ARMI MBH

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Certificate of Analysis



Revision No.: 000

Revision Date: 03/7/2023

Product ID: IARM-FE904L-22

Certified Reference Material

Product Description: Nickel Chromium, Alloy 904L/N08904

Description and Intended Use: This Certified Reference Material is covered under the scope of accreditation to ISO 17034 by LGC Standards - Manchester, NH. As an ISO 17034 certified reference material, appropriate use of this material will fulfill the certified reference material and traceability requirements for use in ISO 17025 accredited laboratories. This CRM may come in the form of a solid disk, or chips. The intended use of this CRM may include, but is not limited to, the calibration of instruments and the validation of analytical methods.

Certified Values listed in wt.% with associated uncertainties														
Al	0.036	±0.004	Cr	19.3	±0.1	Ν	0.045	±0.001	Sb	0.0018	± 0.0008			
As	0.0044	±0.0009	Cu	1.30	±0.02	Nb	0.017	±0.001	Si	0.654	± 0.009			
В	0.0005	±0.0004	Fe	49.0	±0.2	Ni	24.0	±0.1	Sn	0.0051	± 0.0008			
С	0.0133	±0.0009	Mg	0.0009	±0.0002	0	0.0018	±0.0005	Ti	0.0020	± 0.0006			
Ca	0.0041	±0.0003	Mn	1.14	±0.01	Р	0.020	±0.001	V	0.064	± 0.005			
Со	0.126	±0.006	Мо	4.03	±0.04	S	0.0007	±0.0003	W	0.024	±0.002			

Indicative Values listed in ppm

Pb 4 Ta 31 Zr 24

Homogeneity and Uncertainty: "Uncertainty" values, as reported adjacent to certified concentration values, are based on a 95% Confidence Interval. These estimated uncertainties include the combined effects of method imprecision, material inhomogeneity, and any bias between methods. Homogeneity data from experimental XRF results are reflected in both the overall statistics and certified data. Homogeneity samples are selected by a systematic sampling procedure. The number of samples may be determined by equation 1, where Nprod is the number of units produced and Nmin is the number of samples used for homogeneity testing. These samples are arranged in a simple randomized design such that each sample is analyzed multiple times by XRF. Homogeneity may also be determined within sample using an applied version of ASTM E826. A single factor ANOVA is used to calculated uncertainty due to inhomogeneity (Unom). Uncertainty of the material is calculated by equation 2, where H=Uhom, S= Standard deviation, t= t-value at 95% CI, and n= number of observations.

$$1.N_{MIN} = \max(10, \sqrt[3]{N_{PROD}})$$

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$$2.U_{CRM} = \frac{\sqrt{H^2 + S^2}}{\sqrt{n}} * t$$

Certification Laboratories: Much of the analytical work performed to assess this material has been carried out by laboratories with proven competence, as indicated by their accreditation to ISO 17025. It is an implicit requirement for this accreditation that analytical work should be performed with due traceability, via an unbroken chain of comparisons, each with stated uncertainty, to primary standards such as the mole, or to nationally- or internationally-recognised reference materials. Of the individual results herein, some have traceability (to the mole) via primary analytical methods. Some are traceable to substances of known stoichiometry. Most have traceability via commercial solutions. Furthermore, some results have additional traceability to NIST standards, as part of the analytical calibration or process control.

- Anderson Laboratories, Inc. Greendale, WI
- Applied Technical Services Marietta, GA

 - Dirats Laboratories - Westfield, MA .
- Dirats Laboratories Westfield, MA Eurofins EAG Laboratory - Liverpool, NY
- IMR Test Labs Lansing, NY Laboratory Testing, Inc. - Hatfield, PA
- LGC Standards Manchester, NH
- New Hampshire Materials Laboratory Inc Somersworth, NH •
- NSL Analytical Services Cleveland, OH
- Scrooby's Laboratory Service Pty Ltd Benoni, South Africa
- SGS MSi Melrose Park, IL .

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- Sheffield Assay Office Sheffield, England TEC Eurolab - Campogalliano, Italy

Instructions for Use: The test surface is on the opposite side of the labeled surface, which includes the material identification. The entire thickness of the unit is certified. However, the user is cautioned not to measure disks less than 2 mm thick when using X-ray fluorescence spectrometry. Each packaged disk has been prepared by finishing the test surface using a lathe. The user must determine the correct surface preparation procedure for each analytical technique. The user is cautioned to use care when either resurfacing the disk or performing additional polishing, as these processes may contaminate the surface. The minimum sample size for chips should be individually evaluated based on the analytical technique used; this would typically be greater than 0.1 grams. The material should be stored in a cool, dry location when not in use.

Chips are not recommended for gas analysis.

Period of Validity: The certification of this material is valid indefinitely, within the uncertainty specified, provided the material is handled and stored in accordance with the instructions stated on this certificate. The certification is nullified if the material is damaged, contaminated, otherwise modified, or used in a manner for which it was not intended.

Chuck Goudreau, Certifying Officer

March 7, 2023 **Certification Date**



ISO 17034 Accredited: Reference Materials Producer, Certificate # 2848.02 ISO/IEC 17025 Accredited: Chemical Testing, Certificate # 2848.01

Conditions of Sale and Supply: All CRMs & RMs sold are subject to applicable LGC Standard Terms and Conditions of Sale.

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The following data represents all pertinent information reported as it applies to the chemical characterization of this material.

