LGC ARMI

Certificate of Analysis
IARM 29E
AISI 1117 / UNS G11170
Certified Reference Material

Certified Values listed in wt.% with associated uncertainties

Al	0.0032 ± 0.0007	**As**	0.0085 ± 0.0006	**B**	0.0007 ± 0.0002	**C**	0.193 ± 0.002
Ca	0.0012 ± 0.0003	**Co**	0.008 ± 0.001	**Cr**	0.105 ± 0.002	**Cu**	0.253 ± 0.002
Mn	1.19 ± 0.01	**Mo**	0.0269 ± 0.0007	**N**	0.0093 ± 0.0008	**Nb**	0.0024 ± 0.0007
Ni	0.082 ± 0.001	**O**	0.005 ± 0.002	**P**	0.0157 ± 0.0005	**Pb**	0.0010 ± 0.0008
S	0.121 ± 0.005	**Sb**	0.003 ± 0.001	**Si**	0.239 ± 0.003	**Sn**	0.0109 ± 0.0003
Ti	0.0014 ± 0.0005	**V**	0.0255 ± 0.0005				

Indicative Values listed in ppm

Bi (<130)	Mg (3)	Se (6)	Ta (4)	W (<70)	Zn (40)	Zr (<40)

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	Mg	Mn	Mo	N	Nb	Ni	O
1	0.0019	0.0077	0.00025	0.00004	0.1893	0.0008	0.0057	0.10	0.25	0.0001	1.1533	0.0249	0.0064	0.0013	0.0798	0.00303
2	0.002	0.0079	0.0004	0.0003	0.19	0.00086	0.007	0.10	0.2505	0.0002	1.177	0.0255	0.0087	0.0016	0.0799	0.003498
3	0.002	0.0086	0.0004	0.013	0.19	0.0013	0.0071	0.102	0.2506	0.0004	1.1844	0.026	0.0088	0.0018	0.08	0.0037
4	0.0027	0.0087	0.0007	<0.0010	0.1906	0.0013	0.0072	0.103	0.251	0.0006	1.1844	0.0261	0.00911	0.0025	0.081	0.004
5	0.0028	0.0087	0.00078		0.191	0.0013	0.008	0.1044	0.2515	<0.0050	1.185	0.0263	0.00915	0.0026	0.082	0.0056
6	0.0035	0.0093	0.00079		0.192	0.0016	0.0083	0.1056	0.25225		1.1899	0.027	0.0093	0.002667	0.082	0.0059
7	0.0035		0.0009		0.1927		0.0085	0.1059	0.253		1.191	0.027	0.0094	0.0027	0.082	0.0065
8	0.0035		0.00104		0.1934		0.0087	0.106	0.253		1.192	0.027	0.0095	0.004	0.0821	0.0072
9	0.0038		0.0011		0.1934		0.0113	0.1065	0.2538		1.193	0.0273	0.0095		0.083	0.0095
10	0.004				0.1941		0.0124	0.107	0.255		1.197	0.028	0.0096		0.084	
11	0.005				0.196			0.108	0.26		1.20	0.028	0.0098		0.0846	
12					0.1964			0.108	0.2603		1.2043	0.028	0.0099		0.085	
13					0.1971			0.1087			1.21	0.029	0.0123		0.086	
14								0.111			1.2335					
15																
Mean	0.0032	0.0085	0.0007		0.193	0.0012	0.008	0.105	0.253	0.0003	1.19	0.0269	0.0093	0.0024	0.082	0.005
STDV.	0.001	0.0006	0.0003		0.003	0.0003	0.002	0.003	0.003	0.0002	0.02	0.001	0.001	0.0008	0.002	0.002
Certified	**0.0032**	**0.0085**	**0.0007**	**(<0.013)**	**0.193**	**0.0012**	**0.008**	**0.105**	**0.253**	**(0.0003)**	**1.19**	**0.0269**	**0.0093**	**0.0024**	**0.082**	**0.005**
95% C.I.	0.0007	0.0006	0.0002		0.002	0.0003	0.001	0.002	0.002		0.01	0.0007	0.0008	0.0007	0.001	0.002
Methods	O,I,G	X,O,IM,I	O,I,G	O,IM	O,C	O,I,G	X,O,I,G	X,O,I,G	X,O,I,G	O,IM,I	X,O,I,G	X,O,I,G	O,F	X,O,I,G	X,O,I,G	F

