



Certificate of Analysis

IARM 88C

CDA 863 / UNS C86300

Certified Reference Material

Certified Values listed in wt.% with associated uncertainties

Ag	0.004 ± 0.001	Al	5.79 ± 0.03	As	0.007 ± 0.006	Bi	0.004 ± 0.001
C	0.005 ± 0.001	Cd	0.0009 ± 0.0007	Co	0.0010 ± 0.0001	Cr	0.008 ± 0.001
Cu	64.5 ± 0.2	Fe	2.98 ± 0.09	Mg	0.0006 ± 0.0003	Mn	2.99 ± 0.04
Ni	0.276 ± 0.007	P	0.020 ± 0.001	Pb	0.133 ± 0.005	S	0.0010 ± 0.0005
Sb	0.003 ± 0.001	Si	0.091 ± 0.005	Sn	0.147 ± 0.005	Zn	22.86 ± 0.09
Zr	0.0004 ± 0.0002						

Indicative Values listed in ppm

B (<1000)	Be (<50)	N (1.6)	Nb (10)	O (6)	Se (<50)	Te (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.

	Ag	Al	As	B	Be	Bi	C	Cd	Co	Cr	Cu	Fe	Mg	Mn	N	Nb
1	0.003	5.677	0.0005	0.003	0.0005	0.0025	0.0033	0.0001	0.0006	0.0054	63.833	2.66	0.0001	2.8525	0.0001	0.0002
2	0.0038	5.71	0.0011	0.089	0.0027	0.003	0.0036	0.000179	0.0009	0.0063	64.036	2.87	0.0005	2.93	0.00015	0.0004
3	0.0038	5.76	0.0023	<0.001	0.0045	0.0032	0.0039	0.0004	0.0009	0.0077	64.25	2.94	0.0005	2.937	0.0002	0.0005
4	0.0038	5.766	0.0024		<0.00001	0.00385	0.0043	0.0008	0.0009	0.0084	64.4535	2.9418	0.0006	2.94	0.0002	0.001
5	0.0049	5.7906	0.004			0.0049	0.0051	0.001	0.001	0.0087	64.46	2.95	0.0007	2.969		0.0011
6	0.006	5.792	0.0045			0.005	0.0052	0.002	0.001	0.0089	64.4715	2.972	0.0009	2.9724		0.0041
7	0.0061	5.805	0.0051				0.0058	0.002	0.0011	0.0091	64.67	2.9785		2.9724		
8		5.8055	0.016				0.0078		0.0012	0.0098	64.69	2.99		2.976		
9		5.81	0.0226							0.011	64.705	2.9997		2.98		
10		5.83									64.715	3.027		2.984		
11		5.83									64.84	3.028		3.036		
12		5.8449									64.868	3.191		3.05		
13		5.854									64.987	3.25		3.0723		
14														3.13		
15																
Mean	0.004	5.79	0.007		0.003	0.004	0.005	0.0009	0.001	0.008	64.5	2.98	0.0006	2.99	0.00016	0.001
STDV.	0.001	0.05	0.008		0.002	0.001	0.001	0.0008	0.0002	0.002	0.3	0.1	0.0003	0.07	0.00005	0.001
Certified	0.004	5.79	0.007	(<0.1)	(<0.005)	0.004	0.005	0.0009	0.0010	0.008	64.5	2.98	0.0006	2.99	(0.00016)	(0.001)
95% C.I.	0.001	0.03	0.006		0.001	0.001	0.001	0.0007	0.0001	0.001	0.2	0.09	0.0003	0.04		
Methods	O,I	X,O,I	X,O,I	O,I	O,I	O,I	C	O,IM,I	O,I	O,I	O,W	X,O,I	O,I	X,O,I	F	O,I

