



# Certificate of Analysis

## IARM 333A

Mar-M 247 / UNS NA

### Certified Reference Material

Certified Values listed in wt.% with associated uncertainties

<b>Al</b>	<b>5.53 ± 0.01</b>	<b>B</b>	<b>0.016 ± 0.001</b>	<b>C</b>	<b>0.073 ± 0.002</b>	<b>Co</b>	<b>9.45 ± 0.09</b>
<b>Cr</b>	<b>8.37 ± 0.07</b>	<b>Fe</b>	<b>0.041 ± 0.006</b>	<b>Hf</b>	<b>1.40 ± 0.02</b>	<b>Mg</b>	<b>0.0013 ± 0.0001</b>
<b>Mn</b>	<b>0.004 ± 0.003</b>	<b>Mo</b>	<b>0.485 ± 0.002</b>	<b>N</b>	<b>0.0013 ± 0.0001</b>	<b>Nb</b>	<b>0.0043 ± 0.0009</b>
<b>Ni</b>	<b>61.1 ± 0.3</b>	<b>O</b>	<b>0.0004 ± 0.0001</b>	<b>P</b>	<b>0.003 ± 0.001</b>	<b>Re</b>	<b>0.008 ± 0.004</b>
<b>S</b>	<b>0.0004 ± 0.0001</b>	<b>Si</b>	<b>0.08 ± 0.01</b>	<b>Ta</b>	<b>3.14 ± 0.04</b>	<b>Ti</b>	<b>0.725 ± 0.009</b>
<b>V</b>	<b>0.0014 ± 0.0005</b>	<b>W</b>	<b>9.65 ± 0.05</b>	<b>Zr</b>	<b>0.008 ± 0.001</b>		

Indicative Values listed in ppm

As (2)	Bi (0.1)	Ca (<12)	Cu (20)	Pb (<0.1)	Sb (0.2)	Y (<1)
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#### Description and Intended Use

This CRM may come in the form of a solid disc 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.

#### Interpretation of Data

1. Certified values listed reflect analysis results submitted by qualified analytical laboratories using a combination of methods and instrumentation that emulate actual methods and instrumental techniques currently utilized in the analytical community, and are reported as wt% unless otherwise noted.
2. This material was tested using both the solid disks and chips prepared from individual sections of bar. The certified values are considered representative of the overall average composition of the material.
3. Any data reported and enclosed by a parentheses ( ) is a "best estimate" and is not certified. This data could not be quantified sufficiently for certification. It was, however, reported by enough laboratories to be considered as potentially present in the matrix of the material being examined.
4. "Provisional Certificate of Analysis" reports values that support a fully certified reference material; it also indicates that values may be in a continued process of statistical evaluation and are subject to change.
5. Chips are not certified for Oxygen analysis.



The following data and accompanying statements represent all pertinent information reported in the ILAP as it applies to the chemical characterization of this material.

	Al	As	B	Bi	C	Ca	Co	Cr	Cu	Fe	Hf	Mg	Mn	Mo	N	Nb
1	5.4851	0.00003	0.0124	0.0000004	0.0675	0.0009	9.17	8.19	0.0002	0.028	1.356	0.001	0.0004	0.481	0.00091	0.0029
2	5.4878	0.00019	0.0139	0.000001	0.0697	0.0011	9.327	8.238	0.0002	0.033	1.359	0.0011	0.0005	0.4814	0.00102	0.0029
3	5.513	0.0002	0.014	0.00001	0.07	<0.001	9.36	8.288	0.001	0.0333	1.3623	0.0013	0.0009	0.4816	0.0012	0.003
4	5.517	0.0003	0.0144	0.00001	0.071	<0.0010	9.366	8.31	0.00112	0.0335	1.372	0.0013	0.0033	0.482	0.001244	0.0035
5	5.518	<0.0001	0.0145	<0.000001	0.071	<0.005	9.398	8.315	0.0013	0.034	1.387	0.00137	0.004	0.483	0.0013	0.0045
6	5.52	<0.0001	0.0155	<0.0001	0.0711		9.414	8.317	0.0019	0.037	1.3897	0.0014	0.004	0.486	0.00135	0.0045
7	5.528	<0.005	0.0158		0.0723		9.429	8.32	0.0023	0.037	1.403	0.0015	0.0048	0.487	0.0014	0.005
8	5.53		0.0159		0.073		9.441	8.321	0.006	0.0373	1.408	0.0015	0.006	0.488	0.0014	0.005
9	5.5303		0.016		0.0733		9.448	8.37		0.04	1.423		0.0114	0.4896	0.0015	0.0052
10	5.539		0.0164		0.0737		9.4558	8.3773		0.04	1.437			0.49	0.0015	0.0066
11	5.54		0.01693		0.07411		9.503	8.382		0.0515	1.4491			0.49	0.0015	
12	5.541		0.0172		0.075		9.584	8.48		0.0565					0.0015	
13	5.55		0.019		0.0757		9.653	8.592		0.058					0.0015	
14	5.57				0.0787		9.7973	8.6103		0.0607					0.0016	
15																
Mean	5.53	0.0002	0.016	0.000005	0.073	0.001	9.45	8.37	0.002	0.041	1.40	0.0013	0.004	0.485	0.0013	0.0043
STDV.	0.02	0.0001	0.002	0.000005	0.003	0.0001	0.20	0.10	0.002	0.01	0.03	0.0002	0.003	0.004	0.0002	0.0010
<b>Certified</b>	<b>5.53</b>	<b>(0.0002)</b>	<b>0.016</b>	<b>(0.00001)</b>	<b>0.073</b>	<b>(0.001)</b>	<b>9.45</b>	<b>8.37</b>	<b>(0.002)</b>	<b>0.041</b>	<b>1.40</b>	<b>0.0013</b>	<b>0.004</b>	<b>0.485</b>	<b>0.0013</b>	<b>0.0043</b>
95% C.I.	0.01		0.001		0.002		0.09	0.07		0.006	0.02	0.0001	0.003	0.002	0.0001	0.0009
Methods	X,O,I,G	IM,I,H,G	O,IM,I,G	IM,H,G	C	IM,I	X,O,I,G	X,O,I,G	X,O,IM,I,G	X,O,IM,I,G	X,I	O,IM,I	X,O,IM,I,G	X,O,I,G	F	X,O,IM,I,G

