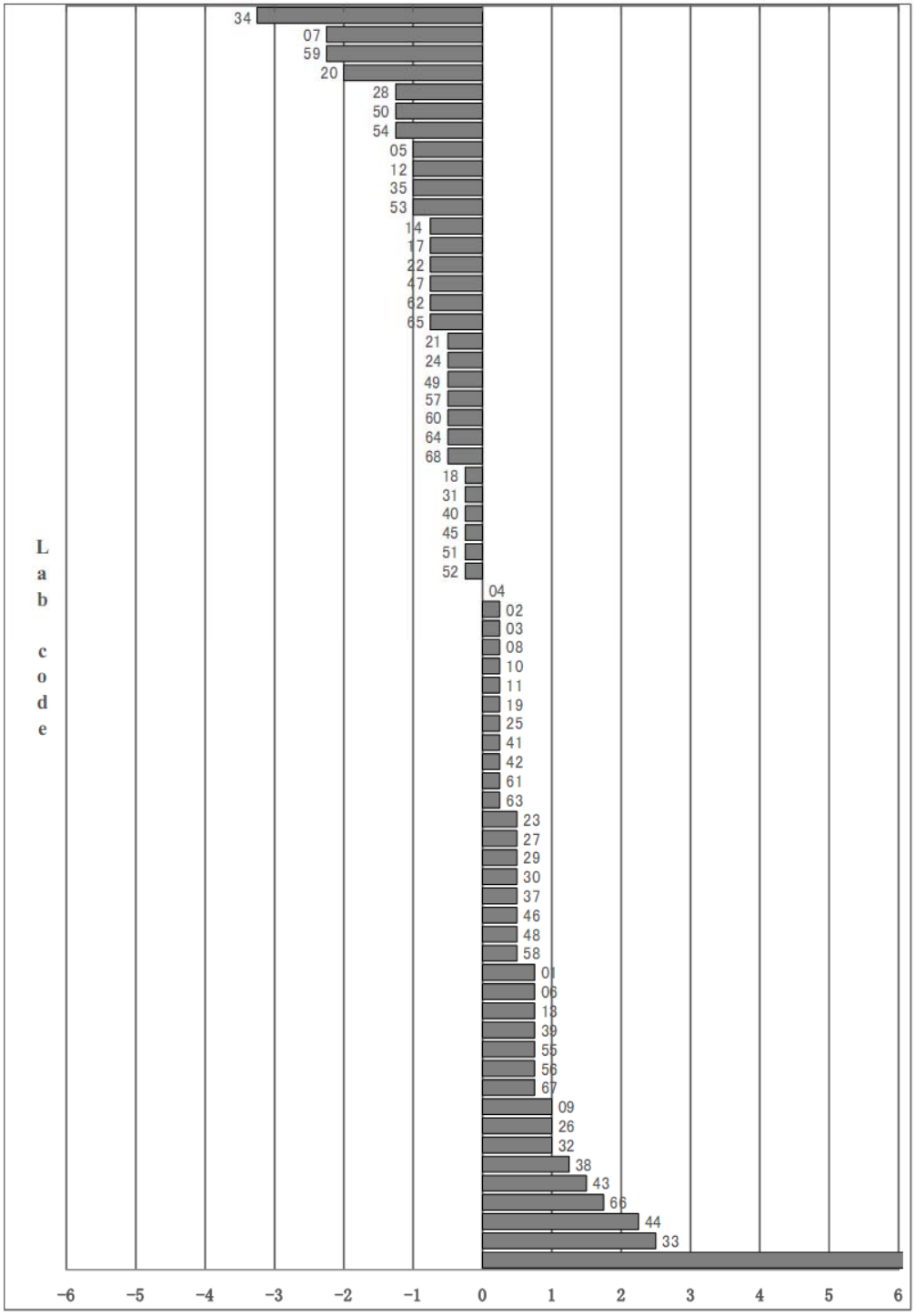
Figure I Results for C



Note: The half of each bar indicates the expanded uncertainty (k=2).

a Assigned value ± expanded uncertainty

Histogram I: z-scores of participating laboratories for C



Results of Si

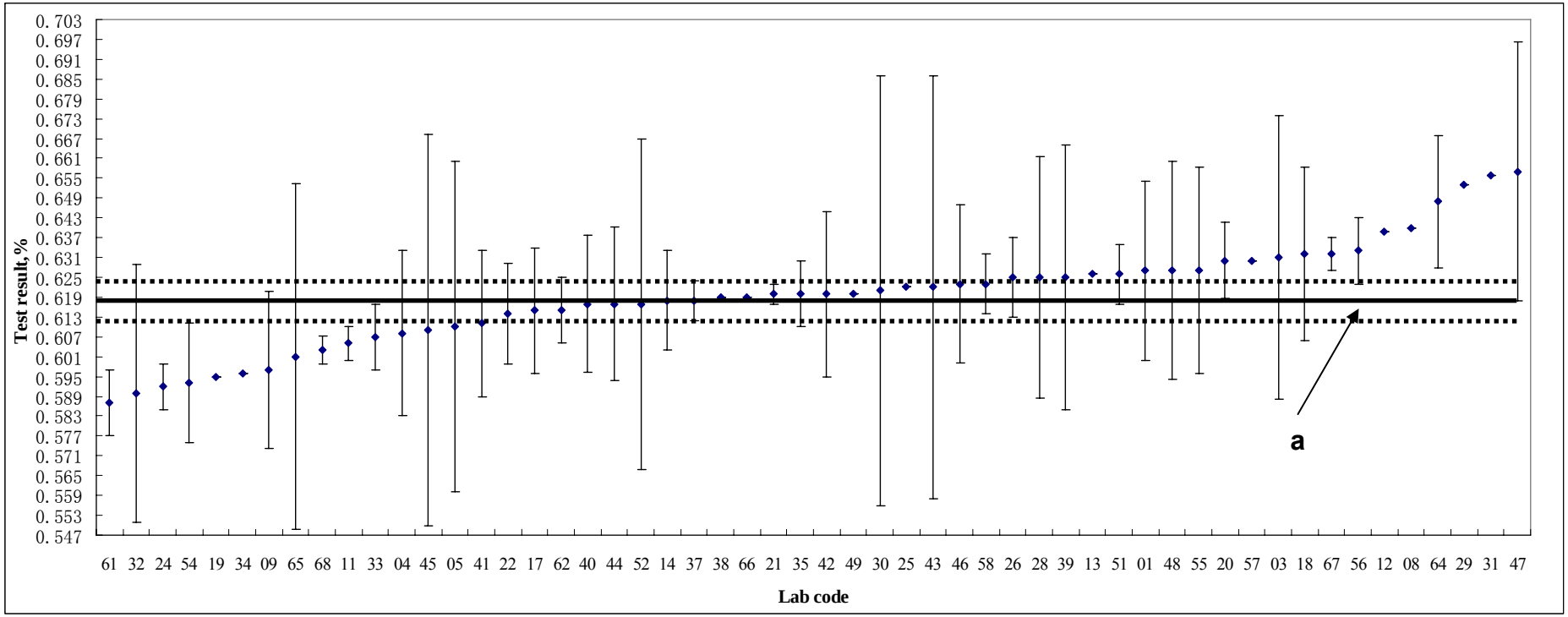
Table II Results and Statistical Analysis for Si

Lab code	BX 07-1# w_{Si}/ %	Expanded Uncertainty (k=2) , %	z-score	Method Code
01	0.627	0.027	0.50	Si-1
02	0.614	0.072	-0.31	Si-2
03	0.631	0.043	0.75	Si-3
04	0.608	0.025	-0.69	Si-1
05	0.610	0.05	-0.56	Si-4
06	0.620	1.48	0.06	Si-4
07	0.570	/	-3.06§	Si-4
08	0.640	/	1.31	Si-1
09	0.597	0.0239	-1.38	Si-5
10	0.535	0.119	-5.25§	Si-2
11	0.605	0.005	-0.88	Si-2
12	0.639	/	1.25	Si-4
13	0.626	/	0.44	Si-4
14	0.618	0.015	-0.06	Si-4
17	0.615	0.019	-0.25	Si-3
18	0.632	0.026261	0.81	Si-4
19	0.595	/	-1.50	Si-4
20	0.630	0.0115	0.69	Si-4
21	0.620	0.003	0.06	Si-4
22	0.614	0.0154	-0.31	Si-3
23	0.747	0.014	8.00§	Si-2
24	0.592	0.0069	-1.69	Si-4
25	0.622	/	0.19	Si-4
26	0.625	0.012	0.38	Si-4
27	0.498	7	-7.56§	Si-5
28	0.625	0.0365	0.38	Si-4
29	0.653	/	2.13#	Si-4
30	0.621	0.065	0.13	Si-4
31	0.656	/	2.31#	Si-4
32	0.590	0.039	-1.81	Si-4
33	0.607	0.010	-0.75	Si-4
34	0.596	/	-1.44	Si-4
35	0.620	0.01	0.06	Si-4
37	0.618	0.006	-0.06	Si-4
38	0.619	/	0.00	Si-4
39	0.625	0.040	0.38	Si-4
40	0.617	0.0207	-0.13	Si-4
41	0.611	0.022	-0.50	Si-4
42	0.620	0.025	0.06	Si-4

Table II Results and Statistical Analysis for Si (Cont'd)

Lab code	BX 07-1# w_{Si}/ %	Expanded Uncertainty (k=2) , %	z-score	Method Code
43	0.622	0.064	0.19	Si-2
44	0.617	0.0231	-0.13	Si-4
45	0.609	0.0591	-0.63	Si-4
46	0.623	0.024	0.25	Si-4
47	0.657	0.0392	2.38#	Si-4
48	0.627	0.033	0.50	Si-4
49	0.620	0.000	0.06	Si-4
50	0.646	0.060	1.69	Si-4
51	0.626	0.009	0.44	Si-1
52	0.617	0.050	-0.13	Si-4
53	0.640	8.3	1.31	Si-4
54	0.593	0.018	-1.63	Si-4
55	0.627	0.0312	0.50	Si-4
56	0.633	0.010	0.88	Si-4
57	0.630	/	0.69	Si-4
58	0.623	0.009	0.25	Si-4
59	0.560	/	-3.69§	Si-4
61	0.587	0.01	-2.00	Si-1
62	0.615	0.01	-0.25	Si-6
63	0.680	0.053	3.81§	Si-4
64	0.648	0.02	1.81	Si-4
65	0.601	0.0523	-1.13	Si-4
66	0.619	/	0.00	Si-4
67	0.632	0.005	0.81	Si-6
68	0.603	0.0042	-1.00	Si-6
No. of results	64			
Assigned value	0.619			
Standard deviation	0.016			
Standard uncertainty	0.003			
Minimum	0.498			
Maximum	0.747			
Range	0.249			