	Ni	O	P	Pb	S	Sb	Se	Si	Sn	Te	Zn	Zr				
1	0.256	0.0001	0.0159	0.1223	0.00008	0.0006	0.0005	0.0759	0.137	0.0001	22.587	0.0001				
2	0.263	0.0006	0.0174	0.125	0.0002	0.0015	0.0006	0.084	0.1375	<0.0001	22.67	0.0001				
3	0.2635	0.00073	0.0185	0.1259	0.0007	0.0018	0.005	0.086	0.1386		22.72	0.0003				
4	0.267	0.0011	0.019	0.128	0.001	0.0025	<0.00001	0.087	0.144		22.7999	0.0005				
5	0.2674		0.0199	0.1292	0.001	0.0026	<0.0001	0.0877	0.1454		22.80	0.0005				
6	0.271		0.0199	0.1317	0.001	0.0028	<0.0010	0.089	0.1455		22.82	0.0006				
7	0.2741		0.021	0.132	0.0014	0.003		0.0904	0.1458		22.88					
8	0.276		0.0211	0.132	0.0014	0.00395		0.0912	0.148		22.89					
9	0.28		0.0217	0.1343	0.0022	0.0043		0.093	0.1503		22.9043					
10	0.282		0.022	0.1365		0.0056		0.1005	0.152		23.011					
11	0.286		0.022	0.1366				0.102	0.156		23.02					
12	0.2863			0.145				0.1035	0.16		23.0254					
13	0.29			0.15							23.11					
14	0.299															
15																
Mean	0.276	0.0006	0.02	0.133	0.001	0.003	0.002	0.091	0.147		22.86	0.0004				
STDV.	0.01	0.0004	0.002	0.008	0.0006	0.001	0.003	0.008	0.007		0.2	0.0002				
Certified	0.276	(0.0006)	0.020	0.133	0.0010	0.003	(<0.005)	0.091	0.147	(0.0001)	22.86	0.0004				
95% C.I.	0.007	0.001	0.005	0.0005	0.001	0.001	0.005	0.005	0.005		0.09	0.0002				
Methods	X,O,I	F	X,O,I	X,O,I,A	O,I,C	X,O,I	O,I	X,O,I	X,O,I	I	X,O,I	O,I				

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



Participating Laboratories

Exova - Alburdis
Sipi-Metals Corp
Special Metals IncoTest
I. Schumann & Company
Anderson Laboratories, Inc.
Riverside Brass & Aluminum Foundry Ltd.

Los Angeles, CA
Chicago, IL
Hereford, UK
Bedford, OH
Greendale, WI
New Hamburg, ON

MetalTek International, Inc.
Laboratory Testing, Inc.
Exova - Teesside
Exova - Glendale Heights
Colonial Metals Co.
Concast Metal Products Co.

Waukesha, WI
Hatfield, PA
Middlesbrough, UK
Glendale Heights, IL
Columbia, PA
Mars, PA

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 AR649	ALPHA AR881	BCR 084	BCR 85	BCS 304	BCS 351	BCS 454/1	BCS 462/1	BNF C38/01-1
BNF C38/02-1	BNF C38/03-1	BNF C38/04-1	BNF C38/05-1	BNF C42/21-1	BNF C42/22-1	BNF C42/23-1	BS 179/1	BS 179/2
BS 180/2	BS 182/2	BS 183/4	BS 207/2	BS 304/1	BS 364	BS 863	BS 863A	CPI-4400 100023
CPI-4400 10M121	CPI-4400 10M131	IARM 77B	IARM 863A	IARM 86C	IARM 87B	IARM 88A	IARM 88B	IMN WM1
IMN WM2	IMN WM3	IMN WM4	IMN WM5	L1A	L2	L20A	L3A	L4-1
L6A	LECO 501-147	LH1	LH12	LH2	LH2A	LH5A	LH6-1	LH7-1A
MBH CBC40	NIST 164	NIST 3102A	NIST 3103A	NIST 3105A	NIST 3106	NIST 3107	NIST 3108	NIST 3112A
NIST 3113	NIST 3131A	NIST 3137	NIST 3139A	NIST 3149	NIST 3151	NIST 3156	NIST 3162A	NIST 3169
NIST C1252	NIST C1253A	WILLAN N4BE						

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.



David Coler, General Manager

Analytical Reference Materials International



Analytical Reference Materials International • 276 Abby Road • Manchester, NH 03103
Telephone (603) 935-4100 • Fax (603) 935-4101 • www.ARMi.com • ARMi@LGCgroup.com

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