Certificate of Analysis

IARM 68E

Haynes 230 / UNS N06230

Certified Reference Material

Certified Values listed in wt.% with associated uncertainties

Al	**0.30** ± 0.01	**B**	**0.007** ± 0.001	**C**	**0.099** ± 0.002	**Co**	**0.16** ± 0.01
Cr	**21.88** ± 0.09	**Cu**	**0.022** ± 0.002	**Fe**	**1.06** ± 0.02	**La**	**0.008** ± 0.005
Mg	**0.006** ± 0.001	**Mn**	**0.51** ± 0.04	**Mo**	**1.18** ± 0.05	**N**	**0.050** ± 0.004
Nb	**0.035** ± 0.005	**O**	**0.0007** ± 0.0003	**P**	**0.005** ± 0.001	**S**	**0.0005** ± 0.0004
Si	**0.39** ± 0.03	**Ti**	**0.015** ± 0.002	**V**	**0.007** ± 0.002	**W**	**14.6** ± 0.1

Indicative Values listed in ppm

Ag (0.5)	As (3)	Au (<4)	Ba (<1)	Be (<1)	Bi (0.04)	Br (<1)	
Ca (0.2)	Cd (<20)	Ce (<1)	Cl (<1)	Cs (<1)	Dy (<1)	Er (<1)	
Eu (<1)	F (<1)	Ga (<30)	Gd (<1)	Ge (<1)	Hf (<20)	Hg (<200)	
Ho (<1)	I (<1)	In (<1)	Ir (<1)	K (<5)	Li (<1)	Lu (<1)	
Na (<40)	Nd (<1)	Ni (59.9%)	Os (<1)	Pb (2)	Pd (<1)	Pr (<1)	
Pt (<1)	Rb (<1)	Re (3)	Rh (<1)	Ru (<1)	Sb (0.6)	Sc (<4)	
Se (<7)	Sm (<1)	Sn (4)	Sr (<5)	Ta (<150)	Tb (<1)	Te (<1)	
Th (<1)	Tl (<1)	Tm (<1)	U (<1)	Y (<10)	Yb (<1)	Zn (0.9)	
Zr (10)							

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	B	C	Co	Cr	Cu	Fe	La	Mg	Mn	Mo	N	Nb	O	P	S
1	0.26	0.0026	0.0953	0.137	21.571	0.0162	1.0127	0.00057	0.0045	0.4514	0.95	0.038	0.03	0.0003	0.0019	0.00005
2	0.27	0.0047	0.0958	0.1401	21.81	0.019	1.02	0.000885	0.0051	0.4868	1.0955	0.0487	0.03	0.0004	0.0021	0.0001
3	0.282	0.0055	0.096	0.1455	21.83	0.0206	1.045	0.0086	0.0057	0.49	1.1687	0.05078	0.03	0.0006	0.0028	0.0001
4	0.2928	0.0067	0.0967	0.15	21.85	0.021	1.054	0.0093	0.0057	0.49	1.18	0.05083	0.0304	0.0006	0.0035	0.00019
5	0.293	0.007	0.09738	0.1549	21.8585	0.022	1.059	0.0106	0.0057	0.4956	1.192	0.0516	0.031	0.00074	0.005	0.000206
6	0.294	0.007	0.098	0.1597	21.8681	0.022	1.0651	0.011	0.00575	0.50	1.198	0.052	0.0319	0.0009	0.005	0.0003
7	0.299	0.0076	0.098	0.1616	21.883	0.0223	1.0716	0.013	0.006	0.501	1.2096	0.052	0.0319	0.0011	0.0052	0.0007
8	0.30	0.0076	0.10	0.164	21.90	0.023	1.073		0.0065	0.506	1.2197	0.0526	0.0323		0.0053	0.001
9	0.302	0.0083	0.10	0.168	21.952	0.0247	1.075		0.0095	0.508	1.227		0.0337		0.0059	0.0012
10	0.3034	0.00856	0.1021	0.178	22.0592	0.025	1.0857			0.51	1.23		0.035		0.00638	0.0013
11	0.304	0.0089	0.1057	0.189	22.0987	0.0258	1.119			0.51	1.232		0.044		0.007	
12	0.317	0.011		0.19		0.028				0.5138	1.247		0.059		0.007	
13	0.322			0.20						0.70					0.0088	
14																
15																
Mean	0.3	0.007	0.099	0.16	21.88	0.022	1.06	0.008	0.006	0.51	1.18	0.05	0.035	0.0007	0.005	0.0005
STDV.	0.02	0.002	0.003	0.02	0.1	0.003	0.03	0.005	0.001	0.06	0.08	0.005	0.009	0.0003	0.002	0.0005
Certified	**0.30**	**0.007**	**0.099**	**0.16**	**21.88**	**0.022**	**1.06**	**0.008**	**0.006**	**0.51**	**1.18**	**0.050**	**0.035**	**0.0007**	**0.005**	**0.0005**
95% C.I.	0.01	0.001	0.002	0.01	0.09	0.002	0.02	0.005	0.001	0.04	0.05	0.004	0.005	0.0003	0.001	0.0004
Methods	X,O,IM,I,G	O,IM,I,G	C	X,O,IM,I,G	X,W,O,I,G	X,O,IM,G	X,O,I,G	O,IM,G	O,IM,G	X,O,IM,I,G	X,O,I,G	F	X,O,IM,G	F	IM,G	G,C