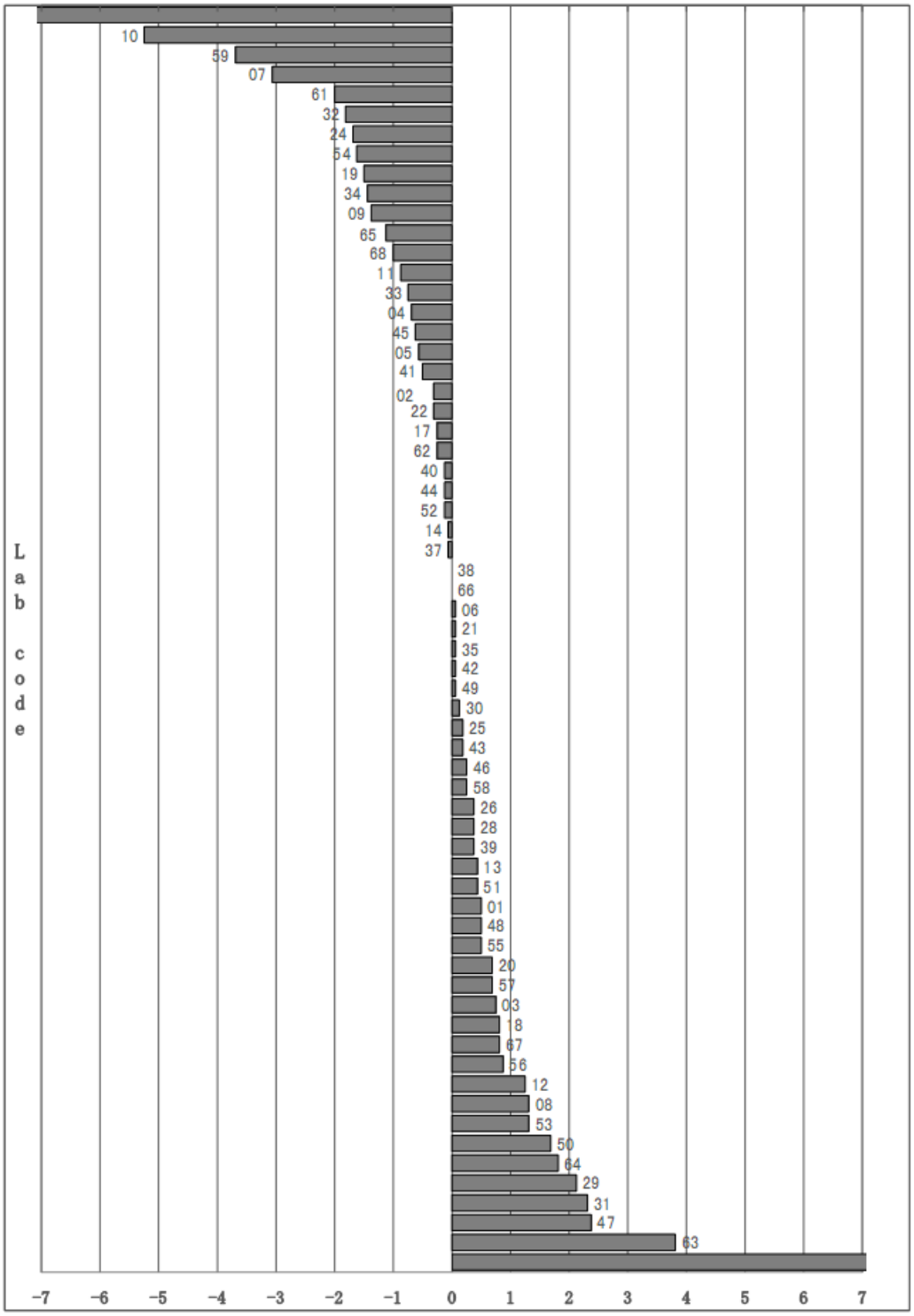
Figure II Results for Si



Note: The half of each bar indicates the expanded uncertainty (k=2).

a Assigned value ± expanded uncertainty

Histogram II: z-scores of participating laboratories for Si



Results of Mn

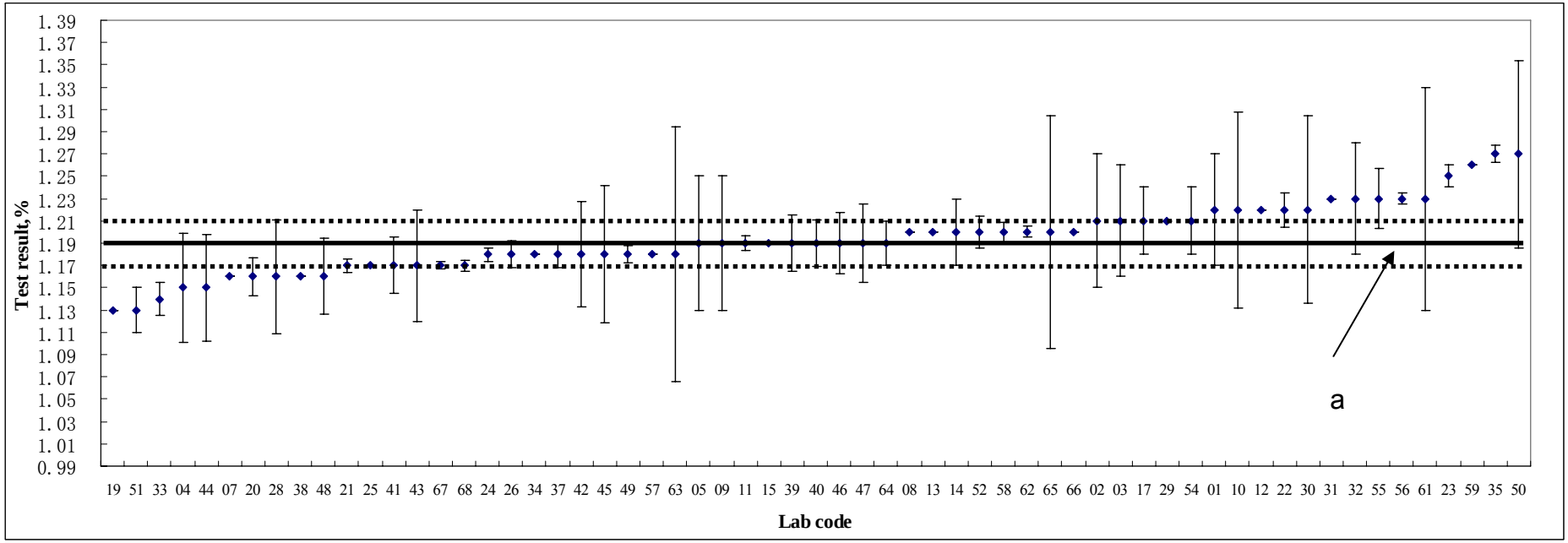
Table III Results and Statistical Analysis for Mn

Lab code	BX 07-1# w_{Mn}/ %	Expanded Uncertainty (k=2) , %	z-score	Method code
01	1.22	0.05	1.00	Mn-1
02	1.21	0.06	0.67	Mn-2
03	1.21	0.05	0.67	Mn-3
04	1.15	0.049	-1.33	Mn-1
05	1.19	0.06	0.00	Mn-4
06	1.16	0.87	-1.00	Mn-4
07	1.16	/	-1.00	Mn-4
08	1.20	/	0.33	Mn-1
09	1.19	0.0609	0.00	Mn-1
10	1.22	0.088	1.00	Mn-2
11	1.19	0.007	0.00	Mn-2
12	1.22	/	1.00	Mn-4
13	1.20	/	0.33	Mn-4
14	1.20	0.03	0.33	Mn-4
15	1.19	/	0.00	Mn-2
17	1.21	0.03	0.67	Mn-2
18	1.11	0.133389	-2.67#	Mn-4
19	1.13	/	-2.00	Mn-4
20	1.16	0.0173	-1.00	Mn-4
21	1.17	0.006	-0.67	Mn-4
22	1.22	0.0153	1.00	Mn-2
23	1.25	0.01	2.00	Mn-2
24	1.18	0.0060	-0.33	Mn-4
25	1.17	/	-0.67	Mn-4
26	1.18	0.012	-0.33	Mn-4
27	1.03	7	-5.33§	Mn-1
28	1.16	0.0514	-1.00	Mn-4
29	1.21	/	0.67	Mn-4
30	1.22	0.084	1.00	Mn-4
31	1.23	/	1.33	Mn-4
32	1.23	0.05	1.33	Mn-4
33	1.14	0.015	-1.67	Mn-4
34	1.18	/	-0.33	Mn-4
35	1.27	0.008	2.67#	Mn-4
37	1.18	0.0115	-0.33	Mn-4
38	1.16	/	-1.00	Mn-4
39	1.19	0.025	0.00	Mn-4
40	1.19	0.021	0.00	Mn-4
41	1.17	0.025	-0.67	Mn-4

Table III Results and Statistical Analysis for Mn (Cont'd)

Lab code	BX 07-1# w_{Mn}/ %	Expanded Uncertainty (k=2) , %	z-score	Method code
42	1.18	0.047	-0.33	Mn-4
43	1.17	0.05	-0.67	Mn-2
44	1.15	0.0479	-1.33	Mn-4
45	1.18	0.0619	-0.33	Mn-4
46	1.19	0.028	0.00	Mn-4
47	1.19	0.0355	0.00	Mn-4
48	1.16	0.034	-1.00	Mn-4
49	1.18	0.0081	-0.33	Mn-4
50	1.27	0.084	2.67#	Mn-4
51	1.13	0.02	-2.00	Mn-1
52	1.20	0.014	0.33	Mn-4
53	1.16	1	-1.00	Mn-4
54	1.21	0.03	0.67	Mn-4
55	1.23	0.027	1.33	Mn-4
56	1.23	0.005	1.33	Mn-4
57	1.18	/	-0.33	Mn-4
58	1.20	0.0085	0.33	Mn-4
59	1.26	/	2.33#	Mn-4
61	1.23	0.1	1.33	Mn-2
62	1.20	0.005	0.33	Mn-5
63	1.18	0.114	-0.33	Mn-4
64	1.19	0.02	0.00	Mn-4
65	1.20	0.1041	0.33	Mn-4
66	1.20	/	0.33	Mn-4
67	1.17	0.003	-0.67	Mn-5
68	1.17	0.005	-0.67	Mn-5
70	1.09	/	-3.33§	Mn-5
No. of results	66			
Assigned value	1.19			
Standard deviation	0.03			
Standard uncertainty	0.01			
Minimum	1.03			
Maximum	1.27			
Range	0.24			

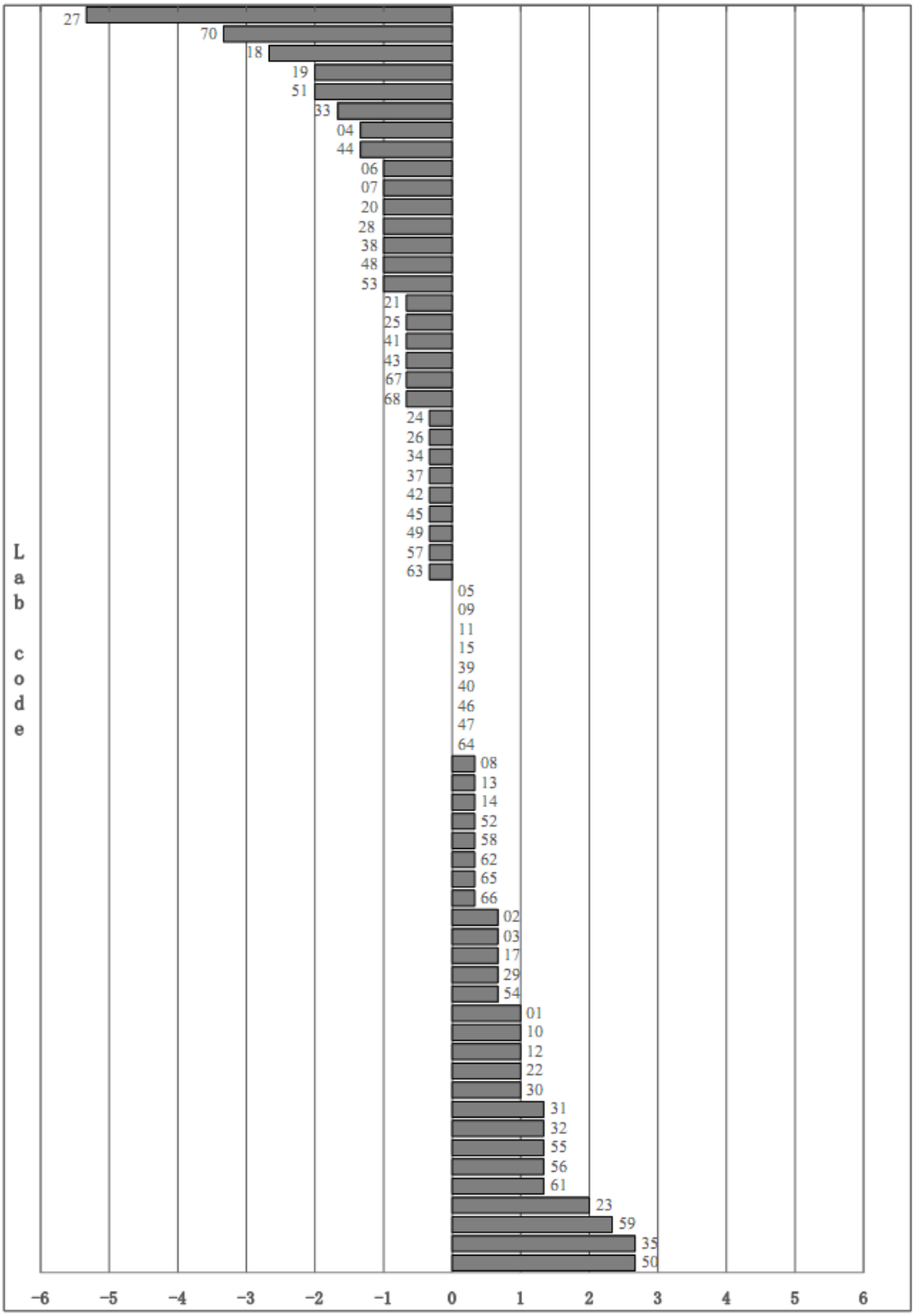
Figure III Results for Mn



Note: The half of each bar indicates the expanded uncertainty (k=2).

