Analytical Reference Materials International

Certificate of Analysis
Certified Reference Material

Grade: **AISI 1141 / UNS G11410**

Part Number (Q.A. NO.): **IARM 348A**

Certificate Date: **07/17/2017** Certificate No.: **348A-07172017-IARM-F** Revision Date: **10/10/2017**

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	Bismuth	Boron	Cadmium	Calcium	Carbon	Chromium
0.002	(0.003)	0.007	(<0.02)	0.0013	(<0.001)	0.0010	0.384	0.123
(0.001)		(0.002)		(0.0009)		(0.0003)	(0.004)	(0.003)
Cobalt	**Copper**	**Lead**	**Magnesium**	**Manganese**	**Molybdenum**	**Nickel**	**Niobium**	**Nitrogen**
0.010	0.230	(0.002)	(<0.006)	1.46	0.026	0.081	0.027	0.010
(0.003)	(0.009)			(0.02)	(0.002)	(0.002)	(0.002)	(0.002)
Oxygen	**Phosphorus**	**Selenium**	**Silicon**	**Sulfur**	**Tantalum**	**Tin**	**Titanium**	**Tungsten**
0.003	0.0121	(<0.005)	0.270	0.102	(<0.008)	0.0112	0.0015	(0.009)
(0.001)	(0.0006)		(0.004)	(0.006)		(0.0005)	(0.0005)	
Vanadium	**Zinc**	**Zirconium**						
0.0029	(<0.003)	(0.003)						
(0.0007)								

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

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

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 AR512	BAM 476	BAS 409/2	BS CA3A	IARM 10D	JSS 168-4	JSS ST04	LECO 501-992	NIST 1164	NIST 15A	NIST 1767	NIST 36
ALPHA AR654	BAS 195-1	BAS 410/2	BS CA-4	IARM 199A	JSS 169-4	JSS ST05	LECO 502-102	NIST 1165	NIST 15D	NIST 293	NIST 361
ALPHA AR657	BAS 401/1	BS 56E	BS CSN2-2	IARM 199B	JSS 170-4	JSS ST06	LECO 502-106	NIST 1166	NIST 16F	NIST 3106	NIST 362
ALPHA AR661	BAS 402/1	BS 66J	BS CSN3	IARM 254A	JSS 171-4	LECO 501-102	LECO 502-194	NIST 1167	NIST 1754	NIST 3108	NIST 363
ALPHA AR873	BAS 403/1	BS 66L	BS CSN4	IARM 28J	JSS 172-4	LECO 501-502	LECO 502-197	NIST 1168	NIST 1760	NIST 3113	NIST 364
ALPHA AR883	BAS 404/1	BS 71A	BS HCN	IARM 29B	JSS 173-4	LECO 501-504	LECO 502-416	NIST 1169	NIST 1761	NIST 3114	NIST 368
ALPHA AR884	BAS 405/1	BS 74E	BS XAAS	IARM 29D	JSS 174-4	LECO 501-506	LECO 502-449	NIST 1261	NIST 1762	NIST 3128	SUS C17
ALPHA AR896	BAS 406/1	BS 75F	BS XCCS	IARM 30G	JSS 175-4	LECO 501-510	MBH 12X10400A	NIST 1261A	NIST 1763	NIST 3131A	SUS D8
ALPHA AR956	BAS 407/2	BS CA-1	BS XCCV	IARM 32D	JSS ST01	LECO 501-550	MBH 12X15253Q	NIST 1262	NIST 1763A	NIST 3137	SUS EISEN 1/3
ASM 1021	BAS 408/1	BS CA1A	CKD 165A	IARM 349A	JSS ST01-5	LECO 501-644	NIST 1161	NIST 1263	NIST 1764	NIST 3155	SUS RE12/19
ASM 2032	BAS 408/2	BS CA-2	CS LF2	IH L43	JSS ST02	LECO 501-646	NIST 1162	NIST 1263A	NIST 1765	NIST 3168A	ZRM 284-1
BAM 128-1	BAS 409/1	BS CA-3	EN 428-2	JK NR21	JSS ST03	LECO 501-677	NIST 1163	NIST 1264	NIST 1766	NIST 3169	ZRM 284-2

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.

276 Abby Road • Manchester, NH • Telephone (603) 935-4100 • FAX (603) 935-4101

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.

