

Analytical Reference Materials International



Certificate of Analysis Certified Reference Material



Grade: **AISI 440F Se / UNS 44023**
Part Number (Q.A. NO.): **IARM 353A**

Certificate Date: **07/19/2017**

Certificate No.: **353A-07192017-IARM-F**

Revision Date: **11/16/2017**

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!

<u>Aluminum</u>	<u>Antimony</u>	<u>Arsenic</u>	<u>Boron</u>	<u>Calcium</u>	<u>Carbon</u>	<u>Cerium</u>	<u>Chromium</u>	<u>Cobalt</u>
0.0018 (0.0004)	(0.002)	0.004 (0.002)	(0.0006)	(0.0003)	0.98 (0.02)	(<0.005)	17.01 (0.08)	0.032 (0.002)
<u>Copper</u>	<u>Lead</u>	<u>Magnesium</u>	<u>Manganese</u>	<u>Molybdenum</u>	<u>Nickel</u>	<u>Niobium</u>	<u>Nitrogen</u>	<u>Oxygen</u>
0.13 (0.003)	(0.002)	(0.004)	0.95 (0.01)	0.50 (0.01)	0.265 (0.005)	0.011 (0.003)	0.027 (0.003)	0.005 (0.001)
<u>Phosphorus</u>	<u>Selenium</u>	<u>Silicon</u>	<u>Sulfur</u>	<u>Tantalum</u>	<u>Tin</u>	<u>Titanium</u>	<u>Tungsten</u>	<u>Vanadium</u>
0.019 (0.002)	0.17 (0.03)	0.49 (0.01)	0.025 (0.002)	(0.004)	0.0056 (0.0008)	0.0015 (0.0004)	0.041 (0.007)	0.116 (0.002)
<u>Zinc</u>	<u>Zirconium</u>							
(0.005)	0.002 (0.001)							

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

AK Steel, Research Center - Middletown, OH	IMR Test Labs - Lansing, NY
Anderson Laboratories, Inc. - Greendale, WI	Keywell Metals LLC - Falconer, NY
Cronimet Specialty Metals USA, Inc - Wheatland, PA	Laboratory Testing, Inc. - Hatfield, PA
Davis Alloys Manufacturing, LLC - Sharpsville, PA	Special Metals IncoTest - Hereford, UK
Ellwood National Steel - Irvine, PA	SPECTRO Analytical Instruments Inc. - Mahwah, NJ
Exova Burlington Lab - Burlington, ON	

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	BS 60C	BS 98	IARM 15A	IARM 253A	IH AK V2867	LECO 502-106	NIST 3103A	NIST 361
ALPHA AR1653	BS 84J	CARPENTER 303SE	IARM 15B	IARM 2B	JSS 650-8	LECO 502-414	NIST 3109A	NIST 363
ALPHA AR1656	BS 89E	IARM 11B	IARM 162C	IARM 2C	LECO 501-503	LECO 502-449	NIST 3128	NIST 50C
ALPHA AR511	BS 90E	IARM 11C	IARM 163D	IARM 4B	LECO 501-504	LECO 502-494	NIST 3131A	NIST 73B
ALPHA AR654	BS 90F	IARM 13A	IARM 16B	IH AK 598	LECO 501-506	MBH 13X41600A	NIST 3155	NIST 73C
ALPHA AR889	BS 91E	IARM 13B	IARM 17B	IH AK 634	LECO 501-644	MBH 13X44004A	NIST 3163	NIST 868
BCS 345	BS 93C	IARM 13C	IARM 182B	IH AK 669	LECO 501-675	MBH 316	NIST 3168A	
BCS 346	BS 93E	IARM 13D	IARM 205A	IH AK 670	LECO 501-991	NIST 1267	NIST 3169	
BS 153	BS 94B	IARM 154A	IARM 205B	IH AK 671	LECO 501-992	NIST 1296	NIST 337A	
BS 156	BS 94C	IARM 154B	IARM 21B	IH AK V2816	LECO 502-102	NIST 129A	NIST 339	

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 10/06/2017.