a Assigned value ± expanded uncertainty

Histogram III: z-scores of participating laboratories for Mn



Results of P

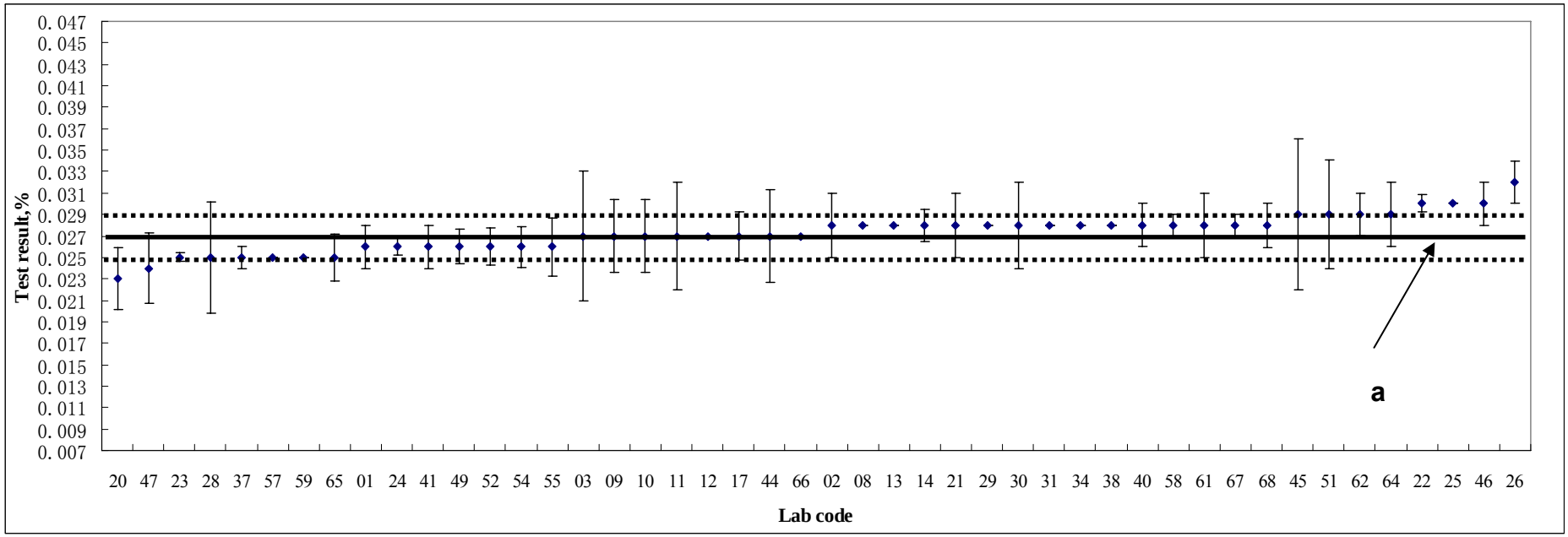
Table IV Results and Statistical Analysis for P

Lab code	BX 07-1# w_P/ %	Expanded Uncertainty (k=2) , %	z-score	Method Code
01	0.026	0.002	-0.50	P-1
02	0.028	0.003	0.50	P-1
03	0.027	0.006	0.00	P-1
04	0.039	0.0054	6.00§	P-5
05	0.027	0.013	0.00	P-2
06	0.026	5.11	-0.50	P-2
07	0.020	/	-3.50§	P-2
08	0.028	/	0.50	P-1
09	0.027	0.0034	0.00	P-3
10	0.027	0.0034	0.00	P-3
11	0.027	0.005	0.00	P-3
12	0.027	/	0.00	P-2
13	0.028	/	0.50	P-2
14	0.028	0.0015	0.50	P-2
17	0.027	0.0022	0.00	P-1
19	0.020	/	-3.50§	P-2
20	0.023	0.0029	-2.00	P-2
21	0.028	0.003	0.50	P-2
22	0.030	0.000808	1.50	P-3
23	0.025	0.0004	-1.00	P-3
24	0.026	0.0008	-0.50	P-2
25	0.030	/	1.50	P-2
26	0.032	0.002	2.50#	P-2
27	0.027	14	0.00	P-1
28	0.025	0.0052	-1.00	P-2
29	0.028	/	0.50	P-2
30	0.028	0.004	0.50	P-2
31	0.028	/	0.50	P-2
32	0.033	0.0025	3.00§	P-2
33	0.034	0.002	3.50§	P-2
34	0.028	/	0.50	P-2
35	0.037	0.0007	5.00§	P-2
37	0.025	0.0010	-1.00	P-2
38	0.028	/	0.50	P-2

Table IV Results and Statistical Analysis for P (Cont'd)

Lab code	BX 07-1# w_P/ %	Expanded Uncertainty (k=2) , %	z-score	Method Code
39	0.024	0.019	-1.50	P-2
40	0.028	0.0020	0.50	P-2
41	0.026	0.002	-0.50	P-2
42	0.020	0.0040	-3.50§	P-2
43	0.020	0.0066	-3.50§	P-3
44	0.027	0.0043	0.00	P-2
45	0.029	0.0070	1.00	P-2
46	0.030	0.0020	1.50	P-2
47	0.024	0.0033	-1.50	P-2
48	0.020	0.0031	-3.50§	P-2
49	0.026	0.0016	-0.50	P-2
50	0.035	0.015	4.00§	P-2
51	0.029	0.0051	1.00	P-1
52	0.026	0.0017	-0.50	P-2
53	0.028	12	0.50	P-2
54	0.026	0.0019	-0.50	P-2
55	0.026	0.0027	-0.50	P-2
56	0.020	0.001	-3.50§	P-2
57	0.025	/	-1.00	P-2
58	0.028	0.001	0.50	P-2
59	0.025	/	-1.00	P-2
61	0.028	0.003	0.50	P-4
62	0.029	0.002	1.00	P-4
63	0.019	0.0026	-4.00§	P-2
64	0.029	0.003	1.00	P-2
65	0.025	0.0022	-1.00	P-2
66	0.027	/	0.00	P-2
67	0.028	0.001	0.50	P-4
68	0.028	0.0021	0.50	P-4
No. of results	63			
Assigned value	0.027			
Standard deviation	0.002			
Standard uncertainty	0.001			
Minimum	0.019			
Maximum	0.039			
Range	0.020			

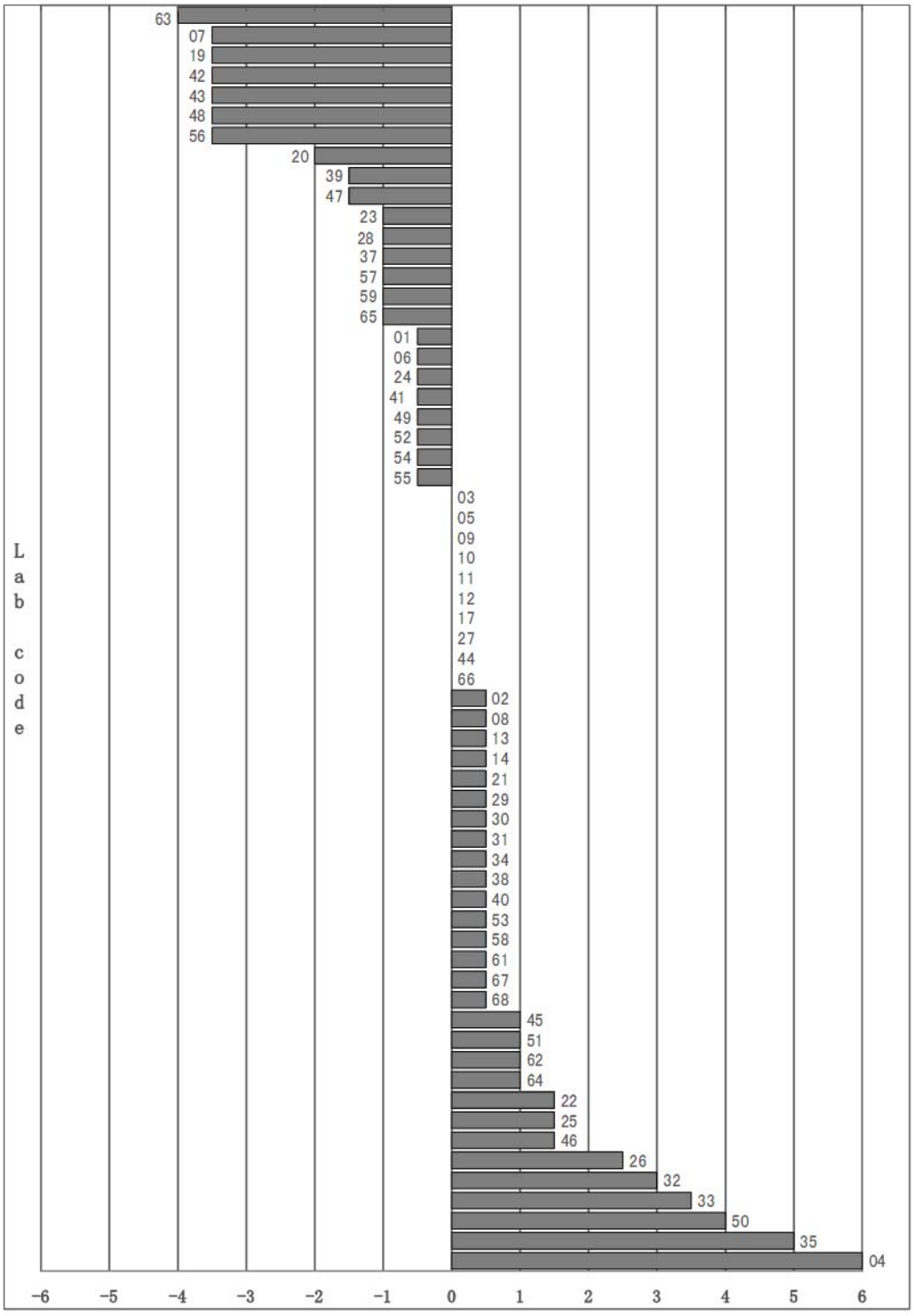
Figure IV Results for P



Note: The half of each bar indicates the expanded uncertainty (k=2).