348A	Al	Sb	As	Bi	B	Cd	Ca	C	Cr	Co	Cu	Pb	Mg	Mn	Mo	Ni
1	0.00016	0.0024	0.0050	0.012	0.00040	<0.0001	0.0007	0.373	0.115	0.0052	0.217	0.0018	0.0001	1.4075	0.022	0.0747
2	0.0007	0.0025	0.0056	<0.0001	0.0004		0.0008	0.374	0.116	0.0070	0.2199	0.0021	0.0001	1.420	0.0233	0.078
3	0.0019	0.0028	0.0063		0.0006		0.00105	0.3798	0.1178	0.0072	0.220	0.0023	0.0055	1.438	0.0240	0.0782
4	0.0020	<0.004	0.0069		0.00088		0.0011	0.380	0.1193	0.008	0.222	0.0024		1.448333	0.025	0.079
5	0.002		0.007		0.00090		0.0012	0.380367	0.12	0.0081	0.2230	<0.0001		1.460	0.025	0.079
6	0.002		0.0074		0.0009		0.0014	0.3813	0.121	0.0082	0.224	<0.0001		1.4625	0.0253	0.079
7	0.0023		0.008133		0.0030			0.3814	0.1219	0.0132	0.224			1.4707	0.0255	0.08
8	0.0026		0.0121		0.003			0.3840	0.1233	0.0150	0.2272			1.4727	0.026	0.081
9	0.0036							0.386	0.124	0.015	0.229			1.473	0.026	0.081
10	0.0040							0.387	0.1250		0.229			1.4785	0.0261	0.081
11	0.006							0.3886	0.125		0.23			1.484	0.027	0.082
12								0.390	0.129		0.2318			1.486	0.027	0.0858
13								0.3930	0.130		0.2432			1.496	0.030	0.0863
14								0.398	0.130		0.281			1.506	0.0340	0.0881
15																
Mean	0.002	0.003	0.007	0.012	0.0013		0.0010	0.384	0.123	0.010	0.230	0.002	0.002	1.46	0.026	0.081
STDV.	0.002	0.000	0.002		0.0011		0.0003	0.007	0.005	0.004	0.016	0.000	0.003	0.03	0.003	0.004
Certified	**0.002**	**(0.003)**	**0.007**	**(<0.02)**	**0.0013**	**(<0.001)**	**0.0010**	**0.384**	**0.123**	**0.010**	**0.230**	**(0.002)**	**(<0.006)**	**1.46**	**0.026**	**0.081**
95% C.I.	0.001		0.002		0.0009		0.0003	0.004	0.003	0.003	0.009			0.02	0.002	0.002
Methods	O,I	O,IM	O,IM,I	O,IM	O,I	I	O,I,G	O,C	X,O,I,G	O,I	,X,O,I	O,IM	O,I	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

348A	Nb	N	O	P	Se	Si	S	Ta	Sn	Ti	W	V	Zn	Zr		
1	0.0209	0.0064	0.0019	0.0099	<0.0001	0.2588	0.087	0.0011	0.0102	0.0002	0.0003	0.0013	0.0023	0.0009		
2	0.023	0.0068	0.00202	0.0113	<0.005	0.261	0.0902	<0.0050	0.0104	0.0009	0.0025	0.0017	0.0025	0.0014		
3	0.0255	0.0089	0.002112	0.01133		0.264	0.094	<0.008	0.0109	0.0013	0.007067	0.0018	<0.0010	0.0027		
4	0.026	0.0092	0.0023	0.0114		0.268	0.0955		0.0110	0.0014	0.0081	0.003		0.0039		
5	0.0269	0.0093	0.0025	0.0115		0.270	0.096		0.011	0.0016	0.0272	0.003		0.0043		
6	0.027	0.0094	0.0027	0.0117		0.270	0.0973		0.011	0.0017	<0.005	0.003		<0.0001		
7	0.0279	0.00943	0.0051	0.012		0.270	0.0982		0.011	0.0019	<0.0050	0.0033		<0.00094		
8	0.029	0.00947	0.0067	0.012		0.2715	0.10036		0.011	0.0019		0.0035				
9	0.0298	0.0095		0.0123		0.273333	0.110		0.0111	0.002233		0.0041				
10	0.030	0.0099		0.0123		0.276	0.1127		0.0117			0.0042				
11	0.031	0.0102		0.0123		0.2766	0.113833		0.0119							
12		0.0138		0.013		0.2774	0.1153		0.013							
13		0.0164		0.0140		0.278	0.1197									
14				0.014												
15																
Mean	0.027	0.010	0.003	0.0121		0.270	0.102	0.001	0.0112	0.0015	0.009	0.0029	0.002	0.003		
STDV.	0.003	0.003	0.002	0.0011		0.006	0.011		0.0007	0.0006	0.011	0.0010	0.000	0.001		
Certified	**0.027**	**0.010**	**0.003**	**0.0121**	**(<0.005)**	**0.270**	**0.102**	**(<0.008)**	**0.0112**	**0.0015**	**(0.009)**	**0.0029**	**(<0.003)**	**(0.003)**		
95% C.I.	0.002	0.002	0.001	0.0006		0.004	0.006		0.0005	0.0005		0.0007				
Methods	X,O,I,G	O,F	F	X,O,I,G	O,I	X,O,I,G	O,C	O,I	O,IM,I	O,I	O,I	O,I	O,I	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.

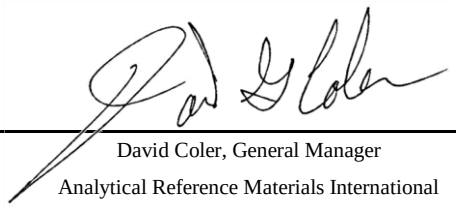
Inter-Laboratory Analysis Program (ILAP): Although ASTM Standard E691-87 applies to inter-laboratory studies to "Determine the Precision of a Single Test Method", it is also a well thought out and logical plan for conducting an inter laboratory program involving multiple techniques. Therefore, the planning,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



David Coler, General Manager

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LGC ARMI ISO 9001:2008

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