	Ni	O	P	Pb	Re	S	Sb	Si	Ta	Ti	V	W	Y	Zr
1	60.505	0.0002	0.0002	0.0000028	0.0043	0.00002	0.0000044	0.0209	3.03	0.6903	0.0005	9.47	0.00005	0.003
2	60.6053	0.000274	0.0006	0.000003	0.006	0.0001	0.000016	0.044	3.054	0.709	0.001	9.557	<0.0001	0.0035
3	60.717	0.0003	0.0011	0.00002	0.0073	0.0002	0.00003	0.0662	3.099	0.718	0.001	9.604	<0.0001	0.007
4	60.92	0.0003	0.0034	<0.00001	0.0075	0.00028		0.0667	3.1	0.722	0.001	9.607	<0.0001	0.007
5	60.973	0.0004	0.0035	<0.00001	0.011	0.0003		0.0677	3.12	0.7229	0.001	9.612	<0.001	0.0076
6	61.04	0.0004	0.0037	<0.0001	0.0148	0.000428		0.069	3.1293	0.723	0.0012	9.62		0.0077
7	61.0495	0.0004	0.0038	<0.005		0.00045		0.0761	3.133	0.723	0.0014	9.62		0.0078
8	61.26	0.0004	0.004			0.0005		0.0782	3.138	0.726	0.0019	9.6266		0.0079
9	61.271	0.00043				0.0006		0.089	3.14	0.729	0.002	9.637		0.008
10	61.71	0.00087				0.00067		0.09	3.16	0.729	0.003	9.6599		0.0088
11	61.858					0.0007		0.095	3.167	0.73		9.753		0.009
12						0.0007		0.1	3.235	0.7337		9.762		0.009
13								0.108	3.275	0.7339		9.764		0.0092
14								0.11		0.76		9.77		0.013
15														<0.02
Mean	61.1	0.0004	0.003	0.00001	0.008	0.0004	0.00002	0.08	3.14	0.725	0.0014	9.65	0.00005	0.008
STDV.	0.4	0.0002	0.002	0.00001	0.004	0.0002	0.00001	0.02	0.07	0.020	0.0007	0.09		0.002
<b>Certified</b>	<b>61.1</b>	<b>0.0004</b>	<b>0.003</b>	<b>(0.00001)</b>	<b>0.008</b>	<b>0.0004</b>	<b>(0.00002)</b>	<b>0.08</b>	<b>3.14</b>	<b>0.725</b>	<b>0.0014</b>	<b>9.65</b>	<b>(0.00005)</b>	<b>0.008</b>
95% C.I.	0.3	0.0001	0.001		0.004	0.0001		0.01	0.04	0.009	0.0005	0.05		0.001
Methods	X,O,I	F	X,O,IM,I,G	O,IM,I,H,G	X,IM,I,G	C	IM,I,H,G	X,O,IM,I,G	X,O,I,G	X,O,I,G	X,O,IM,I,G	X,O,I,G	X,IM,I,G	X,O,IM,I

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

## Participating Laboratories

Alcoa Howmet, Dover Alloy  
ATI Specialty Materials, Monroe  
Timet - Vallejo  
Dirats Laboratories  
NSL Analytical Services  
IMR Test Labs  
ATI Powder Metals

Dover, NJ  
Monroe, NC  
Vallejo, CA  
Westfield, MA  
Cleveland, OH  
Lansing, NY  
Pittsburgh, PA

LECO Corporation  
Laboratory Testing, Inc.  
Alcoa Howmet, Exeter Alloy  
Special Metals IncoTest  
ATI Specialty Materials, Lockport  
Alcoa Howmet, Research Center

St. Joseph, MI  
Hatfield, PA  
Exeter Devon, England  
Hereford, UK  
Lockport, NY  
Whitehall, MI

