Certificate of Analysis

IARM 329A

Alloy G-35 / UNS N06035

Certified Reference Material

Certified Values listed in wt.% with associated uncertainties

Ag	**0.00007** ± 0.00003	**Al**	**0.29** ± 0.01	**As**	**0.0009** ± 0.0002	**B**	**0.0010** ± 0.0004
C	**0.0086** ± 0.0004	**Co**	**0.052** ± 0.006	**Cr**	**33.7** ± 0.3	**Cu**	**0.065** ± 0.004
Fe	**0.92** ± 0.05	**Mg**	**0.0124** ± 0.0007	**Mn**	**0.222** ± 0.004	**Mo**	**8.38** ± 0.06
N	**0.073** ± 0.001	**Nb**	**0.131** ± 0.003	**Ni**	**55.8** ± 0.2	**O**	**0.0027** ± 0.0007
P	**0.0059** ± 0.0009	**Pb**	**0.00003** ± 0.00001	**S**	**0.0003** ± 0.0001	**Sb**	**0.00013** ± 0.00005
Si	**0.053** ± 0.006	**Sn**	**0.0005** ± 0.0004	**Ti**	**0.005** ± 0.002	**V**	**0.009** ± 0.002
W	**0.021** ± 0.004	**Zr**	**0.0012** ± 0.0005				

Indicative Values listed in ppm

Bi (<1) Ca (<60) La (<1) Ta (<80)

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	Bi	C	Ca	Co	Cr	Cu	Fe	La	Mg	Mn	Mo	N
1	0.00004	0.254	0.0006	0.0001	0.000001	0.0075	0.00006	0.034	32.9301	0.052	0.834	0.000001	0.01073	0.214	8.243	0.07
2	0.00004	0.274	0.00065	0.0001	0.000007	0.008	0.0052	0.0429	33.219	0.062	0.835	0.00003	0.0117	0.2154	8.2918	0.0709
3	0.00005	0.283	0.0008	0.0002	0.00001	0.0081	<0.0002	0.0443	33.5453	0.0627	0.837	<0.0001	0.0125	0.217	8.309	0.071
4	0.00007	0.287	0.001	0.0004	<0.00001	0.0082		0.045	33.575	0.0637	0.8505		0.0125	0.2172	8.318	0.071
5	0.0001	0.287	0.001	0.0006	<0.00001	0.00822		0.046	33.58	0.065	0.866		0.0127	0.2198	8.3189	0.0722
6	0.0001	0.2885	0.001	0.0006	<0.00002	0.00825		0.048	33.60	0.065	0.911		0.0129	0.2198	8.352	0.0724
7		0.2895	0.0011	0.0009	<0.0001	0.0089		0.05	33.764	0.065	0.923		0.013	0.224	8.357	0.0726
8		0.29		0.001		0.0091		0.05	33.7915	0.066	0.925		0.0133	0.224	8.38	0.0728
9		0.2963		0.0012		0.0091		0.05	33.869	0.0661	0.944			0.228	8.419	0.0735
10		0.298		0.00134		0.0092		0.0517	33.90	0.0663	0.951			0.229	8.44	0.0745
11		0.305		0.002		0.0092		0.054	34.09	0.06638	0.988			0.23	8.49	0.0749
12		0.315		0.002		0.0093		0.068	34.49	0.078	1.05				8.5845	0.0752
13		0.318		0.002				0.07047			1.09132					0.0756
14								0.071								
15																
Mean	0.00007	0.29	0.0009	0.001	0.00001	0.0086		0.052	33.7	0.065	0.92		0.0124	0.222	8.38	0.073
STDV.	0.00003	0.02	0.0002	0.0007	0.000005	0.0006		0.01	0.4	0.006	0.08		0.0008	0.006	0.09	0.002
Certified	**0.00007**	**0.29**	**0.0009**	**0.0010**	**(<0.0001)**	**0.0086**	**(<0.006)**	**0.052**	**33.7**	**0.065**	**0.92**	**(<0.0001)**	**0.0124**	**0.222**	**8.38**	**0.073**
95% C.I.	0.00003	0.01	0.0002	0.0004		0.0004		0.006	0.3	0.004	0.05		0.0007	0.004	0.06	0.001
Methods	IM,H,G,A	X,O,IM,I,G	IM,H,G	O,IM,I,G	IM,H,G,A	O,C	I,G	X,O,IM,I,G	X,W,O,I,G	X,O,IM,I,G	X,O,I,G	IM,I,G	O,IM,I	X,O,IM,I,G	X,O,I,G	O,F