a Assigned value ± standard deviation

Histogram IV: z-scores of participating laboratories for P



Results of S

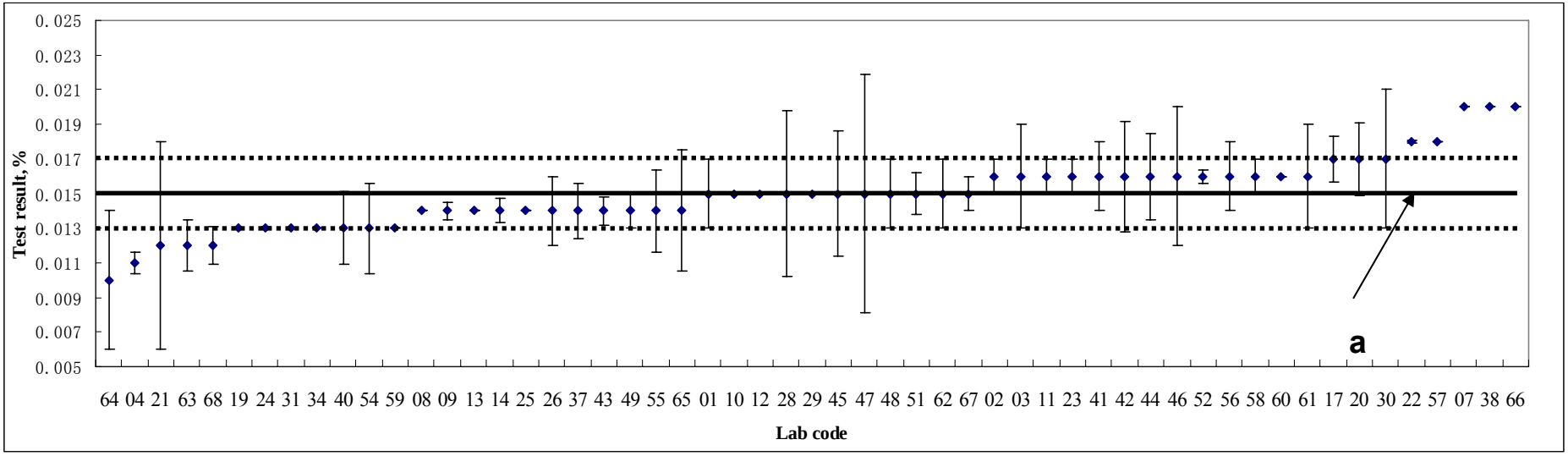
Table V Results and Statistical Analysis for S

Lab code	BX 07-1# w_S/ %	Expanded Uncertainty (k=2) , %	z-score	Method Code
01	0.015	0.002	0.00	S-2
02	0.016	0.001	0.50	S-1
03	0.016	0.003	0.50	S-2
04	0.011	0.0006	-2.00	S-2
05	0.012	0.012	-1.50	S-3
06	0.013	6.10	-1.00	S-3
07	0.020	/	2.50#	S-3
08	0.014	/	-0.50	S-1
09	0.014	0.0005	-0.50	S-1
10	0.015	/	0.00	S-1
11	0.016	0.001	0.50	S-1
12	0.015	/	0.00	S-3
13	0.014	/	-0.50	S-1
14	0.014	0.0007	-0.50	S-3
17	0.017	0.0013	1.00	S-1
19	0.013	/	-1.00	S-3
20	0.017	0.0021	1.00	S-3
21	0.012	0.006	-1.50	S-3
22	0.018	0.0000560	1.50	S-1
23	0.016	0.001	0.50	S-1
24	0.013	0.0001	-1.00	S-3
25	0.014	/	-0.50	S-3
26	0.014	0.002	-0.50	S-3
27	0.016	12	0.50	S-1
28	0.015	0.0048	0.00	S-3
29	0.015	/	0.00	S-3
30	0.017	0.004	1.00	S-3
31	0.013	/	-1.00	S-3
32	0.023	0.0008	4.00§	S-3
33	0.024	0.002	4.50§	S-3
34	0.013	/	-1.00	S-3
35	0.021	0.0007	3.00§	S-3
37	0.014	0.0016	-0.50	S-1
38	0.020	/	2.50#	S-3
39	0.012	0.012	-1.50	S-3
40	0.013	0.0021	-1.00	S-3
41	0.016	0.002	0.50	S-3

Table V Results and Statistical Analysis for S (Cont'd)

Lab code	BX 07-1# w_S/ %	Expanded Uncertainty (k=2) , %	z-score	Method Code
42	0.016	0.0032	0.50	S-3
43	0.014	0.0008	-0.50	S-1
44	0.016	0.0025	0.50	S-3
45	0.015	0.0036	0.00	S-3
46	0.016	0.0040	0.50	S-3
47	0.015	0.0069	0.00	S-3
48	0.015	0.0020	0.00	S-3
49	0.014	0.0010	-0.50	S-3
50	0.018	0.015	1.50	S-3
51	0.015	0.0012	0.00	S-1
52	0.016	0.0004	0.50	S-3
53	0.013	15	-1.00	S-3
54	0.013	0.0026	-1.00	S-3
55	0.014	0.0024	-0.50	S-3
56	0.016	0.002	0.50	S-3
57	0.018	/	1.50	S-3
58	0.016	0.001	0.50	S-3
59	0.013	/	-1.00	S-3
60	0.016	/	0.50	S-1
61	0.016	0.003	0.50	S-1
62	0.015	0.002	0.00	S-1
63	0.012	0.0015	-1.50	S-3
64	0.010	0.004	-2.50#	S-3
65	0.014	0.0035	-0.50	S-1
66	0.020	/	2.50#	S-3
67	0.015	0.001	0.00	S-1
68	0.012	0.0011	-1.50	S-3
No. of results	64			
Assigned value	0.015			
Standard deviation	0.002			
Standard uncertainty	0.001			
Minimum	0.010			
Maximum	0.024			
Range	0.014			

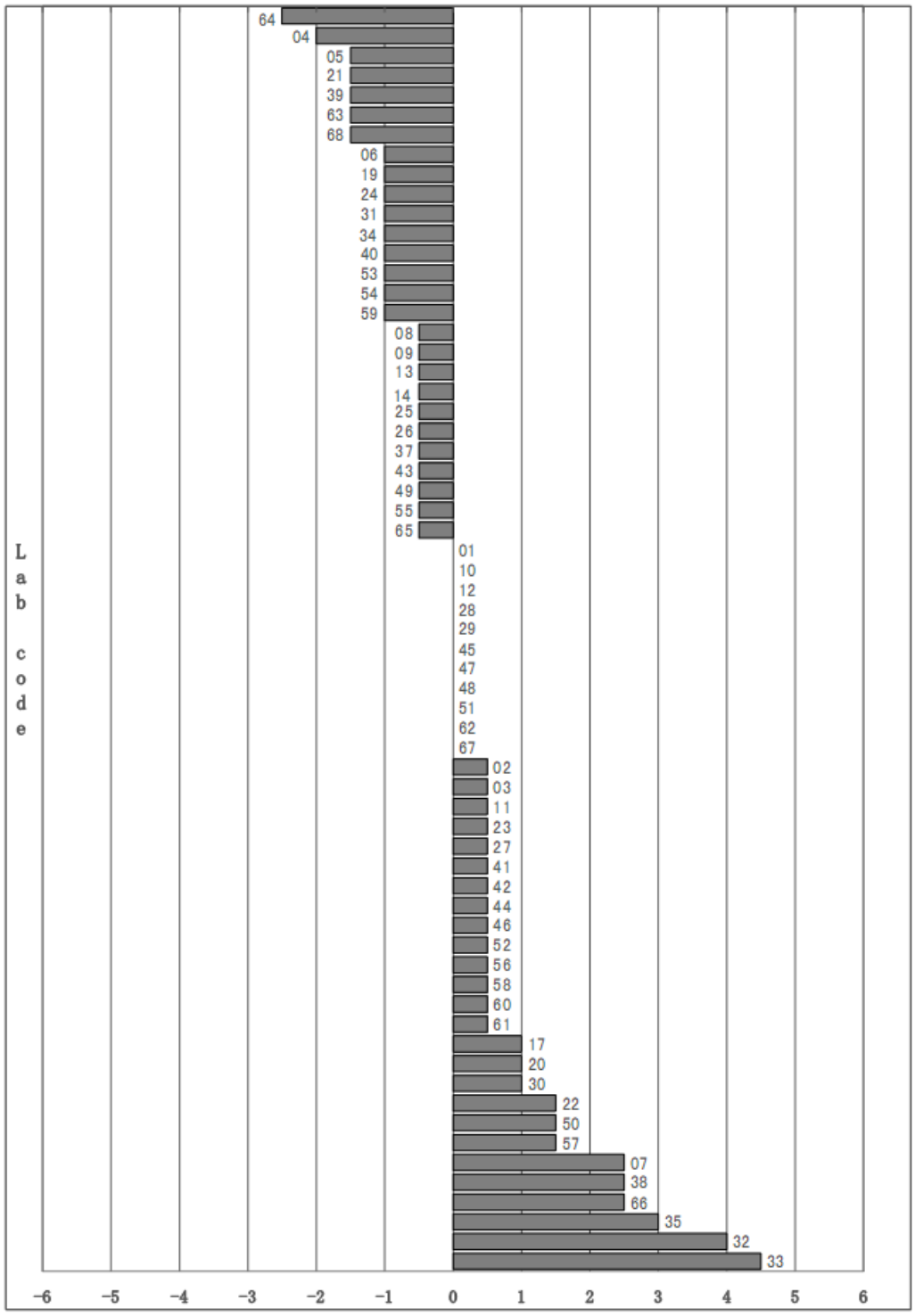
Figure V Results for S



Note: The half of each bar indicates the expanded uncertainty (k=2).

a Assigned value ± its expanded uncertainty

Histogram V: z-scores of participating laboratories for S



Results of Cr

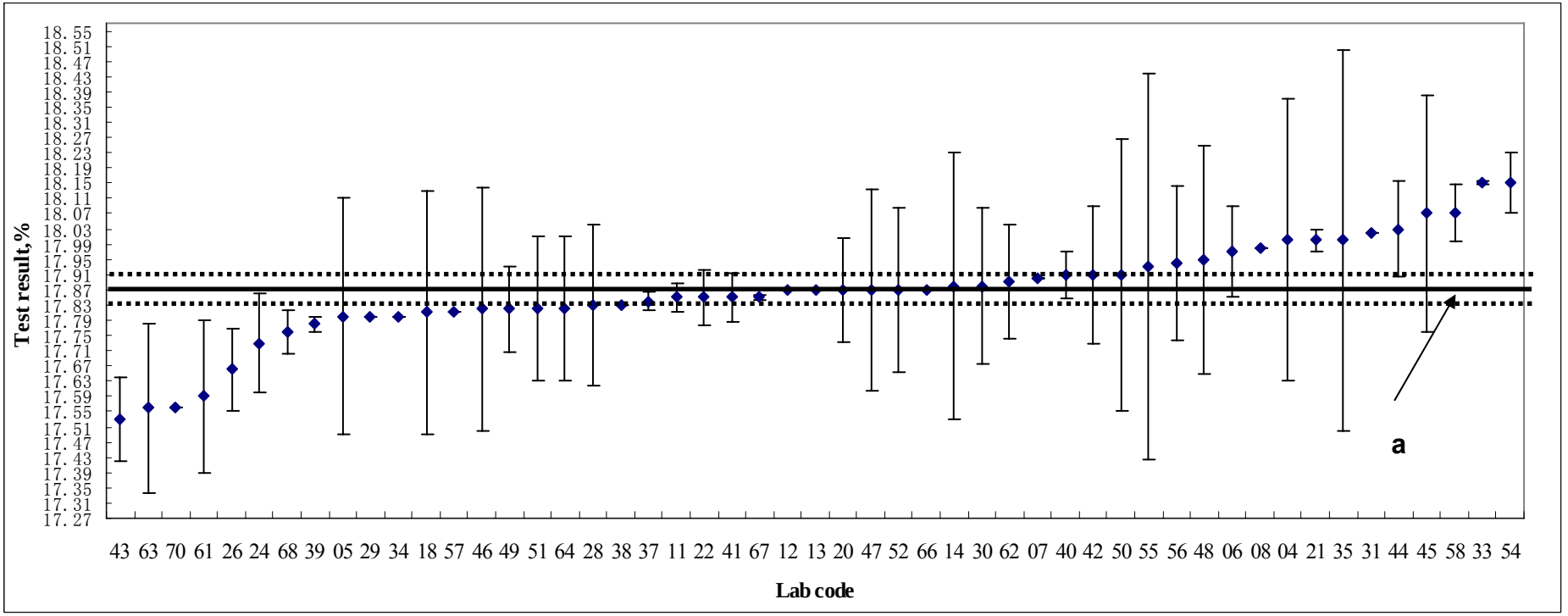
Table VI Results and Statistical Analysis for Cr