## Traceability

Members of the "Inter-Laboratory Analysis Program" (ILAP) validate test methods and instrument performance utilizing SRMs, CRMs, and RMs produced by recognized Certifying Bodies. The specific SRMs, CRMs, and RMs applicable to the material covered by this certificate are:

ALPHA AR645	ALPHA AR872	ALPHA AR892	ALPHA AR892C	ALPHA AR946	BAS 346A	BCS 345	BCS 346	BCS 351
BCS 454/1	BCS 462/1	BICTA 1	BICTA 2	BS 198	BS 750A	BS CSN-4	BS H3B	IARM 190A
IARM 234B	IARM 333A	IARM 50B	IARM 53D	IARM 62A	IARM 62C	IARM 68B	IH AC1102	IH AD1029
IH AD1036	IH AD1056	IH AG1015	IH AG1026	IH AG1087	IH AR3017	IH M247 091012	IH R1780	IH RR37
IH RR49	IH V1080	IM2 181	LECO 501-271	LECO 501-502	LECO 501-503	LECO 501-505	LECO 501-550	LECO 501-643
LECO 501-644	LECO 501-645	LECO 501-646	LECO 501-673	LECO 501-991	LECO 501-992	LECO 502-064	LECO 502-102	LECO 502-265
LECO 502-411	LECO 502-414	LECO 502-416	LECO 502-456	LECO SS345	MBH 210X11774F	MBH 212X11233-E	MBH 215XHC5-S	MBH 219X1867
NIST 101G	NIST 1191	NIST 1192	NIST 1249	NIST 131F	NIST 131G	NIST 15H	NIST 1754	NIST 3103A
NIST 3106	NIST 3107	NIST 3109A	NIST 3128	NIST 3131A	NIST 3151	NIST 3161A	NIST 349	NIST 72G
NIST C2402	RNI 11/10	RNI 12/12	RNI 13/11	RNI 14/11	RNI 15/12	TIMET AD1029	TIMET AG1015	TIMET AM1126
TIMET V1080	TRAMPS 2000	VHG 002-0017	VHG 002-0024	VHG 002-0061R	VHG 003-0136	VHG 006-0119R	VHG 007-0054R	VHG 007-0058R
VHG 010-0030	VHG 012-0075R	VHG 012-0164F	VHG 104-0034R	VHG 104-0064R	VHG 109-0005	VHG 907-0147	VHG 912-0054	

## 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  $N_{prod}$  is the number of units produced and  $N_{min}$  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 is also determined within sample using an applied version of ASTM E826. A single factor ANOVA is used to calculate uncertainty due to inhomogeneity ( $U_{hom}$ ). Uncertainty of the material is calculated by equation 2, where  $H=U_{hom}$ ,  $S$  = Standard deviation,  $t$  = t-value at 95% CI, and  $n$  = number of observations.

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

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

The International Standards Organization (ISO) definitions, expressed in ISO Guide 30–1992 list the following:

**Certifying Body:** Any technically competent body (organization or firm, public or private) that issues a reference material certificate with the information detailed in ISO Guide 31. The only generally accepted certifying body in the United States for primary standards or Standard Reference Materials (SRM) is the U. S. Department of Commerce, National Institute of Standards & Technology (NIST), Gaithersburg, MD. All other certifying bodies in the United States produce Reference Materials (RM) or Certified Reference Materials (CRM).

**Reference Material (RM):** Material or substance, with one or more property values that are sufficiently homogeneous and well established, to be used for the calibration of an apparatus, the assessment of a measurement method, or for assigning values to materials.

**Certified Reference Material (CRM):** Reference material, accompanied by a certificate, with one or more property values certified by a procedure, which establishes its traceability to an accurate realization of the unit in which the property values are expressed, and for which each certified value is accompanied by an uncertainty at a stated level of confidence.

**Inter-Laboratory Analysis Program (ILAP):** ASTM Standard E691-87 applies to inter-laboratory studies to "Determine the Precision of a Single Test Method", but also outlines a well thought out and logical plan for conducting an inter laboratory program involving multiple analytical techniques. Therefore, the guidelines established in ASTM E691-87 were applied to all aspects of this inter laboratory program, including the protocols for planning, handling, analysis and treatment of resulting data.

**Methods of Analysis:** The "Inter Laboratory Analysis Program" analyzes a wide variety of materials, and as a result, no single analytical method would provide optimum analytical results. Therefore, a combination of ASTM Standard Methods for classical wet chemistry, ICP, AA, Optical Emission, X-Ray spectrometric, and other accepted methods were used to produce analytical data. Carbon, Sulfur, Nitrogen, and Oxygen results were supplied from combustion and OE instrument procedures.

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

**Instructions for Use:** The test surface is on the side opposite to the labeled surface, which includes the IARM number. 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 to be used for Oxygen analysis.**

**Selection of Materials:** A "batch" or "series" is defined as a continuous length of bar produced from a single heat. The majority of IARM materials are in wrought condition; other methods of manufacture are utilized if necessary. ILAP samples are removed from equal sections from the total length of the bar. A portion of each section is converted to chips and a thin (pin) disk for analysis by classical wet chemistry, ICP, AA, and combustion procedures, and the balance remains as a thick disk for OES and X-Ray analysis.



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