

Analytical Reference Materials International



Certificate of Analysis Certified Reference Material

Grade: Alloy C-22HS

Part Number (Q.A. NO.): IARM 276A

Certificate Date: 07/18/2017

Certificate No.: 276A-07182017-IARM-F

Revision Date: 10/10/2017

Interpretation of Data

- Certified values listed below 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.
- 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.
- The "Inter laboratory Analysis Program" (ILAP) utilized in the establishment of the data are an ongoing program with permanent membership. Certain elements may be selected by a consensus of the members for more extensive testing. Therefore the data in **brackets []** indicates **further testing is in process**.
Chips are not certified for Oxygen analysis.
- The **"±Estimated Uncertainty"** is enclosed by a **parentheses ()** below the individual **element's concentration** and is based on a Confidence Interval at 95%. Included in this estimated uncertainty, are the combined effects of method imprecision, material inhomogeneity, and any bias between methods.

Important: A "User Registration Card" accompanies all shipments. This card should be completed immediately upon receipt of materials with the appropriate user information. This is the only way in which ARMI can guarantee customer updates or possible data modifications!

<u>Aluminum</u>	<u>Antimony</u>	<u>Arsenic</u>	<u>Bismuth</u>	<u>Boron</u>	<u>Calcium</u>	<u>Carbon</u>	<u>Chromium</u>	<u>Cobalt</u>
0.245 (0.007)	0.00019 (0.00002)	(0.0009)	(0.000003)	0.0038 (0.0005)	(<0.007)	0.0040 (0.0006)	20.54 (0.04)	0.041 (0.005)
<u>Copper</u>	<u>Iron</u>	<u>Lanthanum</u>	<u>Lead</u>	<u>Magnesium</u>	<u>Manganese</u>	<u>Molybdenum</u>	<u>Nickel</u>	<u>Niobium</u>
0.038 (0.003)	1.30 (0.03)	(<0.007)	0.00004 (0.00003)	0.007 (0.001)	0.305 (0.006)	16.20 (0.04)	61.1 (0.2)	0.014 (0.003)
<u>Nitrogen</u>	<u>Oxygen</u>	<u>Phosphorus</u>	<u>Silicon</u>	<u>Silver</u>	<u>Sulfur</u>	<u>Tantalum</u>	<u>Tin</u>	<u>Titanium</u>
0.0388 (0.0009)	0.0010 (0.0004)	0.006 (0.001)	0.043 (0.006)	0.00010 (0.00004)	0.0005 (0.0002)	0.011 (0.004)	0.0004 (0.0002)	0.004 (0.002)
<u>Tungsten</u>	<u>Vanadium</u>	<u>Zirconium</u>						
0.03 (0.01)	0.008 (0.003)	0.003 (0.003)						

The laboratories participating in the "Inter-Laboratory Analysis Program" (ILAP) and certification of this material are as follows:

Alcoa Howmet, Dover Alloy - Dover, NJ	Haynes International, Inc. - Kokomo, IN
Anderson Laboratories, Inc. - Greendale, WI	Huntington Alloys Corporation - Huntington, WV
ATI Specialty Materials, Lockport - Lockport, NY	Laboratory Testing, Inc. - Hatfield, PA
ATI Specialty Materials, Monroe - Monroe, NC	Latrobe Specialty Metals - Latrobe, PA
Exova - Middlesbrough, UK	Special Metals IncoTest - Hereford, UK
Exova - Portland, OR	VDM-Metals USA, LLC - Florham Park, NJ

Traceability: All members of the "Inter-Laboratory Analysis Program" (ILAP) listed above validate test methods and instrument performance utilizing SRMs produced by the National Institute of Standards and Technology, (NIST) as well as other CRMs and RMs produced by recognized Certifying Bodies from around the world. The specific SRMs, CRMs, and RMs applicable to the material covered by this certificate are:

ALPHA AR654	BCS CRM 346	BS HONT	IARM 67B	LECO 501-510	LECO 502-195	NIST 1193	NIST 169	NIST 3137	NIST 361	NIST C2425A
ALPHA AR669	BCS CRM346	HAS 276B	IARM 68B	LECO 501-550	LECO 502-257	NIST 1204	NIST 173	NIST 3138	NIST 362	NIST H5
ALPHA AR673	BCS CRM346A	HAS 622B	IARM 69A	LECO 501-551	LECO 502-412	NIST 1205	NIST 1763	NIST 3151	NIST 363	RNI 11/10
ALPHA AR881	BS 199A	HAS 625A	IH 051221	LECO 501-643	MBH 11383	NIST 1206	NIST 1765	NIST 3155	NIST 364	RNI 12/12
ALPHA AR890	BS CSN-4	IARM 100B	IH 21102Z21	LECO 501-644	MBH 215XHC1	NIST 1207-2	NIST 3102A	NIST 3161A	NIST 36A	RNI 13/11
BCS 310/1	BS H2A	IARM 258A	IH 2321-78764	LECO 501-645	MBH 215XHC5R	NIST 1208-1	NIST 3103A	NIST 3162A	NIST 72G	RNI 14/11
BCS 350	BS H2B	IARM 56D	IH 37969	LECO 501-674	MBH 24XWASP3D	NIST 1249	NIST 3106	NIST 3163	NIST 864	RNI 15/12
BCS 351	BS H5	IARM 65A	IH ALV PT63	LECO 501-929	MBH 26X11383C	NIST 1254	NIST 3107	NIST 3165	NIST 865	SYN QGFB
BCS 432/1	BS H6	IARM 65B	IH PR20	LECO 501-991	MBH 28X7185J	NIST 1262	NIST 3109A	NIST 3169	NIST 867	
BCS 454/1	BS H-68	IARM 66A	IH PT71	LECO 501-992	MBH HC1D	NIST 131G	NIST 3127A	NIST 345	NIST 899	
BCS 461/1	BS H6A	IARM 66B	IH R5657	LECO 502-102	MBH HC3D	NIST 134A	NIST 3128	NIST 348A	NIST C2423	
BCS 462/1	BS H-6A	IARM 66C	LECO 501-503	LECO 502-106	NIST 1187	NIST 155	NIST 3131A	NIST 349A	NIST C2424A	

A specific line of traceability is established to NIST and other Certifying Bodies for those elements that are noted as "Certified Values" on the Certificates of Analyses referenced above.

See Reverse Side for Statistical Data and Additional Information Regarding this Material.

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The following data and accompanying statements represent all pertinent information reported in the ILAP as it applies to the chemical characterization of this material as of 10/10/2017.

276A	Al	Sb	As	Bi	B	Ca	C	Cr	Co	Cu	Fe	La	Pb	Mg	Mn	Mo
1	0.233	0.00017	0.0006	0.000001	0.0025	0.00005	0.0014	20.477	0.030	0.030	1.244	0.0019	0.00001	0.0018	0.29	16.132
2	0.235	0.000171	0.0009	0.000001	0.0025	0.0002	0.0026	20.48	0.030	0.0326	1.262	0.0065	0.000029	0.0064	0.29	16.14
3	0.2352	0.00018	0.00099	0.000001	0.003	0.0009	0.0033	20.48	0.0341	0.0339	1.262	0.0069	0.000032	0.0064	0.2930	16.1408
4	0.237	0.0002	0.0010	0.000002	0.00347	0.0068	0.00358	20.486	0.036	0.036	1.277	0.00004	0.000717	0.0076	0.2944	16.152
5	0.237	0.0002	0.0012	0.00001	0.0035	<0.0001	0.0036	20.50	0.037	0.0365	1.277	0.00005	0.007467	0.0076	0.3050	16.178
6	0.2375	0.0002		<0.0001	0.0037	<0.002	0.0036	20.5117	0.04	0.0374	1.28	0.00001	0.0076	0.0076	0.306	16.218
7	0.240			<0.0001	0.0040		0.0039	20.513	0.0409	0.038	1.32		0.0078	0.0078	0.308	16.22
8	0.2414			<0.0001	0.0040		0.0044	20.53	0.041	0.039	1.32		0.00795	0.00795	0.311	16.223
9	0.2538			<0.0001	0.0041		0.0048	20.540	0.043	0.041	1.3354		0.0080	0.0080	0.3115	16.226
10	0.2555				0.0042		0.0049	20.542	0.0465	0.041	1.338		0.0081	0.0081	0.314	16.30
11	0.2578				0.0045		0.0050	20.5505	0.050	0.042	1.3636				0.3143	16.30
12	0.258				0.0050		0.0050	20.6491	0.052	0.045					0.315	
13	0.27				0.005		0.0051	20.71	0.0545						0.3165	
14							0.0052									
15																
Mean	0.245	0.00019	0.0009	0.000003	0.0038	0.002	0.0040	20.54	0.041	0.038	1.30	0.005	0.00004	0.007	0.305	16.20
STDV.	0.012	0.00001	0.0002	0.000004	0.0008	0.003	0.0011	0.07	0.008	0.004	0.04	0.003	0.00003	0.002	0.010	0.06
Certified	0.245	0.00019	(0.0009)	(0.000003)	0.0038	(<0.007)	0.0040	20.54	0.041	0.038	1.30	(<0.007)	0.00004	0.007	0.305	16.20
95% C.I.	0.007	0.00002			0.0005		0.0006	0.04	0.005	0.003	0.03		0.00003	0.001	0.006	0.04
Methods	X,O,I	IM,H,G	IM,G,A	IM,H,G,A	O,I	I,G	O,C	X,W,O,I	X,O,I	X,O,I	X,O,I	I,G	IM,H,G,A	O,I	X,O,I	X,W,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