	AI	As	В	С	Ca	Co	Cr	Cu	Fe	Mg	Mn	Мо	Ν	Nb
1	0.0235	0.0031		0.0101	0.0038	0.0960	19.00	1.1760	48.26	0.0007	1.0710	3.9360	0.0418	0.0100
2	0.0240	0.0035		0.0111	0.0038	0.1110	19.04	1.2653	48.61	0.0008	1.1020	3.9420	0.0431	0.0128
3	0.0280	0.0036		0.0121	0.0039	0.1112	19.13	1.2775	48.70	0.0008	1.1100	3.9580	0.0431	0.0148
4	0.0283	0.0039		0.0124	0.0039	0.1120	19.17	1.2800	48.96	0.0009	1.1130	3.9600	0.0435	0.0150
5	0.0288	0.0039		0.0130	0.0040	0.1200	19.18	1.2900	49.00	0.0010	1.1180	3.9620	0.0441	0.0151
6	0.0291	0.0043		0.0132	0.0043	0.1200	19.20	1.2900	49.07	0.0011	1.1200	3.9672	0.0442	0.0152
7	0.0297	0.0050	0.0011	0.0137	0.0045	0.1243	19.22	1.2930	49.11	< 0.0005	1.1207	3.9710	0.0445	0.0160
8	0.0313	0.0060	0.0012	0.0139	0.0047	0.1265	19.27	1.3020	49.17	< 0.001	1.1230	3.9764	0.0449	0.0171
9	0.0319	0.0067	< 0.0005	0.0140	< 0.005	0.1290	19.29	1.3090	49.20	<0.005	1.1259	4.0170	0.0453	0.0174
10	0.0362	< 0.005	< 0.005	0.0143	<0.005	0.1300	19.33	1.3110	49.28	<0.005	1.1414	4.0200	0.0470	0.0174
11	0.0383	< 0.01	< 0.005	0.0146	<0.005	0.1300	19.35	1.3140	49.45	<0.005	1.1423	4.0250	0.0491	0.0179
12	0.0410	<0.01	<0.01	0.0150	<0.005	0.1303	19.35	1.3210	49.66	<0.01	1.1500	4.0250		0.0180
13	0.0444		<0.01	0.0150		0.1319	19.42	1.3270		<0.01	1.1510	4.0454		0.0190
14	0.0460					0.1319	19.49	1.3300			1.1540	4.0500		0.0190
15	0.0470					0.1320	19.50	1.3500			1.1540	4.0720		0.0200
16	0.0480					0.1330	19.56	1.3600			1.1550	4.0920		0.0200
17	0.0480					0.1330	19.63	1.3660			1.1590	4.1210		0.0200
18						0.1340	19.70				1.1600	4.1500		0.0225
19						0.1440					1.1650	4.2700		<0.005
20						0.1472					1.1900			
Mean	0.0355	0.0044		0.0133	0.0041	0.1264	19.32	1.3036	49.04	0.0009	1.1363	4.0295	0.0446	0.0171
STDV	0.0087	0.0012		0.0015	0.0004	0.0119	0.196	0.0436	0.379	0.0001	0.0272	0.0845	0.0020	0.0030
Certified	0.036	0.0044		0.0133	0.0041	0.126	19.3	1.30	49.0	0.0009	1.14	4.03	0.045	0.017
UCRM	0.004	0.0009		0.0009	0.0003	0.006	0.1	0.02	0.2	0.0002	0.01	0.04	0.001	0.001
Methods	I,IM,G,O,)	(I,IM,G	I,IM,G	С	I,IM,X	I,IM,G,O,X	I,G,O,X	I.G.O.X	I,G,O,X	I,IM,G,O,X	I,G,O,X	I,G,O,X	F	I,IM,G,O,X
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	NI;	0			6			1-1-1					7.	
1	Ni	0	Р	Pb	S	Sb	Si	Sn	Та	Ti	V	W	Zr	
1	23.40	0.0011	P 0.0150	Pb 0.0003	0.0003	Sb 0.0005	Si 0.6300	Sn 0.0036	Ta 0.0001	Ti 0.0006	V 0.0420	W 0.0130	0.000	02
2	23.40 23.55	0.0011 0.0011	P 0.0150 0.0170	Pb	0.0003	Sb 0.0005 0.0010	Si 0.6300 0.6308	Sn 0.0036 0.0044	Ta 0.0001 0.0002	Ti 0.0006 0.0010	V 0.0420 0.0579	W 0.0130 0.0192	0.000	02 06
2 3	23.40 23.55 23.76	0.0011 0.0011 0.0012	P 0.0150 0.0170 0.0190	Pb 0.0003	0.0003 0.0004 0.0005	Sb 0.0005 0.0010 0.0011	Si 0.6300 0.6308 0.6359	Sn 0.0036 0.0044 0.0045	Ta 0.0001 0.0002 0.0013	Ti 0.0006 0.0010 0.0015	V 0.0420 0.0579 0.0590	W 0.0130 0.0192 0.0194	0.000	02 06 20
2 3 4	23.40 23.55 23.76 23.87	0.0011 0.0011 0.0012 0.0013	P 0.0150 0.0170 0.0190 0.0190	Pb 0.0003	0.0003 0.0004 0.0005 0.0005	Sb 0.0005 0.0010 0.0011 0.0011	Si 0.6300 0.6308 0.6359 0.6410	Sn 0.0036 0.0044 0.0045 0.0048	Ta 0.0001 0.0002 0.0013 0.0043	Ti 0.0006 0.0010 0.0015 0.0017	V 0.0420 0.0579 0.0590 0.0601	W 0.0130 0.0192 0.0194 0.0208	0.000 0.000 0.002 0.002)2)6 20 21
2 3 4 5	23.40 23.55 23.76 23.87 23.89	0.0011 0.0011 0.0012 0.0013 0.0015	P 0.0150 0.0170 0.0190 0.0190 0.0190	Pb 0.0003	0.0003 0.0004 0.0005 0.0005 0.0007	Sb 0.0005 0.0010 0.0011 0.0011 0.0022	Si 0.6300 0.6308 0.6359 0.6410 0.6440	Sn 0.0036 0.0044 0.0045 0.0048 0.0048	Ta 0.0001 0.0002 0.0013 0.0043 0.0044	Ti 0.0006 0.0010 0.0015 0.0017 0.0018	V 0.0420 0.0579 0.0590 0.0601 0.0610	W 0.0130 0.0192 0.0194 0.0208 0.0208	0.000 0.000 0.002 0.002 0.002	02 06 20 21 27