Lab code	BX 07-1# w_{Cr}/ %	Expanded Uncertainty (k=2) , %	z-score	Method Code
01	17.77	0.86	-0.83	Cr-1
02	17.97	0.77	0.83	Cr-2
03	17.90	0.52	0.25	Cr-3
04	18.00	0.37	1.08	Cr-3
05	17.80	0.31	-0.58	Cr-4
06	17.97	0.12	0.83	Cr-4
07	17.90	/	0.25	Cr-4
08	17.98	/	0.92	Cr-3
09	18.69	0.5793	6.83§	Cr-1
10	17.86	0.48	-0.08	Cr-2
11	17.85	0.037	-0.17	Cr-2
12	17.87	/	0.00	Cr-4
13	17.87	/	0.00	Cr-4
14	17.88	0.35	0.08	Cr-4
17	18.84	0.27	8.08§	Cr-2
18	17.81	0.318895	-0.50	Cr-4
19	16.28	/	-13.25§	Cr-4
20	17.87	0.1353	0.00	Cr-4
21	18.00	0.030	1.08	Cr-4
22	17.85	0.0714	-0.17	Cr-3
23	19.39	0.20	12.67§	Cr-2
24	17.73	0.129	-1.17	Cr-4
25	17.47	/	-3.33§	Cr-4
26	17.66	0.107	-1.75	Cr-4
27	17.68	6	-1.58	Cr-1
28	17.83	0.211	-0.33	Cr-4
29	17.80	/	-0.58	Cr-4
30	17.88	0.204	0.08	Cr-4
31	18.02	/	1.25	Cr-4
32	17.40	0.55	-3.92§	Cr-4
33	18.15	0.005	2.33#	Cr-4
34	17.80	/	-0.58	Cr-4
35	18.00	0.5	1.08	Cr-4
37	17.84	0.023	-0.25	Cr-4
38	17.83	/	-0.33	Cr-4
39	17.78	0.020	-0.75	Cr-4
40	17.91	0.0625	0.33	Cr-4
41	17.85	0.064	-0.17	Cr-4
42	17.91	0.18	0.33	Cr-4

Table VI Results and Statistical Analysis for Cr (Cont'd)

Lab code	BX 07-1# w_{Cr}/ %	Expanded Uncertainty (k=2) , %	z-score	Method Code
43	17.53	0.11	-2.83#	Cr-4
44	18.03	0.127	1.33	Cr-4
45	18.07	0.3119	1.67	Cr-4
46	17.82	0.32	-0.42	Cr-4
47	17.87	0.2657	0.00	Cr-4
48	17.95	0.30	0.67	Cr-4
49	17.82	0.113	-0.42	Cr-4
50	17.91	0.358	0.33	Cr-4
51	17.82	0.19	-0.42	Cr-3
52	17.87	0.216	0.00	Cr-4
53	17.95	2	0.67	Cr-4
54	18.15	0.08	2.33#	Cr-4
55	17.93	0.506	0.50	Cr-4
56	17.94	0.203	0.58	Cr-4
57	17.81	/	-0.50	Cr-4
58	18.07	0.075	1.67	Cr-4
59	18.49	/	5.17§	Cr-4
61	17.59	0.2	-2.33#	Cr-3
62	17.89	0.15	0.17	Cr-5
63	17.56	0.223	-2.58#	Cr-4
64	17.82	0.19	-0.42	Cr-4
65	17.94	1.5605	0.58	Cr-4
66	17.87	/	0.00	Cr-4
67	17.85	0.008	-0.17	Cr-5
68	17.76	0.056	-0.92	Cr-5
70	17.56	/	-2.58#	Cr-4
No. of results	65			
Assigned value	17.87			
Standard deviation	0.12			
Standard uncertainty	0.02			
Minimum	16.28			
Maximum	19.39			
Range	3.11			

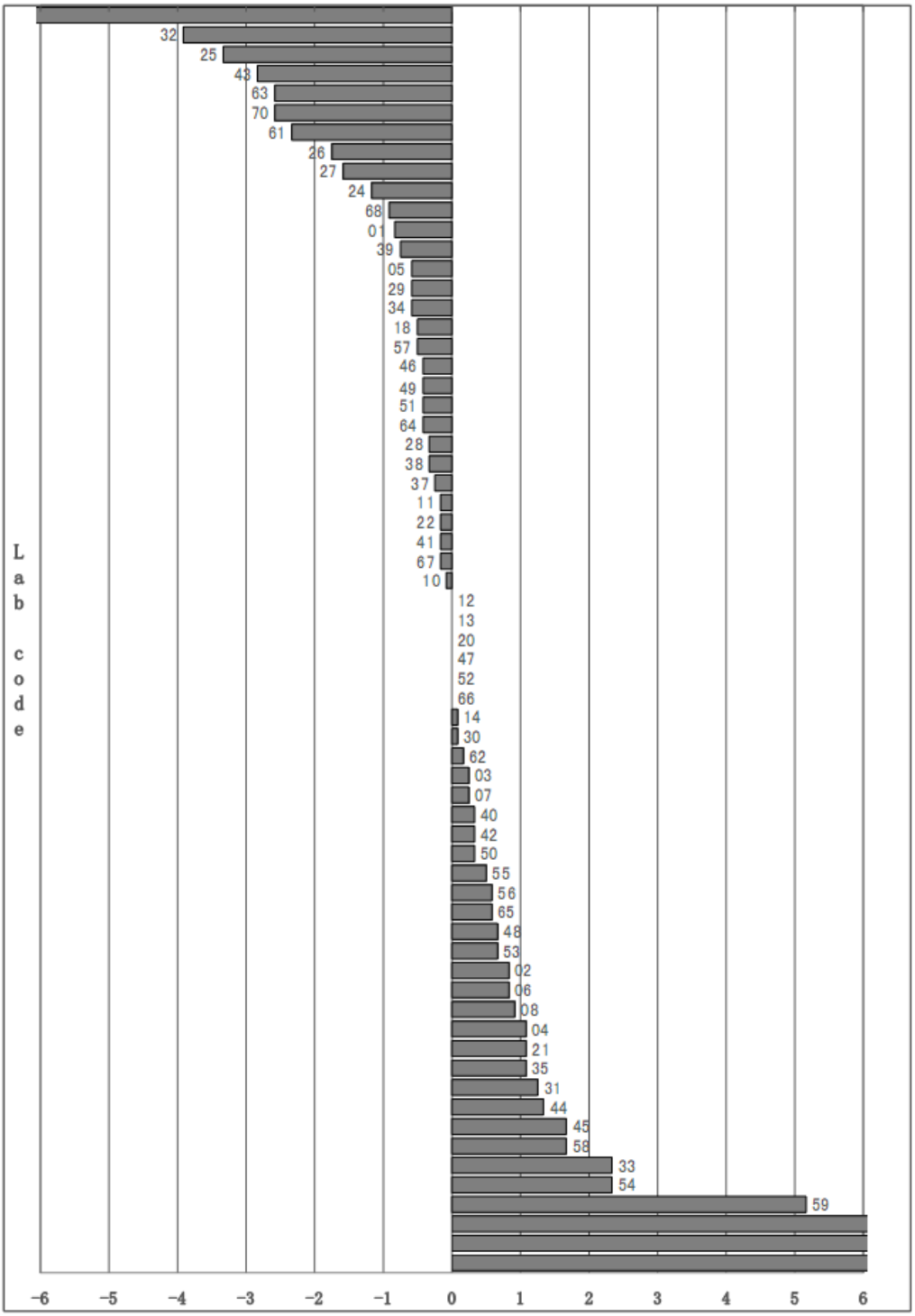
Figure VI Results for Cr



Note: The half of each bar indicates the expanded uncertainty (k=2).

a Assigned value ± its expanded uncertainty

Histogram VI: z-scores of participating laboratories for Cr



Results of Ni

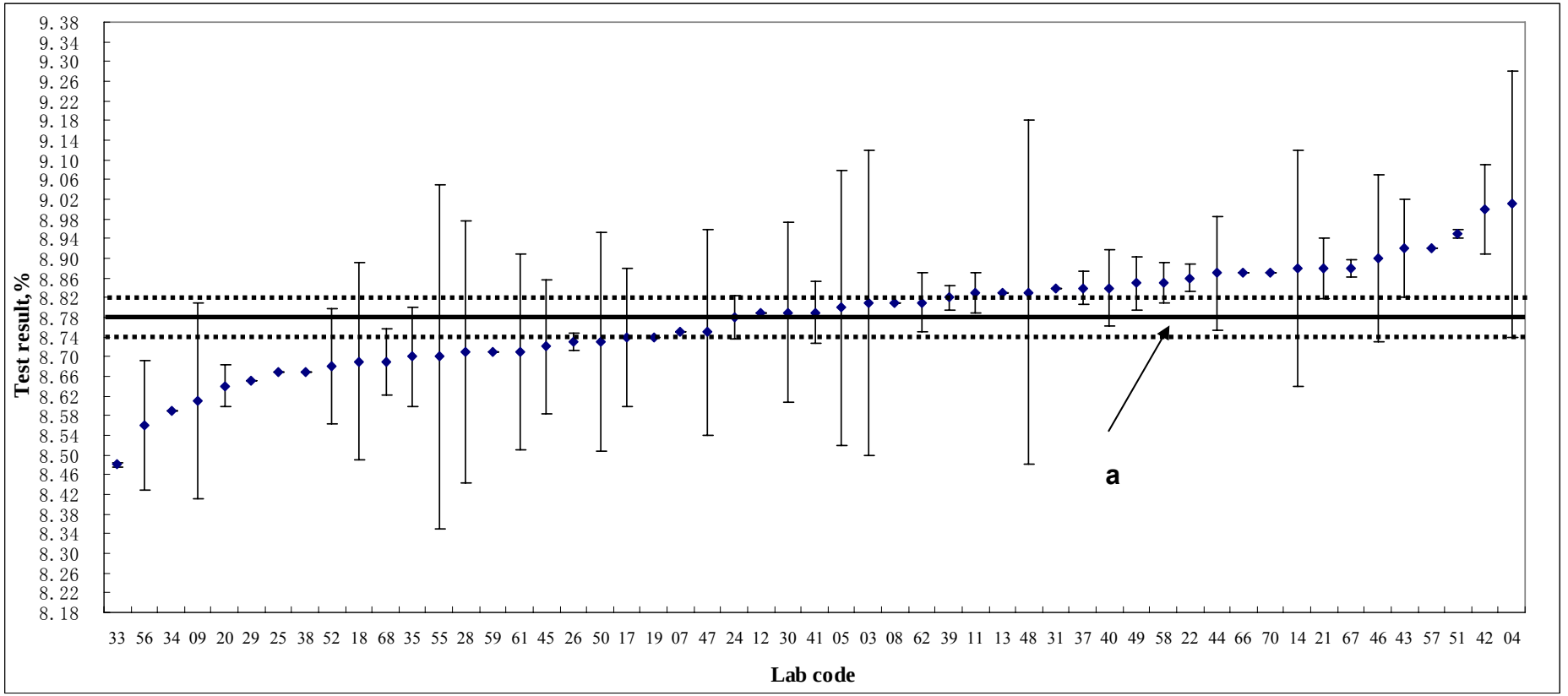
Table VII Results and Statistical Analysis for Ni

