Analytical Reference Materials International

Certificate of Analysis
Certified Reference Material

Grade: **AISI 321 / UNS S32100**

Part Number (Q.A. NO.): **IARM 6I**

Certificate Date: **07/20/2017** Certificate No.: **6I-07202017-IARM-F** Revision Date: **10/11/2017**

Interpretation of Data

1. 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.
2. 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.
3. 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.**
4. 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!**

Aluminum	Antimony	Arsenic	Boron	Calcium	Carbon	Cerium	Chromium	Cobalt
0.084	(0.0008)	(0.005)	0.0034	(0.0004)	0.049	(<0.005)	17.76	0.052
(0.005)			(0.0009)		(0.001)		(0.06)	(0.003)
Copper	**Hydrogen**	**Lead**	**Magnesium**	**Manganese**	**Molybdenum**	**Nickel**	**Niobium**	**Nitrogen**
0.202	(<0.001)	(<0.02)	(<0.03)	1.76	0.133	9.20	0.018	0.013
(0.005)				(0.02)	(0.006)	(0.06)	(0.004)	(0.002)
Oxygen	**Phosphorus**	**Selenium**	**Silicon**	**Sulfur**	**Tantalum**	**Tin**	**Titanium**	**Tungsten**
0.0012	0.0208	(<0.03)	0.31	0.023	(<0.01)	0.0060	0.60	0.023
(0.0002)	(0.0008)		(0.01)	(0.005)		(0.0007)	(0.02)	(0.008)
Vanadium	**Zinc**	**Zirconium**						
0.048	(0.003)	(0.003)						
(0.004)								

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

AADFW, Inc. - Euless, TX
Certified Alloy Products - Long Beach, CA
Crucible Industries - Syracuse, NY
Davis Alloys Manufacturing, LLC - Sharpsville, PA
Dirats Laboratories - Westfield, MA
Ellwood National Steel - Irvine, PA
Laboratorio Prove Materiali S. Marco srl - Schio, Italy
Laboratory Testing, Inc. - Hatfield, PA
MetalTek International, Inc. - Waukesha, WI
Microlab - TamilNadu, India
PM Kalco, Inc - Wheatland, PA

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 AR1650	ALPHA AR882	BCS 346	BS 85D	IARM 346	IARM 6G	NIST 1185	NIST 363
ALPHA AR654	ALPHA AR882	BS 321C	IARM 162C	IARM 35J	LECO 501-502	NIST 3149	NIST 897
ALPHA AR656	ALPHA AR890	BS 321D	IARM 163D	IARM 6B	MBH 13X32100A	NIST 3155	NIST 898
ALPHA AR661	ASTM 9911	BS 602C	IARM 289A	IARM 6E	MBH 321	NIST 3169	NIST 899
ALPHA AR881	ASTM 9912	BS 85C	IARM 2C	IARM 6F	NIST 1171	NIST 361	

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 10/11/2017.

6I	Al	Sb	As	B	Ca	C	Ce	Cr	Co	Cu	H	Pb	Mg	Mn	Mo	Ni
1	0.070	0.0007	0.0036	0.0022	0.0003	0.0459	<0.0001	17.628	0.043	0.185	0.0003	0.00002	0.0014	1.717	0.12	9.060
2	0.0769	0.0008	0.0036	0.0024	0.0003	0.047	<0.0001	17.64	0.0469	0.1966		0.0023	0.023	1.725	0.1250	9.118
3	0.079	0.0009	0.0037	0.0027	0.0005	0.0473	<0.005	17.700	0.0478	0.198		0.018	<0.0001	1.733	0.1251	9.13
4	0.0817	<0.004	0.004	0.0030	0.0005	0.0479		17.702	0.0498	0.198		<0.0001		1.740	0.126	9.155
5	0.082		0.0074	0.0034		0.048		17.733	0.0516	0.2000		<0.0001		1.742	0.1288	9.164
6	0.083			0.0038		0.0491		17.75	0.052	0.20				1.743	0.130	9.2018
7	0.0845			0.0046		0.0496		17.7689	0.053	0.201				1.753	0.1313	9.204
8	0.0848			0.0051		0.050		17.79	0.053	0.205				1.76	0.1336	9.2267
9	0.0876					0.0506		17.808	0.0538	0.208				1.7629	0.135	9.23
10	0.088					0.0507		17.8135	0.055	0.2081				1.7739	0.1394	9.327
11	0.0939					0.051		17.863	0.063	0.2101				1.775	0.147	9.3394
12	0.1005					0.0524		17.949		0.2102				1.7756	0.149	
13														1.8191		
14																
15																
Mean	0.084	0.0008	0.004	0.0034	0.0004	0.049		17.76	0.052	0.202	0.0003	0.007	0.012	1.76	0.133	9.20
STDV.	0.008	0.0001	0.002	0.0010	0.0001	0.002		0.09	0.005	0.007		0.010	0.015	0.03	0.009	0.08
Certified	**0.084**	**(0.0008)**	**(0.005)**	**0.0034**	**(0.0004)**	**0.049**	**(<0.005)**	**17.76**	**0.052**	**0.202**	**(<0.001)**	**(<0.02)**	**(<0.03)**	**1.76**	**0.133**	**9.20**
95% C.I.	0.005			0.0009		0.001		0.06	0.003	0.005				0.02	0.006	0.06
Methods	X,O,I	O,IM,A	O,IM,A	O,I	O,I	O,C	O,IM	X,O	X,O,I	X,O,I		O,IM,A	O,IM	X,O,I	X,O,I	X,O