	Si	Ti	V	W	Ag	As	Au	Ba	Be	Bi	Br	Ca	Cd	Ce	Cl	Cs
1	0.28	0.011	0.003	14.351	0.000016	0.00028	<0.00001	0.000013	<0.0000005	0.000002	<0.000005	0.000016	<0.00002	0.000012	0.0000047	<0.000001
2	0.32	0.0117	0.0041	14.38	0.0000495	0.00035	<0.00005	<0.00003	<0.000005	0.0000047	<0.00005	0.000032	<0.00005	<0.000005	<0.000001	<0.00001
3	0.385	0.0117	0.005	14.526	0.000081	<0.001	<0.0004	<0.00005	<0.00001	0.000005		<0.0005	<0.002	<0.00005		<0.00005
4	0.388	0.012	0.006	14.5737	<0.00005	<0.0010				0.000005						
5	0.39	0.0123	0.0067	14.6969	<0.00005					<0.000005						
6	0.392	0.0135	0.0071	14.705	<0.0005					<0.00002						
7	0.3925	0.014	0.0072	14.7217												
8	0.395	0.0158	0.0087	14.738												
9	0.399	0.0158	0.0093	14.75												
10	0.4097	0.017	0.0094	14.85												
11	0.4111	0.019	0.01													
12	0.4163	0.02	0.011													
13	0.50	0.02														
14																
15																
Mean	0.39	0.015	0.007	14.6	0.00005	0.0003				0.000004		0.00002				
STDV.	0.05	0.003	0.002	0.2	0.00003	0.00005				0.000001		0.00001				
Certified	**0.39**	**0.015**	**0.007**	**14.6**	**(0.00005)**	**(0.0003)**	**(<0.0004)**	**(<0.0001)**	**(<0.0001)**	**(0.000004)**	**(<0.0001)**	**(0.00002)**	**(<0.002)**	**(<0.0001)**	**(<0.0001)**	**(<0.0001)**
95% C.I.	0.03	0.002	0.002	0.1												
Methods	X,O,I,G	X,O,IM,G	X,O,IM,G	X,O,I,G	IM,G,A	IM,G	IM,G	IM,G	IM,G	IM,G,A	IM,G	IM,G	IM,G	IM,G	IM,G	IM,G

	Dy	Er	Eu	F	Ga	Gd	Ge	Hf	Hg	Ho	I	In	Ir	K	Li	Lu
1	<0.000001	<0.000001	<0.000001	<0.00001	0.0013	<0.000001	0.000015	0.000003	<0.00001	<0.000001	<0.000001	0.000017	0.000005	<0.000005	<0.0000005	<0.000001
2	<0.000005	<0.000005	<0.000005	<0.00001	0.003	<0.000005	<0.00005	0.0002	<0.00005	<0.000005	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.000005
3	<0.00005	<0.00005	<0.00005		<0.0001	<0.00005	<0.0001	0.0016	<0.015	<0.00005		<0.00005	<0.00005	<0.0005	<0.00005	<0.00005
4								<0.00005								
5								<0.0001								
6								<0.0005								
7																
8																
9																
10																
Mean					0.002			0.001								
STDV.					0.001			0.0009								
Certified	**(<0.0001)**	**(<0.0001)**	**(<0.0001)**	**(<0.0001)**	**(<0.003)**	**(<0.0001)**	**(<0.0001)**	**(<0.002)**	**(<0.02)**	**(<0.0001)**	**(<0.0001)**	**(<0.0001)**	**(<0.0001)**	**(<0.0005)**	**(<0.0001)**	**(<0.0001)**
95% C.I.																
Methods	IM,G	IM,G	IM,G	IM,G	IM,G	IM,G	IM,G	IM,I,G	IM,G	IM,G	IM,G	IM,G	IM,G	IM,G	IM,G	IM,G