Lab code	BX 07-1# w_{Ni}/ %	Expanded Uncertainty (k=2) , %	z-score	Method Code
01	8.92	0.45	1.08	Ni-1
02	8.94	0.48	1.23	Ni-2
03	8.81	0.31	0.23	Ni-3
04	9.01	0.27	1.77	Ni-3
05	8.80	0.28	0.15	Ni-4
06	8.70	0.52	-0.62	Ni-4
07	8.75	/	-0.23	Ni-4
08	8.81	/	0.23	Ni-3
09	8.61	0.1979	-1.31	Ni-1
10	8.89	0.57	0.85	Ni-2
11	8.83	0.040	0.38	Ni-2
12	8.79	/	0.08	Ni-4
13	8.83	/	0.38	Ni-4
14	8.88	0.24	0.77	Ni-4
17	8.74	0.14	-0.31	Ni-2
18	8.69	0.20116	-0.69	Ni-4
19	8.74	/	-0.31	Ni-4
20	8.64	0.0422	-1.08	Ni-4
21	8.88	0.062	0.77	Ni-4
22	8.86	0.0284	0.62	Ni-6
23	9.72	0.10	7.23§	Ni-2
24	8.78	0.0437	0.00	Ni-4
25	8.67	/	-0.85	Ni-4
26	8.73	0.018	-0.38	Ni-4
27	7.87	6	-7.00§	Ni-1
28	8.71	0.267	-0.54	Ni-4
29	8.65	/	-1.00	Ni-4
30	8.79	0.182	0.08	Ni-4
31	8.84	/	0.46	Ni-4
32	7.60	0.11	-9.08§	Ni-4
33	8.48	0.005	-2.31#	Ni-4
34	8.59	/	-1.46	Ni-4
35	8.70	0.1	-0.62	Ni-4
37	8.84	0.035	0.46	Ni-4
38	8.67	/	-0.85	Ni-4
39	8.82	0.025	0.31	Ni-4
40	8.84	0.0775	0.46	Ni-4

Table VII Results and Statistical Analysis for Ni (Cont'd)

Lab code	BX 07-1# w_{Ni}/ %	Expanded Uncertainty (k=2) , %	z-score	Method Code
41	8.79	0.064	0.08	Ni-4
42	9.00	0.09	1.69	Ni-4
43	8.92	0.10	1.08	Ni-4
44	8.87	0.116	0.69	Ni-4
45	8.72	0.1375	-0.46	Ni-4
46	8.90	0.17	0.92	Ni-4
47	8.75	0.2091	-0.23	Ni-4
48	8.83	0.35	0.38	Ni-4
49	8.85	0.054	0.54	Ni-4
50	8.73	0.222	-0.38	Ni-4
51	8.95	0.01	1.31	Ni-3
52	8.68	0.117	-0.77	Ni-4
53	8.76	2.5	-0.15	Ni-4
54	8.22	0.08	-4.31§	Ni-4
55	8.70	0.349	-0.62	Ni-4
56	8.56	0.131	-1.69	Ni-4
57	8.92	/	1.08	Ni-4
58	8.85	0.04	0.54	Ni-4
59	8.71	/	-0.54	Ni-4
61	8.71	0.2	-0.54	Ni-3
62	8.81	0.06	0.23	Ni-5
63	8.99	0.735	1.62	Ni-4
64	8.05	0.04	-5.62§	Ni-4
65	8.60	0.7482	-1.38	Ni-4
66	8.87	/	0.69	Ni-4
67	8.88	0.017	0.77	Ni-5
68	8.69	0.067	-0.69	Ni-5
70	8.87	/	0.69	Ni-4
No. of results	65			
Assigned value	8.78			
Standard deviation	0.13			
Standard uncertainty	0.02			
Minimum	7.60			
Maximum	9.72			
Range	2.12			

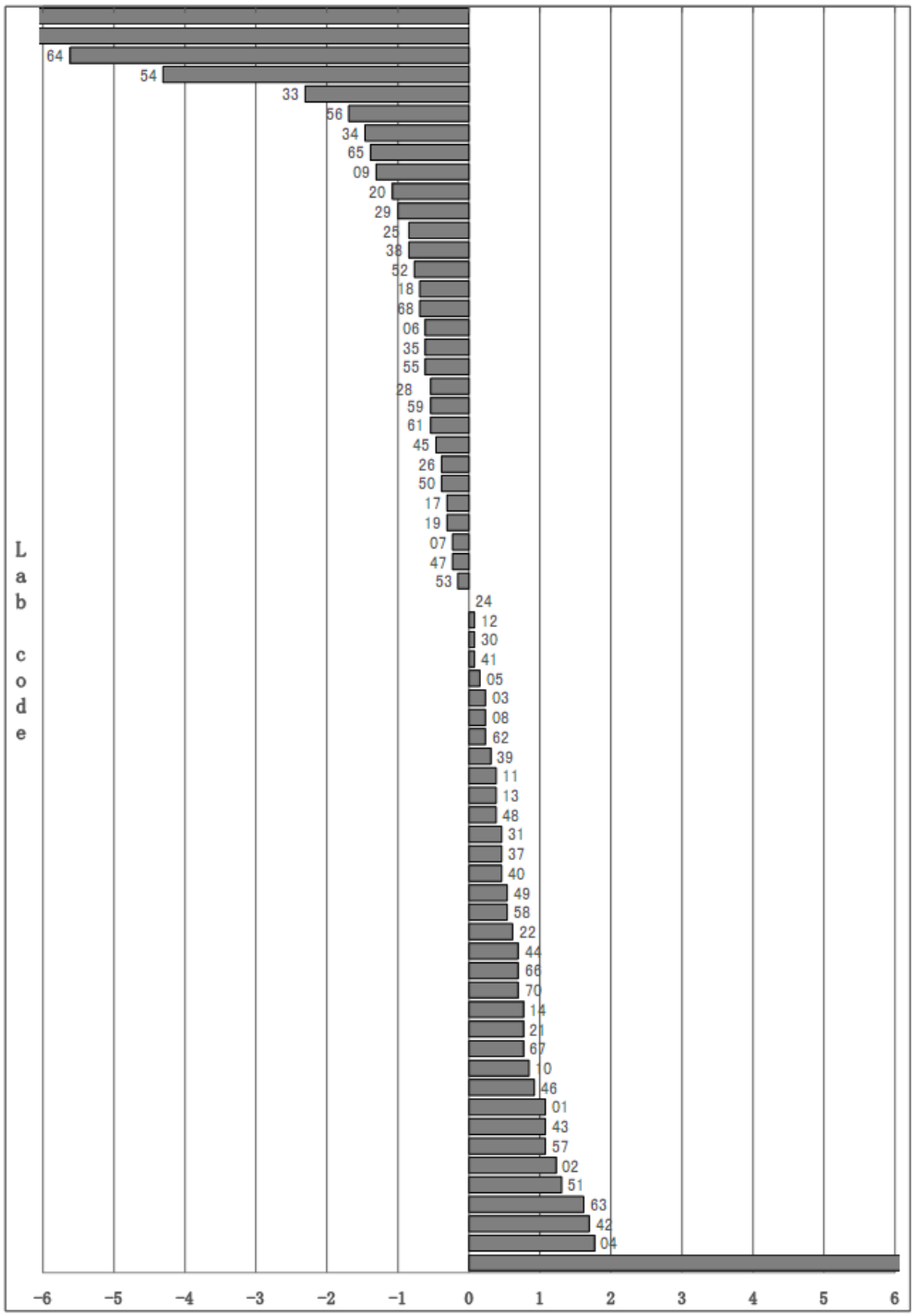
Figure VII Results for Ni



Note: The half of each bar indicates the expanded uncertainty (k=2).

a Assigned value ± its expanded uncertainty

Histogram VII: z-scores of participating laboratories for Ni



Results of Ti

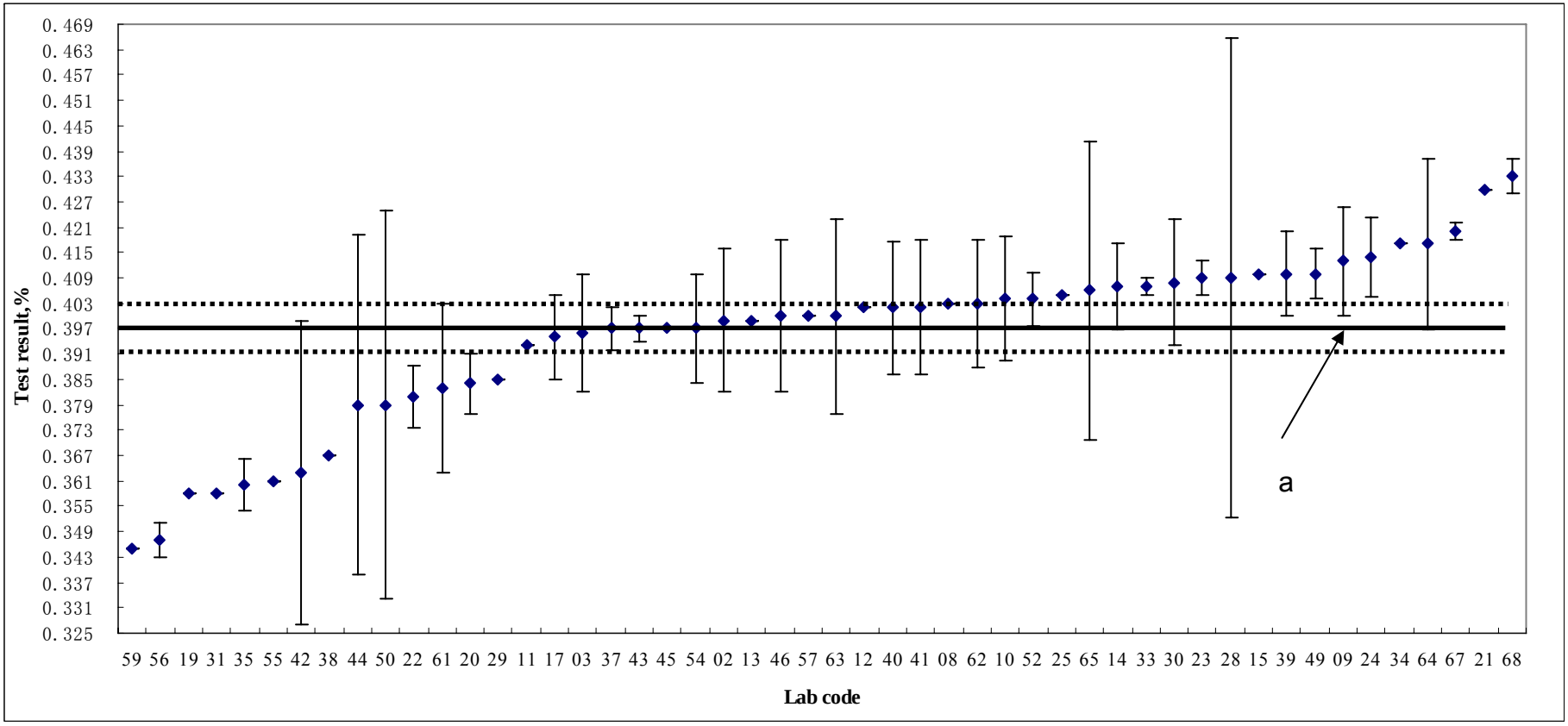
Table VIII Results and Statistical Analysis for Ti