2 3 4	23.40 23.55 23.76 23.87 23.89 23.90	0.0011 0.0011 0.0012 0.0013 0.0015 0.0018	P 0.0150 0.0170 0.0190 0.0190 0.0190 0.0190	Pb 0.0003	0.0003 0.0004 0.0005 0.0005 0.0007 0.0008	Sb 0.0005 0.0010 0.0011 0.0011 0.0022 0.0025	Si 0.6300 0.6308 0.6359 0.6410 0.6440 0.6458	Sn 0.0036 0.0044 0.0045 0.0048 0.0048 0.0049	Ta 0.0001 0.0002 0.0013 0.0043 0.0044 0.0053	Ti 0.0006 0.0010 0.0015 0.0017 0.0018 0.0018	V 0.0420 0.0579 0.0590 0.0601 0.0610 0.0621	W 0.0130 0.0192 0.0194 0.0208 0.0208 0.0220	0.000 0.000 0.002 0.002 0.002 0.002	02 06 20 21 27 34
2 3 4 5 6 7	23.40 23.55 23.76 23.87 23.89 23.90 23.92	0.0011 0.0011 0.0012 0.0013 0.0015 0.0018 0.0021	P 0.0150 0.0170 0.0190 0.0190 0.0190 0.0190 0.0191	Pb 0.0003	0.0003 0.0004 0.0005 0.0005 0.0007 0.0008 0.0013	Sb 0.0005 0.0010 0.0011 0.0011 0.0022 0.0025 0.0028	Si 0.6300 0.6308 0.6359 0.6410 0.6440 0.6458 0.6470	Sn 0.0036 0.0044 0.0045 0.0048 0.0048 0.0049 0.0049	Ta 0.0001 0.0002 0.0013 0.0043 0.0044 0.0053 0.0059	Ti 0.0006 0.0010 0.0015 0.0017 0.0018 0.0018 0.0018	V 0.0420 0.0579 0.0590 0.0601 0.0610 0.0621 0.0626	W 0.0130 0.0192 0.0194 0.0208 0.0220 0.0220	0.000 0.000 0.002 0.002 0.002 0.003	02 06 20 21 27 34 58
2 3 4 5 6 7 8	23.40 23.55 23.76 23.87 23.89 23.90 23.92 23.95	0.0011 0.0011 0.0012 0.0013 0.0015 0.0018 0.0021 0.0021	P 0.0150 0.0170 0.0190 0.0190 0.0190 0.0190 0.0191 0.0196	Pb 0.0003	0.0003 0.0004 0.0005 0.0005 0.0007 0.0008 0.0013 <0.0005	Sb 0.0005 0.0010 0.0011 0.0011 0.0022 0.0025	Si 0.6300 0.6308 0.6359 0.6410 0.6440 0.6458 0.6470 0.6480	Sn 0.0036 0.0044 0.0045 0.0048 0.0048 0.0049 0.0049 0.0049	Ta 0.0001 0.0002 0.0013 0.0043 0.0044 0.0053	Ti 0.0006 0.0010 0.0015 0.0017 0.0018 0.0018 0.0018 0.0018 0.0021	V 0.0420 0.0579 0.0590 0.0601 0.0610 0.0621 0.0626 0.0634	W 0.0130 0.0192 0.0194 0.0208 0.0220 0.0220 0.0229	0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000)2)6 20 21 27 34 58 05
2 3 4 5 6 7 8 9	23.40 23.55 23.76 23.87 23.89 23.90 23.92 23.95 23.96	0.0011 0.0011 0.0012 0.0013 0.0015 0.0018 0.0021	P 0.0150 0.0170 0.0190 0.0190 0.0190 0.0190 0.0191 0.0196 0.0198	Pb 0.0003	0.0003 0.0004 0.0005 0.0005 0.0007 0.0008 0.0013 <0.0005 <0.0005	Sb 0.0005 0.0010 0.0011 0.0012 0.0022 0.0025 0.0028 0.0030	Si 0.6300 0.6308 0.6359 0.6410 0.6440 0.6458 0.6470 0.6480 0.6515	Sn 0.0036 0.0044 0.0045 0.0048 0.0048 0.0049 0.0049 0.0049 0.0057 0.0063	Ta 0.0001 0.0012 0.0013 0.0043 0.0044 0.0053 0.0059	Ti 0.0006 0.0010 0.0015 0.0017 0.0018 0.0018 0.0018 0.0018 0.0021	V 0.0420 0.0579 0.0590 0.0601 0.0610 0.0621 0.0626	W 0.0130 0.0192 0.0194 0.0208 0.0220 0.0220 0.0229 0.0229	0.000 0.000 0.002 0.002 0.002 0.003)2)6 20 21 27 34 58 05 05
2 3 4 5 6 7 8	23.40 23.55 23.76 23.87 23.89 23.90 23.92 23.95	0.0011 0.0012 0.0012 0.0013 0.0015 0.0018 0.0021 0.0021	P 0.0150 0.0170 0.0190 0.0190 0.0190 0.0190 0.0191 0.0196	Pb 0.0003	0.0003 0.0004 0.0005 0.0005 0.0007 0.0008 0.0013 <0.0005	Sb 0.0005 0.0010 0.0011 0.0012 0.0025 0.0028 0.0030 <0.002	Si 0.6300 0.6308 0.6359 0.6410 0.6440 0.6458 0.6470 0.6480	Sn 0.0036 0.0044 0.0045 0.0048 0.0048 0.0049 0.0049 0.0049	Ta 0.0001 0.0013 0.0043 0.0043 0.0053 0.0059 <0.0010	Ti 0.0006 0.0010 0.0015 0.0017 0.0018 0.0018 0.0018 0.0018 0.0021	V 0.0420 0.0579 0.0590 0.0601 0.0610 0.0621 0.0626 0.0634 0.0637	W 0.0130 0.0192 0.0194 0.0208 0.0220 0.0220 0.0229	0.000 0.000 0.000 0.000 0.000 0.000 <0.000 <0.000 <0.000)2)6 20 21 27 34 58 05 05 05 10