	Nb	Ni	O	P	Pb	S	Sb	Si	Sn	Ta	Ti	V	W	Zr		
1	0.122	55.425	0.0009	0.0032	0.000006	0.0001	0.0001	0.042	0.0002	0.0001	0.0017	0.003	0.01	0.0002		
2	0.126	55.55	0.0009	0.0044	0.00002	0.00013	0.0001	0.0433	0.00023	0.0006	0.0021	0.0064	0.017	0.001		
3	0.127	55.60	0.0018	0.0048	0.00002	0.000234	0.0001	0.0452	0.0003	0.005	0.0026	0.0068	0.0172	0.001		
4	0.129	55.6136	0.00235	0.0049	0.00003	0.0003	0.0001	0.0452	0.0003	0.0065	0.0044	0.008	0.0175	0.0011		
5	0.1309	55.822	0.0024	0.005	0.00004	0.0003	0.0002	0.05	0.0003	0.0078	0.0047	0.0082	0.0197	0.0013		
6	0.131	55.8928	0.00251	0.0055	0.00004	0.0003	0.0002	0.05	0.0003	<0.0001	0.00595	0.0087	0.0214	0.0015		
7	0.133	55.95	0.0027	0.0056		0.0004		0.0547	0.0003	<0.001	0.0063	0.0091	0.0224	0.0016		
8	0.1337	55.955	0.00278	0.0057		0.0004		0.0548	0.0013		0.0068	0.0095	0.0232	0.0021		
9	0.135	56.05	0.0028	0.0058		0.0005		0.056	0.0015		0.00709	0.01	0.0264			
10	0.135	56.175	0.0034	0.0059		0.0006		0.058			0.008	0.01	0.029			
11	0.1361		0.0034	0.007				0.06			0.0098	0.0106	0.03			
12			0.0039	0.008				0.073				0.011				
13			0.0048	0.008								0.0134				
14				0.0088												
15																
Mean	0.131	55.8	0.0027	0.0059	0.00003	0.0003	0.00013	0.053	0.0005	0.004	0.005	0.009	0.021	0.0012		
STDV.	0.004	0.2	0.001	0.002	0.00001	0.0002	0.00005	0.009	0.0005	0.003	0.003	0.003	0.006	0.0006		
Certified	**0.131**	**55.8**	**0.0027**	**0.0059**	**0.00003**	**0.0003**	**0.00013**	**0.053**	**0.0005**	**(<0.008)**	**0.005**	**0.009**	**0.021**	**0.0012**		
95% C.I.	0.003	0.2	0.0007	0.0009	0.00001	0.0001	0.00005	0.006	0.0004		0.002	0.002	0.004	0.0005		
Methods	X,O,IM,I,G	X,O,I	F	X,W,O,IM,I,G	O,IM,H,G,A	G,C	IM,H,G	X,O,IM,I,G	X,O,IM,H,G,A		X,O,IM,I,G	X,O,IM,I,G	X,O,IM,I,G	X,O,IM,I,G		

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	NSL Analytical Services	Cleveland, OH
ATI Specialty Materials, Monroe	Monroe, NC	Laboratory Testing, Inc.	Hatfield, PA
Special Metals Corporation, North	New Hartford, NY	Alcoa Howmet, Dover Alloy	Dover, NJ
Dirats Laboratories	Westfield, MA	Haynes International, Inc.	Kokomo, IN
Anderson Laboratories, Inc.	Greendale, WI	ATI Specialty Materials, Lockport	Lockport, NY
Cronimet Specialty Metals USA, Inc.	Wheatland, PA	Latrobe Specialty Metals, A Carpenter Co.	Latrobe, 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 AR654	ALPHA AR660	ALPHA AR662	ALPHA AR881	ALPHA AR892	BCS 346A	BCS 351	BCS 454/1	BCS 462/1
BS 617	BS 625A	BS 690	BS H8	BS H-8	CSN-4	H3-B	HAS 625A	HAS 690B
IARM 100B	IARM 201A	IARM 258A	IARM 54A	IARM 54C	IARM 60B	IARM 65B	IARM 66B	IARM 67A
IARM 67B	IARM 68B	IARM 68C	IARM 98B	IH ALVJ895	IH G-35/31885	IH 022113	IH R5657	JK 37
LECO 501-102	LECO 501-503	LECO 501-510	LECO 501-550	LECO 501-643	LECO 501-644	LECO 501-674	LECO 501-992	LECO 502-102
LECO 502-257	LECO 502-328	LECO 502-348	LECO 502-456	NIST 131G	NIST 1765	NIST 3102A	NIST 3103A	NIST 3106
NIST 3107	NIST 3127	NIST 3128	NIST 3131A	NIST 3151	NIST 3161A	NIST 345A	NIST 349A	NIST 361
NIST 366	NIST 864	NIST 865	NIST 867	NIST 868	NIST 892	NIST 899	TRAMPS 100412	

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

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

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