276A	Ni	Nb	N	O	P	Si	Ag	S	Ta	Sn	Ti	W	V	Zr
1	60.5855	0.0083	0.0369	0.0007	0.0020	0.030	0.000043	0.00025	0.0038	0.0001	0.001	0.0020	0.0003	0.0010
2	60.88	0.009	0.0369	0.0007	0.0039	0.031	0.00009	0.00028	0.0065	0.00017	0.0030	0.0051	0.0031	0.0010
3	60.88	0.009	0.03762	0.0007	0.0047	0.0354	0.000091	0.00028	0.0079	0.0003	0.003	0.0070	0.0034	0.0016
4	61.02951	0.010	0.0377	0.0007	0.0048	0.0376	0.0001	0.00028	0.0085	0.0004	0.0032	0.0073	0.004	0.0018
5	61.03	0.0116	0.03817	0.000757	0.0050	0.0398	0.0001	0.000368	0.0089	0.0004	0.0032	0.022	0.005	0.003
6	61.05	0.013	0.0383	0.0008	0.0050	0.043	0.00015	0.0004	0.0110	0.00073	0.0036	0.027	0.005	0.0051
7	61.127	0.013182	0.039	0.0008	0.0060	0.044		0.0004	0.015		0.0038	0.030	0.0063	0.00924
8	61.18	0.0160	0.0391	0.0008	0.0061	0.0441		0.0005	0.0153		0.0051	0.041	0.007	
9	61.304	0.016	0.0392	0.0009	0.0064	0.050		0.0006	0.0180		0.008	0.0459	0.0090	
10	61.34	0.0182	0.0395	0.00093	0.0065	0.053		0.0008			0.008	0.056	0.0124	
11	61.381	0.0208	0.0399	0.0011	0.0066	0.054		0.0010			0.008	0.059	0.013	
12		0.022	0.0400	0.0030	0.0073	0.0554		0.0012			0.070	0.015	0.015	
13			0.0422		0.0084								0.0185	
14														
15														
Mean	61.1	0.014	0.0388	0.0010	0.006	0.043	0.00010	0.0005	0.011	0.0004	0.004	0.03	0.008	0.003
STDV.	0.2	0.005	0.0015	0.0006	0.002	0.009	0.00003	0.0003	0.005	0.0002	0.002	0.02	0.005	0.003
Certified	61.1	0.014	0.0388	0.0010	0.006	0.043	0.00010	0.0005	0.011	0.0004	0.004	0.03	0.008	0.003
95% C.I.	0.2	0.003	0.0009	0.0004	0.001	0.006	0.00004	0.0002	0.004	0.0002	0.002	0.01	0.003	0.003
Methods	X,W,O,I	X,O,I,G	O,F	F	X,W,O,I,G	X,O,I	IM,H,G,A	O,G,C	X,O,I,G	IM,H,G,A	X,O,I,G	X,O,I,G	X,O,I,G	X,O,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

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, which provides the information, detailed in ISO Guide 31. The only generally accepted certifying body in the United States for primary standards - 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 one or more of whose property values 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, one or more of whose property values are 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): Although ASTM Standard E691-87 applies to inter-laboratory studies to "Determine the Precision of a Single Test Method", it is also a well thought out and logical plan for conducting an inter laboratory program involving multiple techniques. Therefore, the planning, conducting, analyzing, protocol, and treatment of data resulting from this inter laboratory program were performed utilizing the guidelines established in ASTM E691-87.

Methods of Analysis: In view of the fact, that the "Inter Laboratory Analysis Program" entails a wide variety of materials, no single analytical method would provide optimum data results. Therefore, the methods utilized were a combination of ASTM Standard Methods for classical wet chemistry, ICP, AA, Optical Emission, and X-Ray spectrometric methods. The determinations for Carbon, Sulfur, Nitrogen, and Oxygen are the result of 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 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. When not in use, the material should be stored in a cool, dry location. This material was tested using both the solid disks and chips prepared from the disks. The certified values are considered representative of the overall average composition of the material. Chips are not to be used for Oxygen analysis.

Selection of Materials: A "batch" or "series" is defined as a single bar of one continuous length and heat. The majority of materials are in wrought condition; other methods of manufacture are utilized as a less desirable resort. ILAP samples are taken by removing a section, a minimum of, every one-twelfth of total length from the entire bar. A portion of the section is converted to chips and 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. This systematic sampling procedure results in the homogeneity being reflected as a product of the overall statistics and certified data. This method of homogeneity testing is in accordance with ISO Guide 34, regarding the systematic selection and testing of a representative number of units for the assessment of homogeneity.


 David Coler, General Manager
 Analytical Reference Materials International



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