2 3 4 5 6 7 8 9 10	23.40 23.55 23.76 23.87 23.89 23.90 23.92 23.95 23.96 23.98	0.0011 0.0012 0.0013 0.0015 0.0018 0.0021 0.0021 0.0021 0.0021 0.0027	P 0.0150 0.0170 0.0190 0.0190 0.0190 0.0190 0.0191 0.0196 0.0198 0.0198	Pb 0.0003	0.0003 0.0004 0.0005 0.0005 0.0007 0.0008 0.0013 <0.0005 <0.0005 <0.0005	Sb 0.0005 0.0010 0.0011 0.0012 0.0025 0.0028 0.0020 <0.002	Si 0.6300 0.6308 0.6359 0.6410 0.6440 0.6458 0.6470 0.6480 0.6515 0.6600	Sn 0.0036 0.0044 0.0045 0.0048 0.0048 0.0049 0.0049 0.0057 0.0063 0.0075	Ta 0.0001 0.0002 0.0013 0.0043 0.0043 0.0053 <0.0005	Ti 0.0006 0.0010 0.0015 0.0017 0.0018 0.0018 0.0018 0.0021 0.0029 0.0033	V 0.0420 0.0579 0.0590 0.0601 0.0610 0.0621 0.0626 0.0634 0.0637 0.0642	W 0.0130 0.0192 0.0194 0.0208 0.0220 0.0220 0.0220 0.0229 0.0240	0.000 0.000 0.000 0.000 0.000 0.000 <0.00 <0.00 <0.00)2)6 20 21 27 34 58 05 05 05 10)5
2 3 4 5 6 7 8 9 10 11 12 13	23.40 23.55 23.76 23.87 23.89 23.90 23.92 23.95 23.96 23.98 23.98 24.00 24.00 24.01	0.0011 0.0012 0.0013 0.0015 0.0018 0.0021 0.0021 0.0021 0.0021 0.0027	P 0.0150 0.0170 0.0190 0.0190 0.0190 0.0190 0.0191 0.0196 0.0198 0.0198 0.0200	Pb 0.0003	0.0003 0.0004 0.0005 0.0005 0.0007 0.0008 0.0013 <0.0005 <0.0005 <0.0005 <0.0010 <0.002	Sb 0.0005 0.0010 0.0011 0.0012 0.0025 0.0028 0.0020 <0.002	Si 0.6300 0.6308 0.6359 0.6410 0.6440 0.6458 0.6470 0.6480 0.6515 0.6600 0.6630	Sn 0.0036 0.0044 0.0045 0.0048 0.0048 0.0049 0.0049 0.0057 0.0063 0.0075 <0.005	Ta 0.0001 0.0002 0.0013 0.0043 0.0043 0.0053 <0.0005	Ti 0.0006 0.0010 0.0015 0.0017 0.0018 0.0018 0.0018 0.0021 0.0029 0.0033	V 0.0420 0.0579 0.0590 0.0601 0.0610 0.0621 0.0626 0.0634 0.0637 0.0642 0.0650	W 0.0130 0.0192 0.0194 0.0208 0.0220 0.0220 0.0220 0.0220 0.0220 0.0220 0.0220 0.0220 0.02240 0.0241 0.0249	0.000 0.002 0.002 0.002 0.003 0.003 0.003 0.003 0.000 <0.000 <0.000 <0.000 <0.000)2)6 20 21 27 34 58 05 05 05 10)5
2 3 4 5 6 7 8 9 10 11 12	23.40 23.55 23.76 23.87 23.89 23.90 23.92 23.95 23.96 23.98 23.98 24.00 24.00	0.0011 0.0012 0.0013 0.0015 0.0018 0.0021 0.0021 0.0021 0.0021 0.0027	P 0.0150 0.0170 0.0190 0.0190 0.0190 0.0190 0.0191 0.0196 0.0198 0.0198 0.0200 0.0204	Pb 0.0003	0.0003 0.0004 0.0005 0.0005 0.0007 0.0008 0.0013 <0.0005 <0.0005 <0.0005 <0.0010 <0.002	Sb 0.0005 0.0010 0.0011 0.0012 0.0025 0.0028 0.0028 0.002 <0.002	Si 0.6300 0.6308 0.6359 0.6410 0.6440 0.6458 0.6470 0.6480 0.6515 0.6600 0.6630 0.6660	Sn 0.0036 0.0044 0.0045 0.0048 0.0048 0.0049 0.0049 0.0057 0.0063 0.0075 <0.005 <0.01	Ta 0.0001 0.0002 0.0013 0.0043 0.0043 0.0053 <0.0059	Ti 0.0006 0.0010 0.0015 0.0017 0.0018 0.0018 0.0018 0.0021 0.0023 0.0033 0.0027	V 0.0420 0.0579 0.0590 0.0601 0.0610 0.0621 0.0626 0.0634 0.0637 0.0642 0.0650 0.0660	W 0.0130 0.0192 0.0194 0.0208 0.0220 0.0229 0.0240 0.0241 0.0249 0.0240	0.000 0.002 0.002 0.002 0.003 0.003 0.003 0.003 0.000 <0.000 <0.000 <0.000 <0.000)2)6 20 21 27 34 58 05 05 05 10)5
2 3 4 5 6 7 8 9 10 11 12 13 14 15	23.40 23.55 23.76 23.87 23.89 23.90 23.92 23.95 23.96 23.98 23.98 24.00 24.00 24.01	0.0011 0.0012 0.0013 0.0015 0.0018 0.0021 0.0021 0.0021 0.0021 0.0027	P 0.0150 0.0170 0.0190 0.0190 0.0190 0.0190 0.0191 0.0196 0.0198 0.0198 0.0200 0.0204 0.0210	Pb 0.0003	0.0003 0.0004 0.0005 0.0005 0.0007 0.0008 0.0013 <0.0005 <0.0005 <0.0005 <0.0010 <0.002	Sb 0.0005 0.0010 0.0011 0.0012 0.0025 0.0028 0.0028 0.002 <0.002	Si 0.6300 0.6308 0.6359 0.6410 0.6440 0.6458 0.6470 0.6480 0.6515 0.6600 0.6630 0.6660 0.6720	Sn 0.0036 0.0044 0.0045 0.0048 0.0048 0.0049 0.0049 0.0057 0.0063 0.0075 <0.005 <0.01	Ta 0.0001 0.0002 0.0013 0.0043 0.0043 0.0053 <0.0059	Ti 0.0006 0.0010 0.0015 0.0017 0.0018 0.0018 0.0018 0.0021 0.0033 0.0037 <0.002	V 0.0420 0.0579 0.0590 0.0601 0.0610 0.0621 0.0626 0.0634 0.0637 0.0642 0.0650 0.0660	W 0.0130 0.0192 0.0194 0.0208 0.0220 0.0229 0.0240 0.0241 0.0260 0.0260 0.0260	0.000 0.002 0.002 0.002 0.003 0.003 0.003 0.003 0.000 <0.000 <0.000 <0.000 <0.000)2)6 20 21 27 34 58 05 05 05 10)5