	Na	Nd	Ni	Os	Pb	Pd	Pr	Pt	Rb	Re	Rh	Ru	Sb	Sc	Se	Sm
1	<0.000001	0.000002	59.5	<0.000005	0.000015	<0.00001	<0.000001	<0.00001	<0.0001	0.00015	<0.00001	<0.00001	0.000058	<0.000005	<0.00005	<0.000001
2	<0.00001	<0.000005	59.86	<0.00001	0.0000458	<0.00005	<0.000005	<0.00001	<0.0001	0.00017	<0.00001	<0.00005	0.00006	<0.00001	<0.0002	<0.000005
3	<0.004	<0.000005	60.0709	<0.00005	0.000059	<0.00005	<0.00005	<0.00005	<0.0001	0.00063	<0.00005	<0.0001	0.000075	<0.0004	<0.0007	<0.00005
4			60.2762		0.000094					<0.0005			<0.0005			
5					0.001											
6					<0.00005											
7					<0.0001											
8																
9																
10																
Mean			59.9		0.0002					0.0003			0.00006			
STDV.			0.3		0.0004					0.0003			0.000009			
Certified	**(<0.004)**	**(<0.0001)**	**(59.9)**	**(<0.0001)**	**(0.0002)**	**(<0.0001)**	**(<0.0001)**	**(<0.0001)**	**(<0.0001)**	**(0.0003)**	**(<0.0001)**	**(<0.0001)**	**(0.00006)**	**(<0.0004)**	**(<0.0007)**	**(<0.0001)**
95% C.I.																
Methods	IM,G	IM,G	X,I,G	IM,G	O,IM,G,A	IM,G	IM,G	IM,G	IM,G	IM,G	IM,G	IM,G	IM,G	IM,G	IM,G	IM,G

	Sn	Sr	Ta	Te	Tb	Te	Th	Tl	Tm	U	Y	Yb	Zn	Zr		
1	0.0002	<0.00005	0.0004	<0.000001	<0.000001	<0.000001	<0.000001	<0.000005	<0.000005	0.0000029	0.0000008	<0.000001	0.000087	0.00033		
2	0.00025	<0.0005	0.0006	<0.00001	<0.000005	<0.00001	<0.000001	<0.00001	<0.00001	0.000005	<0.00005	<0.000005	0.000089	0.00034		
3	0.00031	<0.0005	0.00069	<0.0001	<0.00005	<0.0001	<0.00005	<0.00005	<0.00005	<0.00005	<0.0001	<0.00005	<0.0011	0.001		
4	0.001		0.0017								<0.0005			0.0012		
5	<0.0005		0.0085								<0.0010			0.003		
6			0.0137											0.003		
7			0.015											<0.0005		
8																
9																
10																
Mean	0.0004		0.006										0.00009	0.001		
STDV.	0.0004		0.006										0.000001	0.001		
Certified	**(0.0004)**	**(<0.0005)**	**(<0.015)**	**(<0.0001)**	**(<0.0001)**	**(<0.0001)**	**(<0.0001)**	**(<0.0001)**	**(<0.0001)**	**(<0.0001)**	**(<0.001)**	**(<0.0001)**	**(0.00009)**	**(0.001)**		
95% C.I.																
Methods	O,IM,G	IM,G	X,O,IM,G	IM,G	IM,G	IM,G	IM,G	IM,G	IM,G	IM,G	IM,G	IM,G	IM,G	X,O,IM,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

Alcoa Howmet, Dover Alloy	Dover, NJ	Latrobe Specialty Metals	Latrobe, PA
Anderson Laboratories, Inc.	Greendale, WI	Leco Corporation	St. Joseph, MI
Cannon-Muskegon	Muskegon, MI	MetalTek International, Inc.	Waukesha, WI
EAG Laboratories	Liverpool, NY	Northern Analytical Laboratory, Inc.	Londonderry, NH
Hitchiner Manufacturing Co.	Milford, NH	NSL Analytical Services	Cleveland, OH
Laboratory Testing, Inc.	Hatfield, PA	VDM-Metals USA, LLC	Florham Park, NJ

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 AR1650	BAS 346A	IARM 203A	IV H2-C02054R	IV M2-NI654716	LECO 501-991	LECO 502-870	NIST 73C	VHG 119875R-20
ALPHA AR1651	BCR NR58	IARM 241A	IV J2-MN02124	LECO 0675-31	LECO 502-016	NBS 101e	NIST 864	VHG 710679419-1
ALPHA AR1652	BCS 351	IARM 56D	IV J2-NB01082	LECO 501-147	LECO 502-257	NBS 36A	NIST 867	VHG 97415R-21
ALPHA AR695	BCS 461/1	IARM 68A	IV K2-FE04057	LECO 501-502	LECO 502-348	NIST 1188	NIST 899C	
ALPHA AR890	BCS CRM-346	IARM 68B	IV K2-MO02086	LECO 501-503	LECO 502-414	NIST 1244	VHG 101593-12	
ALPHA AR892	BS CSN-4	IARM 68C	IV K2-NB01088	LECO 501-646	LECO 502-416	NIST 343A	VHG 103665-13	
ALPHA AR914K	IARM 100B	IARM 68D	IV K2-TI02119	LECO 501-676	LECO 502-494	NIST 36B	VHG 118879R-33	

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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