Lab code	BX 07-1# w_{Ti}/ %	Expanded Uncertainty (k=2) , %	z-score	Method Code
02	0.399	0.017	0.11	Ti-1
03	0.396	0.014	-0.05	Ti-2
05	0.360	0.25	-1.95	Ti-3
06	0.388	2.06	-0.47	Ti-3
07	0.480	/	4.37§	Ti-3
08	0.403	/	0.32	Ti-5
09	0.413	0.0128	0.84	Ti-5
10	0.404	0.0147	0.37	Ti-1
11	0.393	/	-0.21	Ti-1
12	0.402	/	0.26	Ti-3
13	0.399	/	0.11	Ti-3
14	0.407	0.010	0.53	Ti-3
15	0.410	/	0.68	Ti-1
17	0.395	0.010	-0.11	Ti-1
18	0.334	0.015178	-3.32§	Ti-3
19	0.358	/	-2.05#	Ti-3
20	0.384	0.0071	-0.68	Ti-3
21	0.430	/	1.74	Ti-3
22	0.381	0.00740	-0.84	Ti-1
23	0.409	0.004	0.63	Ti-1
24	0.414	0.0095	0.89	Ti-3
25	0.405	/	0.42	Ti-3
27	0.282	6	-6.05§	Ti-5
28	0.409	0.0566	0.63	Ti-3
29	0.385	/	-0.63	Ti-3
30	0.408	0.015	0.58	Ti-3
31	0.358	/	-2.05#	Ti-3
32	0.650	0.026	13.32§	Ti-3
33	0.407	0.002	0.53	Ti-3
34	0.417	/	1.05	Ti-3
35	0.360	0.006	-1.95	Ti-3
37	0.397	0.005	0.00	Ti-3
38	0.367	/	-1.58	Ti-3
39	0.410	0.010	0.68	Ti-3
40	0.402	0.0157	0.26	Ti-3
41	0.402	0.016	0.26	Ti-3
42	0.363	0.036	-1.79	Ti-3
43	0.397	0.003	0.00	Ti-1

Table VIII Results and Statistical Analysis for Ti (Cont'd)

Lab code	BX 07-1# w_{Ti}/ %	Expanded Uncertainty (k=2) , %	z-score	Method Code
44	0.379	0.0402	-0.95	Ti-3
45	0.397	/	0.00	Ti-3
46	0.400	0.018	0.16	Ti-3
49	0.410	0.006	0.68	Ti-3
50	0.379	0.046	-0.95	Ti-3
52	0.404	0.0062	0.37	Ti-3
53	0.360	15	-1.95	Ti-3
54	0.397	0.013	0.00	Ti-3
55	0.361	/	-1.89	Ti-3
56	0.347	0.004	-2.63#	Ti-3
57	0.400	/	0.16	Ti-3
58	0.290	0.01	-5.63§	Ti-3
59	0.345	/	-2.74#	Ti-3
61	0.383	0.02	-0.74	Ti-1
62	0.403	0.015	0.32	Ti-4
63	0.400	0.023	0.16	Ti-3
64	0.417	0.02	1.05	Ti-3
65	0.406	0.0353	0.47	Ti-3
66	0.505	/	5.68§	Ti-3
67	0.420	0.002	1.21	Ti-4
68	0.433	0.004	1.89	Ti-4
No. of results	59			
Assigned value	0.397			
Standard deviation	0.019			
Standard uncertainty	0.003			
Minimum	0.282			
Maximum	0.650			
Range	0.368			

Figure VIII Results for Ti



Note: The half of each bar indicates the expanded uncertainty (k=2).

a Assigned value ± its expanded uncertainty

Histogram VIII: z-scores of participating laboratories for Ti

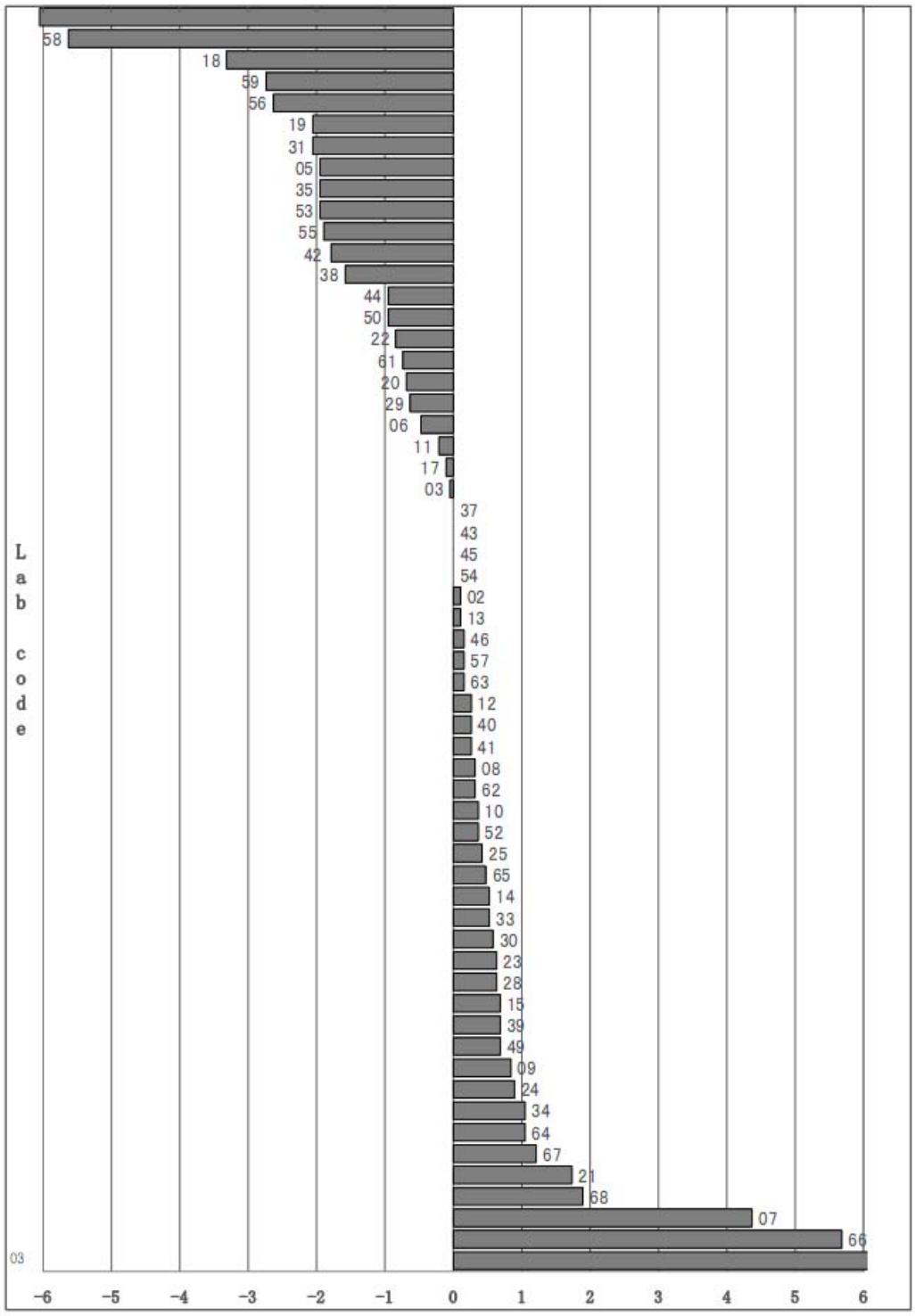


Table IX Geographical Distribution of Participants

Economies	Enrolled	Returned results
Australia	4	4
Brazil	1	1
Bulgaria	1	1
Canada	3	3
Chile	1	0
China	4	4
Cuba	1	0
Finland	1	1
Germany	1	1
Greece	2	2
Hong Kong	4	4
India	4	4
Indonesia	3	3
Israel	1	1
Japan	3	3
Korea	1	1
Lithuania	2	2
Malaysia	2	2
The Netherlands	1	1
New Zealand	2	2
Norway	1	1
Philippines	2	2
Portugal	1	1
Singapore	1	1
South Africa	4	3
Spain	1	1
Sri Lanka	1	1
Sweden	1	1
Switzerland	1	1
Taiwan	4	4
Thailand	5	5
USA	4	4
Vietnam	2	2
Total	70	67

Appendix I

Homogeneity Testing

Prior to the distribution of the samples, 10 discs of samples were selected from the parts of top, tail and equally divided points of mother bar length. Each sample was tested 3 times by Spark Discharge Atomic Emission Spectrometry for all the eight elements in repeatability condition. Standard deviations of 30 measurements and 10 means of three measurements are calculated. SD of 10 means of three measurements was evaluated in comparison with acceptable SD specified in *GB/T 11170-2008 Stainless steel- Determination of multi-element contents - Spark discharge atomic emission spectrometric method (Routine method)*. SD of all elements satisfies these criteria. It demonstrates that the prepared samples are of good homogeneity. Homogeneity testing results are attached in the following Appendix.

Results of homogeneity tests			Unit: mass %				Sample BX07-1	
Sample No.	C		Si		Mn		P	
	1 Measurement	Mean of 3 measurements	1 Measurement	Mean of 3 measurements	1 Measurement	Mean of 3 measurements	1 Measurement	Mean of 3 measurements
BX07-1-1	0.068	0.067	0.709	0.715	1.16	1.16	0.029	0.030
	0.068		0.720		1.17		0.030	
	0.066		0.715		1.16		0.030	
BX07-1-2	0.060	0.062	0.711	0.708	1.17	1.17	0.029	0.029
	0.064		0.702		1.17		0.029	
	0.062		0.710		1.16		0.030	
BX07-1-3	0.061	0.063	0.707	0.709	1.17	1.16	0.028	0.029
	0.066		0.714		1.17		0.028	
	0.061		0.706		1.15		0.030	
BX07-1-4	0.066	0.066	0.708	0.707	1.16	1.15	0.031	0.030
	0.068		0.709		1.15		0.030	
	0.064		0.704		1.15		0.029	
BX07-1-5	0.067	0.067	0.713	0.710	1.16	1.16	0.029	0.030
	0.064		0.711		1.15		0.030	
	0.069		0.707		1.18		0.030	
BX07-1-6	0.066	0.064	0.714	0.710	1.17	1.17	0.030	0.029
	0.062		0.709		1.17		0.029	
	0.063		0.708		1.16		0.029	
BX07-1-7	0.067	0.064	0.712	0.710	1.16	1.16	0.030	0.030
	0.064		0.705		1.16		0.029	
	0.061		0.714		1.16		0.030	
BX07-1-8	0.063	0.065	0.707	0.709	1.18	1.18	0.030	0.029
	0.066		0.707		1.17		0.030	
	0.067		0.712		1.18		0.028	
BX07-1-9	0.066	0.064	0.715	0.711	1.16	1.16	0.029	0.029
	0.066		0.707		1.18		0.029	
	0.062		0.711		1.15		0.030	
BX07-1-10	0.067	0.068	0.710	0.715	1.16	1.17	0.030	0.030
	0.067		0.721		1.18		0.029	
	0.070		0.714		1.18		0.030	
N	30	10	30	10	30	10	30	10
Mean	0.065	0.065	0.710	0.710	1.17	1.17	0.029	0.029
SD	0.0026	0.00193	0.0043	0.00263	0.010	0.00653	0.00073	0.00043
Acceptable SD		0.013		0.030		0.035		0.004