2 3 4 5 6 7 8 9 10 11 12 13 14 15 16	23.40 23.55 23.76 23.87 23.89 23.90 23.92 23.95 23.96 23.98 24.00 24.01 24.04 24.09 24.17	0.0011 0.0012 0.0013 0.0015 0.0018 0.0021 0.0021 0.0021 0.0021 0.0027	P 0.0150 0.0170 0.0190 0.0190 0.0190 0.0190 0.0191 0.0196 0.0198 0.0198 0.0200 0.0204 0.0210 0.0211 0.0215 0.0237	Pb 0.0003	0.0003 0.0004 0.0005 0.0005 0.0007 0.0008 0.0013 <0.0005 <0.0005 <0.0005 <0.0010 <0.002	Sb 0.0005 0.0010 0.0011 0.0012 0.0025 0.0028 0.0028 0.002 <0.002	Si 0.6300 0.6308 0.6359 0.6410 0.6440 0.6458 0.6470 0.6480 0.6515 0.6600 0.6630 0.6660 0.6720 0.6760	Sn 0.0036 0.0044 0.0045 0.0048 0.0048 0.0049 0.0049 0.0057 0.0063 0.0075 <0.005 <0.01	Ta 0.0001 0.0002 0.0013 0.0043 0.0043 0.0053 <0.0059	Ti 0.0006 0.0010 0.0015 0.0017 0.0018 0.0018 0.0018 0.0021 0.0023 0.0033 0.0027 <0.002	V 0.0420 0.0579 0.0590 0.0601 0.0610 0.0621 0.0626 0.0634 0.0637 0.0642 0.0650 0.0660 0.0660 0.0660 0.0662 0.0715	W 0.0130 0.0192 0.0194 0.0208 0.0220 0.0220 0.0220 0.0220 0.0241 0.0260 0.0260 0.0261 0.0270	0.000 0.002 0.002 0.002 0.003 0.003 0.003 0.003 0.000 <0.000 <0.000 <0.000 <0.000)2)6 20 21 27 34 58 05 05 05 10)5
2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17	23.40 23.55 23.76 23.87 23.89 23.90 23.92 23.95 23.96 23.98 24.00 24.00 24.01 24.04 24.09 24.17 24.18	0.0011 0.0012 0.0013 0.0015 0.0018 0.0021 0.0021 0.0021 0.0021 0.0027	P 0.0150 0.0170 0.0190 0.0190 0.0190 0.0190 0.0190 0.0191 0.0196 0.0198 0.0198 0.0198 0.0200 0.0204 0.0211 0.0215 0.0237 0.0245	Pb 0.0003	0.0003 0.0004 0.0005 0.0005 0.0007 0.0008 0.0013 <0.0005 <0.0005 <0.0005 <0.0010 <0.002	Sb 0.0005 0.0010 0.0011 0.0012 0.0025 0.0028 0.0028 0.002 <0.002	Si 0.6300 0.6308 0.6359 0.6410 0.6440 0.6458 0.6470 0.6480 0.6515 0.6600 0.6630 0.6660 0.6720 0.6770	Sn 0.0036 0.0044 0.0045 0.0048 0.0048 0.0049 0.0049 0.0057 0.0063 0.0075 <0.005 <0.01	Ta 0.0001 0.0002 0.0013 0.0043 0.0043 0.0053 <0.0059	Ti 0.0006 0.0010 0.0015 0.0017 0.0018 0.0018 0.0018 0.0021 0.0023 0.0033 0.0027 <0.002	V 0.0420 0.0579 0.0590 0.0601 0.0610 0.0621 0.0626 0.0637 0.0642 0.0650 0.0660 0.0660 0.0660 0.0660	W 0.0130 0.0192 0.0194 0.0208 0.0220 0.0220 0.0220 0.0220 0.0220 0.0241 0.0260 0.0260 0.0261 0.0271 0.0280	0.000 0.002 0.002 0.002 0.003 0.003 0.003 0.003 0.000 <0.000 <0.000 <0.000 <0.000)2)6 20 21 27 34 58 05 05 05 10)5
2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18	23.40 23.55 23.76 23.87 23.89 23.90 23.92 23.95 23.96 23.98 24.00 24.00 24.01 24.04 24.04 24.09 24.17 24.18 24.65	0.0011 0.0012 0.0013 0.0015 0.0018 0.0021 0.0021 0.0021 0.0021 0.0027	P 0.0150 0.0170 0.0190 0.0190 0.0190 0.0190 0.0191 0.0196 0.0198 0.0198 0.0200 0.0204 0.0210 0.0211 0.0215 0.0237	Pb 0.0003	0.0003 0.0004 0.0005 0.0005 0.0007 0.0008 0.0013 <0.0005 <0.0005 <0.0005 <0.0010 <0.002	Sb 0.0005 0.0010 0.0011 0.0012 0.0025 0.0028 0.0028 0.002 <0.002	Si 0.6300 0.6308 0.6359 0.6410 0.6440 0.6458 0.6470 0.6480 0.6515 0.6600 0.6630 0.6660 0.6720 0.6770	Sn 0.0036 0.0044 0.0045 0.0048 0.0048 0.0049 0.0049 0.0057 0.0063 0.0075 <0.005 <0.01	Ta 0.0001 0.0002 0.0013 0.0043 0.0043 0.0053 <0.0059	Ti 0.0006 0.0010 0.0015 0.0017 0.0018 0.0018 0.0018 0.0021 0.0023 0.0033 0.0027 <0.002	V 0.0420 0.0579 0.0590 0.0601 0.0610 0.0621 0.0626 0.0634 0.0637 0.0642 0.0650 0.0660 0.0660 0.0660 0.0662 0.0715	W 0.0130 0.0192 0.0194 0.0208 0.0220 0.0220 0.0220 0.0220 0.0241 0.0260 0.0260 0.0261 0.0270	0.000 0.002 0.002 0.002 0.003 0.003 0.003 0.003 0.000 <0.000 <0.000 <0.000 <0.000)2)6 20 21 27 34 58 05 05 05 10)5