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

6I	Nb	N	O	P	Se	Si	S	Ta	Sn	Ti	W	V	Zn	Zr
1	0.011	0.0093	0.0009	0.019	0.00001	0.258	0.005	0.0001	0.0042	0.5594	0.0052	0.0350	0.00001	0.00002
2	0.0131	0.0109	0.0011	0.019	0.0014	0.2698	0.0052	0.0069	0.0048	0.580	0.0127	0.0423	0.0004	0.0003
3	0.014	0.0114	0.0012	0.0192	0.029	0.293	0.0227	<0.0001	0.0052	0.58	0.0136	0.0466	0.0039	0.001
4	0.014	0.0121	0.0013	0.0200	<0.0001	0.30	0.0229	<0.0020	0.0056	0.59	0.0170	0.047	0.006	0.0029
5	0.0158	0.0123	0.0013	0.020		0.3100	0.024	<0.01	0.0059	0.5902	0.0207	0.0476	<0.0001	0.006
6	0.0164	0.013	0.0014	0.0209		0.3185	0.0260		0.0060	0.594	0.022	0.049		0.0084
7	0.0168	0.013	0.0014	0.021		0.3201	0.026		0.0060	0.595	0.0300	0.0496		<0.0001
8	0.0174	0.0146		0.021		0.322	0.0262		0.006	0.5954	0.0314	0.050		
9	0.020	0.0158		0.021		0.322	0.0264		0.0067	0.5997	0.036	0.050		
10	0.027	0.0159		0.0211		0.323	0.0265		0.0075	0.6076	0.037	0.051		
11	0.028	0.02		0.0225		0.3277	0.0272		0.008	0.6206		0.051		
12				0.0225		0.333	0.0276			0.641		0.0622		
13				0.0235		0.3341	0.028			0.669				
14														
15														
Mean	0.018	0.013	0.0012	0.0208	0.010	0.31	0.023	0.004	0.0060	0.60	0.023	0.048	0.003	0.003
STDV.	0.005	0.003	0.0002	0.0014	0.016	0.02	0.008	0.005	0.0011	0.03	0.011	0.006	0.003	0.003
Certified	**0.018**	**0.013**	**0.0012**	**0.0208**	**(<0.03)**	**0.31**	**0.023**	**(<0.01)**	**0.0060**	**0.60**	**0.023**	**0.048**	**(0.003)**	**(0.003)**
95% C.I.	0.004	0.002	0.0002	0.0008		0.01	0.005		0.0007	0.02	0.008	0.004		
Methods	X,O,IM,I	O,F	F	X,O,I	O,IM,I,A	X,O,I	O,C	X,O,IM,I	X,O,IM,A	X,O,I	X,O,I	X,O,I	O,IM,A	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

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.

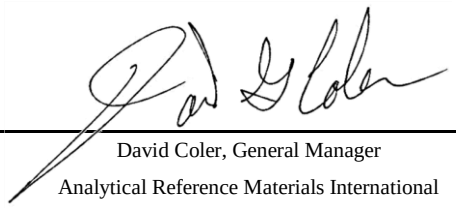
Inter-Laboratory Analysis Program (ILAP): Although ASTM Standard E691-87 applies to inter-laboratory studies to "Determine the Precision of a Single Test Method", it is also a well thought out and logical plan for conducting an inter laboratory program involving multiple techniques. Therefore, the planning, 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.



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