	P	Pb	S	Sb	Se	Si	Sn	Ta	Ti	V	W	Zn	Zr
1	0.014	0.0002	0.109	0.0012	0.0005	0.229	0.0101	0.0003	0.0004	0.0244	0.0009	0.0032	0.0001
2	0.0148	0.00035	0.1122	0.0018	0.0006	0.2333	0.01033	0.0004	0.0007	0.025	0.0009	0.0037	0.0001
3	0.0148	0.0007	0.1132	0.0025	0.0008	0.2339	0.0105	0.0005	0.0008	0.025	0.0034	0.0047	0.0007
4	0.015	0.0009	0.114	0.0025	<0.001	0.234	0.0108	<0.001	0.0009	0.025	0.0063	0.0058	0.0013
5	0.0153	0.0018	0.1166	0.0028	<0.005	0.238	0.01085	<0.0050	0.0011	0.0252	0.0063		0.0034
6	0.0157	0.0019	0.1181	0.0045		0.2385	0.0109	<0.008	0.0014	0.02567	<0.005		<0.00097
7	0.016		0.1207			0.239	0.011		0.0014	0.0257	<0.0050		<0.002
8	0.016		0.122			0.2397	0.011		0.0016	0.0257	<0.010		
9	0.016		0.1235			0.24	0.01107		0.0017	0.0258			
10	0.0162		0.1253			0.242	0.0111		0.0025	0.0258			
11	0.0165		0.12735			0.242	0.0114		0.002667	0.027			
12	0.017		0.128			0.2429	0.012						
13	0.017		0.1368			0.244							
14						0.245							
15													
Mean	0.0157	0.001	0.121	0.003	0.0006	0.239	0.0109	0.0004	0.0014	0.0255	0.004	0.004	0.001
STDV.	0.0009	0.0007	0.008	0.001	0.0002	0.005	0.0005	0.0001	0.0007	0.0007	0.003	0.001	0.001
Certified	**0.0157**	**0.0010**	**0.121**	**0.003**	**(0.0006)**	**0.239**	**0.0109**	**(0.0004)**	**0.0014**	**0.0255**	**(<0.007)**	**(0.004)**	**(0.004)**
95% C.I.	0.0005	0.0008	0.005	0.001		0.003	0.0003		0.0005	0.0005			
Methods	X,O,I,G	O,IM,I,G	O,C	X,O,IM	X,O,I	X,O,I,G	O,I,IM,G	X,O,IM	X,O,I,G	X,O,I,G	X,O,I,G	X,O,I	X,O,IM

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

LECO Corporation	St. Joseph, MI	TimkenSteel Corporation	Canton, OH
Anderson Laboratories, Inc.	Greendale, WI	Laboratory Testing, Inc.	Hatfield, PA
Laboratorio Prove Materiali S. Marco srl	Schio, Italy	AADFW, Inc.	Euless, TX
Nucor Steel Norfolk	Norfolk, NE	Cronimet Specialty Metals USA, Inc.	Wheatland, PA
Essar Steel Algoma, Inc.	Sault Ste. Marie, ON	Davis Alloys Manufacturing, LLC	Sharpsville, PA
Exova - Gary	Gary, IN	revierlabor GmbH	Essen, Germany

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 AR512	ALPHA AR654	ALPHA AR657	ALPHA AR661	ALPHA AR873	ALPHA AR878	ALPHA AR883	ALPHA AR896	ASM 1021
ASM 2032	BAM 128-1	BAM 195-1	BAM 476	BAS 401/1	BAS 402/1	BAS 403/1	BAS 404/1	BAS 405/1
BAS 406/1	BAS 407/2	BAS 408/1	BAS 408/2	BAS 409/1	BAS 409/2	BAS 410/2	BS 405/1	BS 56E
BS 665	BS 66L	BS 71A	BS 74E	BS 75F	BS 75G	BS CA-1	BS CA1A	BS CA-2
BS CA-3	BS CA3A	BS CA-4	BS HCN	CKD 165A	EN 482-2	IARM 10D	IARM 199A	IARM 199B
IARM 254A	IARM 29B	IARM 29D	IARM 30G	IARM 32D	JK NR21	JSS 168-4	JSS 169-4	JSS 170-4
JSS 171-4	JSS 172-4	JSS 173-4	JSS 175-4	JSS 174-4	JSS 175-4	JSS ST01	JSS ST01-5	JSS ST03
JSS ST04	JSS ST05	JSS ST06	LECO 501-504	LECO 501-550	LECO 501-644	LECO 501-646	LECO 501-992	LECO 502-102
LECO 502-194	LECO 502-197	LECO 502-416	LECO 502-449	NIST 1160	NIST 1161	NIST 1162	NIST 1163	NIST 1164
NIST 1261A	NIST 1263	NIST 1263A	NIST 1269	NIST 16F	NIST 1754	NIST 1760	NIST 1761	NIST 1762
NIST 1763	NIST 1763A	NIST 1764	NIST 1765	NIST 1766	NIST 1767	NIST 2163	NIST 2167	NIST 293
NIST 3101A	NIST 3108	NIST 3109A	NIST 3113	NIST 3114	NIST 3128	NIST 3131A	NIST 3134	NIST 3136
NIST 3137	NIST 3149	NIST 3150	NIST 3155	NIST 3162A	NIST 3163	NIST 3168A	NIST 3169	NIST 361
NIST 362	NIST 363	NIST 364	NIST 368	SUS EISEN 1/3	ZRM 284-1	ZRM 284-2	ZRM H1	

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 calculated 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.

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

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

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