2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19	23.40 23.55 23.76 23.87 23.89 23.90 23.92 23.95 23.96 23.98 24.00 24.00 24.01 24.04 24.09 24.17 24.18	0.0011 0.0012 0.0013 0.0015 0.0018 0.0021 0.0021 0.0021 0.0021 0.0027	P 0.0150 0.0170 0.0190 0.0190 0.0190 0.0190 0.0190 0.0191 0.0196 0.0198 0.0198 0.0198 0.0200 0.0204 0.0211 0.0215 0.0237 0.0245	Pb 0.0003	0.0003 0.0004 0.0005 0.0005 0.0007 0.0008 0.0013 <0.0005 <0.0005 <0.0005 <0.0010 <0.002	Sb 0.0005 0.0010 0.0011 0.0012 0.0025 0.0028 0.0028 0.002 <0.002	Si 0.6300 0.6308 0.6359 0.6410 0.6440 0.6458 0.6470 0.6480 0.6515 0.6600 0.6630 0.6660 0.6720 0.6770	Sn 0.0036 0.0044 0.0045 0.0048 0.0048 0.0049 0.0049 0.0057 0.0063 0.0075 <0.005 <0.01	Ta 0.0001 0.0002 0.0013 0.0043 0.0043 0.0053 <0.0059	Ti 0.0006 0.0010 0.0015 0.0017 0.0018 0.0018 0.0018 0.0021 0.0023 0.0033 0.0027 <0.002	V 0.0420 0.0579 0.0590 0.0601 0.0610 0.0621 0.0626 0.0634 0.0637 0.0642 0.0650 0.0660 0.0660 0.0660 0.0662 0.0715	W 0.0130 0.0192 0.0194 0.0208 0.0220 0.0220 0.0220 0.0220 0.0220 0.0241 0.0260 0.0260 0.0261 0.0271 0.0280	0.000 0.002 0.002 0.002 0.003 0.003 0.003 0.003 0.000 <0.000 <0.000 <0.000 <0.000)2)6 20 21 27 34 58 05 05 05 10)5
2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18	23.40 23.55 23.76 23.87 23.89 23.90 23.92 23.95 23.96 23.98 24.00 24.00 24.01 24.04 24.04 24.09 24.17 24.18 24.65	0.0011 0.0012 0.0013 0.0015 0.0018 0.0021 0.0021 0.0021 0.0021 0.0027	P 0.0150 0.0170 0.0190 0.0190 0.0190 0.0190 0.0190 0.0191 0.0196 0.0198 0.0198 0.0198 0.0200 0.0204 0.0211 0.0215 0.0237 0.0245	Pb 0.0003	0.0003 0.0004 0.0005 0.0005 0.0007 0.0008 0.0013 <0.0005 <0.0005 <0.0005 <0.0010 <0.002	Sb 0.0005 0.0010 0.0011 0.0012 0.0025 0.0028 0.0028 0.002 <0.002	Si 0.6300 0.6308 0.6359 0.6410 0.6440 0.6458 0.6470 0.6480 0.6515 0.6600 0.6630 0.6660 0.6720 0.6770	Sn 0.0036 0.0044 0.0045 0.0048 0.0048 0.0049 0.0049 0.0057 0.0063 0.0075 <0.005 <0.01	Ta 0.0001 0.0002 0.0013 0.0043 0.0043 0.0053 <0.0059	Ti 0.0006 0.0010 0.0015 0.0017 0.0018 0.0018 0.0018 0.0021 0.0023 0.0033 0.0027 <0.002	V 0.0420 0.0579 0.0590 0.0601 0.0610 0.0621 0.0626 0.0634 0.0637 0.0642 0.0650 0.0660 0.0660 0.0660 0.0662 0.0715	W 0.0130 0.0192 0.0194 0.0208 0.0220 0.0220 0.0220 0.0220 0.0220 0.0241 0.0260 0.0260 0.0261 0.0271 0.0280	0.000 0.002 0.002 0.002 0.003 0.003 0.003 0.003 0.000 <0.000 <0.000 <0.000 <0.000)2)6 20 21 27 34 58 05 05 05 10)5
2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 Mean	23.40 23.55 23.76 23.87 23.89 23.90 23.92 23.95 23.96 23.98 24.00 24.00 24.00 24.00 24.01 24.04 24.04 24.17 24.18 24.65 24.70 24.00	0.0011 0.0011 0.0012 0.0013 0.0015 0.0018 0.0021 0.0021 0.0027 0.0033 0.0033 0.0018	P 0.0150 0.0170 0.0190 0.0190 0.0190 0.0190 0.0190 0.0190 0.0190 0.0191 0.0198 0.0198 0.0200 0.0204 0.0210 0.0215 0.0237 0.0245 0.0247	Pb 0.0003 0.0005	0.0003 0.0004 0.0005 0.0005 0.0007 0.0008 0.0013 <0.0005 <0.0005 <0.0010 <0.002 <0.002 <0.002 <0.002	Sb 0.0005 0.0010 0.0011 0.0011 0.0022 0.0025 0.002 <0.002	Si 0.6300 0.6308 0.6359 0.6410 0.6440 0.6458 0.6470 0.6480 0.6515 0.6600 0.6660 0.6720 0.6760 0.6720 0.6820 0.6544	Sn 0.0036 0.0044 0.0045 0.0048 0.0049 0.0049 0.0057 0.0063 0.0075 <0.001	Ta 0.0001 0.0002 0.0013 0.0043 0.0053 0.0059 <0.0010	Ti 0.0006 0.0010 0.0015 0.0017 0.0018 0.0018 0.0018 0.0021 0.0023 0.0033 0.0023 <0.002	V 0.0420 0.0579 0.0590 0.0601 0.0610 0.0621 0.0626 0.0634 0.0637 0.0642 0.0642 0.0660 0.0660 0.0660 0.0660 0.0662 0.0715 0.0949 0.0642	W 0.0130 0.0192 0.0194 0.0208 0.0220 0.0220 0.0220 0.0220 0.0220 0.0240 0.0240 0.0240 0.0240 0.0240 0.0261 0.0260 0.0271 0.0280 0.0331 0.0237	0.000 0.002 0.002 0.002 0.002 0.0000 0.00000 0.0000 0.0000 0.0000 0.00000 0.00000 0.0000 0.0000	22 36 20 21 27 34 38 05 05 05 10 35 55