Results of homogeneity tests			Unit: mass %				Sample BX07-1	
Sample No.	S		Cr		Ni		Ti	
	1 Measurement	Mean of 3 measurements	1 Measurement	Mean of 3 measurements	1 Measurement	Mean of 3 measurements	1 Measurement	Mean of 3 measurements
BX07-1-1	0.012	0.012	17.92	17.91	8.82	8.83	0.403	0.402
	0.012		17.96		8.83		0.407	
	0.013		17.86		8.85		0.395	
BX07-1-2	0.013	0.012	17.91	17.90	8.79	8.78	0.390	0.397
	0.011		17.86		8.76		0.400	
	0.012		17.94		8.79		0.400	
BX07-1-3	0.015	0.015	17.88	17.91	8.84	8.79	0.409	0.405
	0.015		17.98		8.75		0.409	
	0.014		17.86		8.79		0.398	
BX07-1-4	0.012	0.013	17.97	17.95	8.83	8.81	0.400	0.397
	0.013		17.91		8.77		0.393	
	0.012		17.96		8.82		0.397	
BX07-1-5	0.013	0.012	17.97	17.92	8.78	8.82	0.409	0.403
	0.012		17.93		8.84		0.397	
	0.012		17.87		8.85		0.402	
BX07-1-6	0.013	0.013	17.95	17.90	8.85	8.83	0.393	0.401
	0.012		17.93		8.80		0.406	
	0.014		17.82		8.83		0.403	
BX07-1-7	0.013	0.013	18.03	17.96	8.80	8.83	0.403	0.404
	0.013		17.93		8.85		0.400	
	0.013		17.93		8.85		0.408	
BX07-1-8	0.014	0.013	17.96	17.97	8.85	8.82	0.404	0.397
	0.013		17.92		8.78		0.398	
	0.013		18.03		8.84		0.390	
BX07-1-9	0.013	0.013	17.84	17.89	8.79	8.82	0.394	0.399
	0.012		17.94		8.81		0.395	
	0.013		17.88		8.86		0.407	
BX07-1-10	0.014	0.015	17.91	17.86	8.86	8.84	0.397	0.395
	0.015		17.78		8.83		0.399	
	0.015		17.88		8.82		0.390	
N	30	10	30	10	30	10	30	10
Mean	0.013	0.013	17.92	17.92	8.82	8.82	0.400	0.400
SD	0.00103	0.00094	0.0569	0.03501	0.031	0.01866	0.00590	0.00341
Acceptable SD		0.003		0.26		0.17		0.022

Appendix II Instructions for Accreditation Body

CHINA NIL RESEARCH CENTER FOR PROFICIENCY TESTING

PROFICIENCY TESTING SCHEME ON
CHEMICAL ANALYSIS OF THE COMPONENTS IN STAINLESS STEEL
(APLAC T067)

INSTRUCTIONS
(FOR ACCREDITATION BODIES)

1. ORGANIZATION

The PT scheme on "Chemical analysis of the components in stainless steel (APLAC T067)" is organized by the China National Accreditation Service for Conformity Assessment (CNAS) and executed by the China NIL Research Centre for Proficiency Testing, as the collaborator under the auspices of Asia-Pacific Laboratory Accreditation Cooperation (APLAC). The main objective of the scheme is to evaluate the performance of participating laboratories on the concerned tests through inter-laboratory comparison.

2. SAMPLE

Accreditation bodies (AB) will receive the PT samples and instruction information from the organizers. Each sample is solid and of about 36 mm diameter and about 12 mm thickness, which is titled BX07-1, and it is properly packaged in a plastic bag. Upon receipt, AB are recommended to carefully check the samples and promptly acknowledge the NIL by e-mail or faxing the "Receipt Form (for Accreditation Bodies)". New sample(s) will be re-sent by the NIL for any damaged claims.

AB are suggested to promptly distribute the samples, together with the "Instructions for Participating Laboratories" and "Results Sheet", to their participating laboratories respectively. The samples shall be stored in a secured environment at room temperature before dispatch.

AB are recommended to remind their participating laboratories of carefully checking the sample upon receipt and promptly acknowledging the NIL by e-mail or faxing the "Receipt Form (for Participating Laboratories)".

3. RESULTS

AB are suggested to inform their participating laboratories of completing the "Result Sheet" and submitting the paper-based document and e-document to the NIL **by 20 February 2009** (Notes: Unless for allowable reasons, results submitted after the deadline might be rejected by the organizers.)

4. ENQUIRIES

Please contact the representative of the NIL for further enquiries concerning the scheme:

Mr. GAO Wengong, Ms. KONG Xinxin
China NIL Research Centre for Proficiency Testing
Add: Box 14, No. 76 Xueyuan South Road, Beijing 100081, P. R. China
Tel: +86 10 62185713, +86 10 62188310
Fax: +86 10 62181163
Email: nil@analysis.org.cn
Website: http://www.nil.org.cn

Appendix III Receipt from for Accreditation Body

CHINA NIL RESEARCH CENTER FOR PROFICIENCY TESTING

PROFICIENCY TESTING SCHEME ON
CHEMICAL ANALYSIS OF THE COMPONENTS IN STAINLESS STEEL
(APLAC T067)

RECEIPT FORM
(FOR ACCREDITATION BODIES)

From: _____
(Name of AB)

_____
(Contact Person)

Email: _____

Date: .....

To: Mr. GAO Wengong, Ms. KONG Xinxin
China NIL Research Centre for Proficiency Testing
Add: Box 14, No. 76 Xueyuan South Road, Beijing 100081, P. R. China
Tel: +86 10 62185713, +86 10 62188310
Fax: +86 10 62181163
Website: http://www.nil.org.cn

Email: nil@analysis.org.cn

I hereby acknowledge the receipt of sample(s) for the APLAC T067 scheme.
The sample(s) is/are found (☐ damaged / ☐ intact)* and should be (☐ suitable / ☐ not suitable)* for laboratory testing.

Remark(s) : .....
.....
.....
.....

* Tick as appropriate

Appendix IV Instructions for Laboratories

CHINA NIL RESEARCH CENTER FOR PROFICIENCY TESTING

PROFICIENCY TESTING SCHEME ON
CHEMICAL ANALYSIS OF THE COMPONENTS IN STAINLESS STEEL
(APLAC T067)

INSTRUCTIONS
(FOR PARTICIPATING LABORATORIES)

1. ORGANIZATION

The PT scheme on "Chemical analysis of the components in stainless steel (APLAC T067)" is organized by the China National Accreditation Service for Conformity Assessment (CNAS) and executed by the China NIL Research Centre for Proficiency Testing, as the collaborator under the auspices of Asia-Pacific Laboratory Accreditation Cooperation (APLAC). The main objective of the scheme is to evaluate the performance of participating laboratories on the concerned tests through inter-laboratory comparison.

2. SAMPLE

(a) Participating laboratories shall receive a plastic sample bag containing solid samples of 36 mm diameter and about 12 mm thickness, which is titled BX07-1, from their respective accreditation bodies (AB).

(b) Upon receipt of the sample, participating laboratories are recommended to carefully check the sample for any physical damages and defects.

(c) Participating laboratories are suggested to promptly acknowledge receipt of the sample by e-mail or faxing the "Receipt Form (for Participating Laboratories)" to the NIL. New sample will be re-sent by the NIL for any damaged claims.

(d) Intact sample is recommended to be stored in a secured environment at room temperature before use.

3. ANALYSIS

(a) Eight elements are required to be determined in the sample, and the content ranges of the elements are showed in the table below:

Unit: mass %

C	Si	Mn	P	S	Cr	Ni	Ti
0.03~0.08	0.5~1	1~2	0.01~0.05	0.01~0.05	16~19	7~9	0.2~0.7

(b) Participating laboratories are supposed to use their preferable test methods (could be accredited, in-house, modified, etc.), which are normally implemented to test their customer samples. However, it is strongly suggested to implement the international or national consensus standards. It is requested that a copy of the full text of analysis method (except ISO Standard) be provided to the NIL.

(c) Each laboratory shall be requested to test each element for three times, and provide three tested results and their average value. The determination results are requested to be reported in mass percent.

(d) The reported significant figure is correspondingly affected by the content range of elements tested. The significant figures recommended are as follows: XX.XX%, X.XX%, 0.XXX%, 0.0XXX%.

Appendix IV Instructions for Laboratories(Cont'd)

CHINA NIL RESEARCH CENTER FOR PROFICIENCY TESTING

PROFICIENCY TESTING SCHEME ON
CHEMICAL ANALYSIS OF THE COMPONENTS IN STAINLESS STEEL
(APLAC T067)

INSTRUCTIONS
(FOR PARTICIPATING LABORATORIES)

4. **RESULTS**

(a) Report all the triplicate data and the arithmetic average in the "Results Sheet".

(b) Please try to evaluate and report the expanded uncertainty for individual element.

(c) Fill in the information of your testing condition and instrument information in the "Results Sheet".

(d) Participating laboratories should complete the "Result Sheet" and submit the paper-based document and e-document to the NIL **by 20 February 2009** (Notes: Unless for allowable reasons, results submitted after the deadline might be rejected by the organizers.)

5. **ENQUIRIES**

Please contact the representative of NIL for further enquiries concerning the scheme:

Mr. GAO Wengong, Ms. KONG Xinxin
China NIL Research Centre for Proficiency Testing
Add: Box 14, No. 76 Xueyuan South Road, Beijing 100081, P. R. China
Tel: +86 10 62185713, +86 10 62188310
Email: nil@analysis.org.cn
Website: http://www.nil.org.cn

Appendix V Receipt Form for Laboratories

CHINA NIL RESEARCH CENTER FOR PROFICIENCY TESTING

PROFICIENCY TESTING SCHEME ON
CHEMICAL ANALYSIS OF THE COMPONENTS IN STAINLESS STEEL
(APLAC T067)

INSTRUCTIONS
(FOR PARTICIPATING LABORATORIES)

From: _____
(Name of Participating Laboratory)

_____
(Contact Person)

To: Mr. GAO Wengong, Ms. KONG Xinxin
China NIL Research Centre for Proficiency Testing
Add: Box 14, No. 76 Xueyuan South Road, Beijing 100081, P. R. China
Tel: +86 10 62185713, +86 10 62188310
Fax: +86 10 62181163
Website: http://www.nil.org.cn

E-mail: _____

E-mail: nil@analysis.org.cn

Date: .....

I hereby acknowledge the receipt of the sample(s) for the APLAC T067 scheme.

The sample(s) is/are found (☐ damaged / ☐ satisfactory)* and should be (☐ suitable / ☐ not suitable)* for laboratory testing.

Remark(s) : .....

.....

.....

.....

_____.

* Tick as appropriate

Appendix VI Result Sheet

APLAC Proficiency Testing Scheme
RESULT SHEET
APLAC T067 Chemical analysis of the components in stainless steel

Name of Laboratory:______________________ **Lab Code:** APLAC T067-______

Sample No.	Element	Found (%)			Mean (%)	*Expanded Uncertainty (k=2)	Title of Analytical Method	Standard No.	Operator
BX07-1	C								
	Si								
	Mn								
	P								
	S								
	Cr								
	Ni								
	Ti								

Note: 1. Modification is forbidden. 2. Please try to evaluate and report the expanded uncertainty for individual element.

Please provide "Testing Condition and Instrument Information" in the following appendix.

Director: ____________________

(Signature)

Appendix VI Result Sheet (Cont'd)

Appendix Testing Condition and Instrument Information

Element	Test Date	Lab Temperature (℃)	Analytical Line (nm)	Instrument			
				Name & Model	Manufacturer	Installation Date	Calibration Date
C							
Si							
Mn							
P							
S							
Cr							
Ni							
Ti							
Comments							