353A	Al	Sb	As	B	Ca	C	Ce	Cr	Co	Cu	Pb	Mg	Mn	Mo	Ni	Nb
1	0.001	0.001	0.0004	0.0001	0.0002	0.91	<0.0001	16.8	0.0221	0.119	0.0001	0.0001	0.915	0.486	0.25	0.0012
2	0.0013	0.001	0.0039	0.0001	0.00024	0.9396	<0.005	16.841	0.026	0.1234	0.0003	0.0002	0.925	0.487	0.253	0.0056
3	0.00147	0.0011	0.0039	0.0004	0.00036	0.977		16.85	0.031	0.125	0.0004	0.0005	0.929	0.4892	0.255	0.011
4	0.0016	0.0033	0.004	0.0007	<0.0001	0.9778		16.88	0.0312	0.127	<0.00057	0.0009	0.93	0.49	0.257	0.011
5	0.002	<0.003	0.0043	0.00088	<0.001	0.98		16.95	0.0318	0.1275	0.0052	0.018	0.93	0.493	0.26	0.0111
6	0.002	<0.004	0.0051		<0.005	0.982		16.999	0.032	0.128	0.0073		0.94	0.494	0.261	0.0112
7	0.002	<0.005	0.0058			0.986		17.022	0.032	0.1297	<0.0001		0.941	0.495	0.263	0.013
8	0.0027		0.01			0.9887		17.06	0.0333	0.131	<0.003		0.9545	0.503	0.266	0.013
9						0.993		17.07	0.0338	0.132			0.956	0.505	0.268	0.0132
10						0.9932		17.101	0.034	0.133			0.96	0.507	0.268	0.014
11						0.995		17.13	0.034	0.135			0.969	0.51	0.272	0.014
12						0.995		17.183	0.034	0.136			0.973	0.5247	0.2745	0.0215
13								17.23	0.0401	0.136			0.982	0.53	0.2758	
14										0.14				0.534	0.2853	
15																
Mean	0.0018	0.002	0.004	0.0006	0.0003	0.98		17.01	0.032	0.13	0.002	0.004	0.95	0.50	0.265	0.011
STDV.	0.0005	0.001	0.002	0.0003	0.0001	0.02		0.13	0.004	0.01	0.003	0.007	0.02	0.02	0.010	0.005
Certified	0.0018	(0.002)	0.004	(0.0006)	(0.0003)	0.98	(<0.005)	17.01	0.032	0.13	(0.002)	(0.004)	0.95	0.50	0.265	0.011
95% C.I.	0.0004		0.002			0.02		0.08	0.002	0.003			0.01	0.01	0.005	0.003
Methods	X,O,I	O,IM,I,H,A	O,IM,I,H,A	O,I	O,I	O,C	O,IM	X,O,I	X,O,I	X,O,I	O,IM,H	O,I,H	X,O,I	X,O,I	X,O,I	X,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

353A	N	O	P	Se	Si	S	Ta	Sn	Ti	W	V	Zn	Zr
1	0.0175	0.0033	0.013	0.14	0.441	0.016	0.001	0.0033	0.00003	0.0124	0.112	0.0001	0.0006
2	0.0239	0.004	0.0163	0.145	0.445	0.023	0.001	0.0039	0.001	0.023	0.112	0.0007	0.0007
3	0.0245	0.0046	0.017	0.149	0.481	0.023	0.003	0.004	0.001	0.034	0.1144	0.0022	0.002
4	0.025	0.005	0.0183	0.1534	0.482	0.0232	0.0099	0.0049	0.0013	0.04	0.115	0.006	0.002
5	0.027	0.0062	0.0185	0.154	0.484	0.0234		0.0053	0.0015	0.0453	0.115	0.017	0.0023
6	0.027	0.00667	0.0185	0.161	0.486	0.0237		0.0056	0.0017	0.0454	0.115	<0.005	0.004
7	0.0271	0.0071	0.0189	0.1688	0.49	0.0237		0.0057	0.0017	0.0455	0.116		0.0048
8	0.0279	0.0078	0.019	0.22	0.492	0.0256		0.006	0.0019	0.0458	0.117		
9	0.0279		0.0191	0.234	0.495	0.0257		0.0065	0.002	0.047	0.12		
10	0.029		0.02	0.5026	0.5026	0.0262		0.007	0.0024	0.048	0.121		
11	0.0369		0.021	0.503	0.503	0.0292		0.0074		0.051	0.121		
12			0.022	0.506	0.506	0.031		0.0077		0.0569			
13			0.0231	0.513	0.513								
14			0.0275	0.516	0.516								
15													
Mean	0.027	0.005	0.019	0.17	0.49	0.025	0.004	0.0056	0.0015	0.041	0.116	0.005	0.002
STDV.	0.004	0.001	0.003	0.03	0.02	0.004	0.004	0.0014	0.0006	0.012	0.003	0.006	0.001
Certified	0.027	0.005	0.019	0.17	0.49	0.025	(0.004)	0.0056	0.0015	0.041	0.116	(0.005)	0.002
95% C.I.	0.003	0.001	0.002	0.03	0.01	0.002		0.0008	0.0004	0.007	0.002		0.001
Methods	O,F	O,F	X,O,I	X,O,I	X,O,I	O,C	X,O,I	X,O,IM,I,A	X,O,I	X,O,I	X,O,I	O,I,H,A	X,O,IM,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

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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David Coler, General Manager

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