2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 Mean STDV	23.40 23.55 23.76 23.87 23.89 23.90 23.92 23.95 23.96 23.98 24.00 24.00 24.01 24.04 24.09 24.17 24.18 24.65 24.70	0.0011 0.0011 0.0012 0.0013 0.0015 0.0018 0.0021 0.0021 0.0027 0.0033	P 0.0150 0.0170 0.0190 0.0190 0.0190 0.0190 0.0190 0.0191 0.0196 0.0198 0.0198 0.0198 0.0200 0.0204 0.0210 0.0215 0.0237 0.0245 0.0247	Pb 0.0003 0.0005	0.0003 0.0004 0.0005 0.0005 0.0007 0.0008 0.0013 <0.0005 <0.0005 <0.0005 <0.0002 <0.002 <0.002	Sb 0.0005 0.0010 0.0011 0.0011 0.0022 0.0025 0.0028 0.002 <0.002	Si 0.6300 0.6308 0.6359 0.6410 0.6440 0.6458 0.6470 0.6480 0.6515 0.6600 0.6630 0.6660 0.6720 0.6770 0.6820	Sn 0.0036 0.0044 0.0045 0.0048 0.0049 0.0049 0.0057 0.0063 0.0075 <0.001	Ta 0.0001 0.0002 0.0013 0.0043 0.0053 0.0059 <0.0010	Ti 0.0006 0.0010 0.0015 0.0017 0.0018 0.0018 0.0018 0.0021 0.0033 0.0037 <0.002	V 0.0420 0.0579 0.0590 0.0601 0.0610 0.0621 0.0626 0.0634 0.0637 0.0642 0.0650 0.0660 0.0660 0.0660 0.0662 0.0715 0.0949	W 0.0130 0.0192 0.0194 0.0208 0.0220 0.0220 0.0220 0.0220 0.0220 0.0241 0.0260 0.0260 0.0260 0.0271 0.0280 0.0331	0.000 0.002 0.002 0.002 0.002 0.000 <0.000 <0.000 <0.000 <0.000 <0.000 <0.000 <0.000 <0.000 <0.000 <0.000 <0.000 <0.000 <0.000 <0.000 <0.000 <0.000 <0.000 <0.000 <0.000 <0.000 <0.000 <0.000 <0.000 <0.000 <0.000 <0.000 <0.000 <0.000 <0.000 <0.000 <0.000 <0.000 <0.000 <0.000 <0.000 <0.000 <0.000 <0.000 <0.000 <0.000 <0.000 <0.000 <0.000 <0.000 <0.000 <0.000 <0.000 <0.000 <0.000 <0.000 <0.000 <0.000 <0.000 <0.000 <0.000 <0.000 <0.000 <0.000 <0.000 <0.000 <0.000 <0.000 <0.000 <0.000 <0.000 <0.000 <0.000 <0.000 <0.000 <0.000 <0.000 <0.000 <0.000 <0.000 <0.000 <0.000 <0.000 <0.000 <0.000 <0.000 <0.000 <0.000 <0.000 <0.000 <0.000 <0.000 <0.000 <0.000 <0.000 <0.000 <0.000 <0.000 <0.000 <0.000 <0.000 <0.000 <0.000 <0.000 <0.000 <0.000 <0.000 <0.000 <0.000 <0.000 <0.000 <0.000 <0.000 <0.000 <0.000 <0.000 <0.000 <0.000 <0.000 <0.000 <0.000 <0.000 <0.000 <0.000 <0.000 <0.000 <0.000 <0.000 <0.000 <0.000 <0.000 <0.000 <0.000 <0.000 <0.000 <0.000 <0.000 <0.000 <0.000 <0.000 <0.000 <0.000 <0.000 <0.000 <0.000 <0.000 <0.000 <0.000 <0.000 <0.000 <0.000 <0.000 <0.000 <0.000 <0.000 <0.000 <0.000 <0.000 <0.000 <0.000 <0.000 <0.000 <0.000 <0.000 <0.000 <0.000 <0.000 <0.000 <0.000 <0.000 <0.000 <0.000 <0.000 <0.000 <0.000 <0.000 <0.000 <0.000 <0.000 <0.000 <0.000 <0.000 <0.000 <0.000 <0.000 <0.000 <0.000 <0.000 <0.000 <0.000 <0.000 <0.000 <0.0000 <0.000 <0.000 <0.000 <0.000 <0.000 <0.000 <0.000 <0.000 <0.000 <0.000 <0.000 <0.0000 <0.0000 <0.0000 <0.0000 <0.0000 <0.0000 <0.0000 <0.0000 <0.0000 <0.0000 <0.0000 <0.0000 <0.0000 <0.0000 <0.0000 <0.0000 <0.0000 <0.0000 <0.0000 <0.0000 <0.0000 <0.0000 <0.0000 <0.0000 <0.00000 <0.00000 <0.00000 <0.00000 <0.00000 <0.00000 <0.00000 <0.00000 <0.000000000 <0.0000000000	22 36 20 21 27 34 38 05 05 05 10 35 55
2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 Mean	23.40 23.55 23.76 23.87 23.89 23.90 23.92 23.95 23.96 23.98 24.00 24.00 24.00 24.01 24.04 24.09 24.17 24.18 24.65 24.70 24.00 0.303 24.0	0.0011 0.0011 0.0012 0.0013 0.0015 0.0018 0.0021 0.0021 0.0027 0.0033 0.0033 0.0018 0.0018 0.0007 0.0018	P 0.0150 0.0170 0.0190 0.0190 0.0190 0.0190 0.0190 0.0191 0.0193 0.0194 0.0195 0.0198 0.0200 0.0204 0.0211 0.0215 0.0227 0.0247 0.0202 0.0024 0.0202	Pb 0.0003 0.0005	0.0003 0.0004 0.0005 0.0005 0.0007 0.0008 0.0013 <0.0005 <0.0005 <0.0010 <0.002 <0.002 <0.002 <0.002 <0.002 <0.002	Sb 0.0005 0.0010 0.0011 0.0011 0.0022 0.0025 0.002 <0.002	Si 0.6300 0.6308 0.6359 0.6410 0.6440 0.6458 0.6470 0.6480 0.6515 0.6600 0.6630 0.6660 0.6720 0.6760 0.6770 0.6820 0.6544 0.0168 0.654	Sn 0.0036 0.0044 0.0045 0.0048 0.0049 0.0049 0.0057 0.0063 0.0075 <0.005	Ta 0.0001 0.0002 0.0013 0.0043 0.0053 0.0059 <0.0010	Ti 0.0006 0.0010 0.0015 0.0017 0.0018 0.0018 0.0018 0.0021 0.0029 0.0033 0.0037 <0.002	V 0.0420 0.0579 0.0590 0.0601 0.0610 0.0621 0.0626 0.0634 0.0637 0.0642 0.0650 0.0660 0.0660 0.0660 0.0660 0.0662 0.0715 0.0949 0.0949 0.0642 0.0100 0.064	W 0.0130 0.0192 0.0194 0.0208 0.0220 0.0220 0.0220 0.0220 0.0220 0.0240 0.0240 0.0240 0.0240 0.0240 0.0241 0.0260 0.0261 0.0271 0.0237 0.00237 0.0024 0.0244	0.000 0.002 0.002 0.002 0.002 0.0000 0.00000 0.0000 0.0000 0.0000 0.00000 0.00000 0.0000 0.0000	22 36 20 21 27 34 38 05 05 05 05 10 35 55
2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 15 16 17 18 19 20 Mean STDV Certified U _{CRM}	23.40 23.55 23.76 23.87 23.89 23.90 23.92 23.95 23.96 23.98 24.00 24.00 24.00 24.01 24.04 24.09 24.17 24.18 24.65 24.70 24.00 0.303 24.0 0.1	0.0011 0.0011 0.0012 0.0013 0.0015 0.0018 0.0021 0.0021 0.0027 0.0033 0.0033 0.0018 0.0007 0.0018 0.0005	P 0.0150 0.0170 0.0190 0.0190 0.0190 0.0190 0.0190 0.0191 0.0198 0.0198 0.0200 0.0210 0.0211 0.0215 0.0247 0.0245 0.0202 0.0024 0.0202 0.0202 0.0204	Pb 0.0003 0.0005	0.0003 0.0004 0.0005 0.0005 0.0007 0.0008 0.0013 <0.0005 <0.0010 <0.0005 <0.0010 <0.002 <0.002 <0.002 <0.002 <0.002 <0.002 <0.002	Sb 0.0005 0.0010 0.0011 0.0011 0.0022 0.0025 0.002 <0.002	Si 0.6300 0.6308 0.6359 0.6410 0.6440 0.6458 0.6470 0.6480 0.6515 0.6600 0.6630 0.6660 0.6720 0.6760 0.6770 0.6820 0.6544 0.0168 0.654 0.009	Sn 0.0036 0.0044 0.0045 0.0048 0.0049 0.0049 0.0057 0.0063 0.0075 <0.001	Ta 0.0001 0.0002 0.0013 0.0043 0.0053 0.0059 <0.0010	Ti 0.0006 0.0010 0.0015 0.0017 0.0018 0.0018 0.0018 0.0021 0.0029 0.0033 0.0037 <0.002	V 0.0420 0.0579 0.0590 0.0601 0.0621 0.0626 0.0634 0.0637 0.0642 0.0650 0.0660 0.0660 0.0660 0.0660 0.0662 0.0715 0.0949 0.0949 0.0942 0.0100 0.0642 0.0100 0.064 0.005	W 0.0130 0.0192 0.0194 0.0208 0.0220 0.0220 0.0220 0.0220 0.0220 0.0240 0.0240 0.0241 0.0260 0.0261 0.0271 0.0280 0.0331 0.0237 0.0044 0.024 0.024	0.000 0.002 0.002 0.002 0.002 0.0000 0.00000 0.00000 0.00000 0.00000 0.00000 0.00000000	12 16 20 21 127 134 18 005 005 10 105 10 105 10 105 10 105 10 105 10 105 10 105 10 105 10 105 10 105 10 105 10 105 105 107 108 109 124
2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 Mean STDV Certified	23.40 23.55 23.76 23.87 23.89 23.90 23.92 23.95 23.96 23.98 24.00 24.00 24.00 24.01 24.04 24.09 24.17 24.18 24.65 24.70 24.00 0.303 24.0	0.0011 0.0011 0.0012 0.0013 0.0015 0.0018 0.0021 0.0021 0.0027 0.0033 0.0033 0.0018 0.0018 0.0007 0.0018	P 0.0150 0.0170 0.0190 0.0190 0.0190 0.0190 0.0190 0.0191 0.0193 0.0194 0.0195 0.0198 0.0200 0.0204 0.0211 0.0215 0.0227 0.0247 0.0202 0.0024 0.0202	Pb 0.0003 0.0005	0.0003 0.0004 0.0005 0.0005 0.0007 0.0008 0.0013 <0.0005 <0.0005 <0.0010 <0.002 <0.002 <0.002 <0.002 <0.002 <0.002	Sb 0.0005 0.0010 0.0011 0.0011 0.0022 0.0025 0.002 <0.002	Si 0.6300 0.6308 0.6359 0.6410 0.6440 0.6458 0.6470 0.6480 0.6515 0.6600 0.6630 0.6660 0.6720 0.6760 0.6770 0.6820 0.6544 0.0168 0.654	Sn 0.0036 0.0044 0.0045 0.0048 0.0049 0.0049 0.0057 0.0063 0.0075 <0.005	Ta 0.0001 0.0002 0.0013 0.0043 0.0043 0.0053 0.0059 <0.0010	Ti 0.0006 0.0010 0.0015 0.0017 0.0018 0.0018 0.0018 0.0021 0.0029 0.0033 0.0037 <0.002	V 0.0420 0.0579 0.0590 0.0601 0.0610 0.0621 0.0626 0.0634 0.0637 0.0642 0.0650 0.0660 0.0660 0.0660 0.0660 0.0662 0.0715 0.0949 0.0949 0.0642 0.0100 0.064	W 0.0130 0.0192 0.0194 0.0208 0.0220 0.0220 0.0220 0.0220 0.0220 0.0240 0.0240 0.0241 0.0260 0.0261 0.0271 0.0280 0.0331 0.0237 0.0044 0.024 0.024	0.000 0.002 0.002 0.002 0.002 0.0000 0.00000 0.00000 0.00000 0.00000 0.00000 0.00000000	22 36 20 21 27 34 38 05 06 07 08 09 24)

Legend: W = Classical, C = Combustion, F = Fusion, A = AA or GFAA, I = ICP or DCP, IM=ICP-MS, D = DC Arc, O = AES, X = XRF, G = GDAES or GDMS, H = Hollow Cathode AES

