

# Analytical Reference Materials International

## Certificate of Analysis Certified Reference Material



Grade: **AISI 316 / UNS S31600**

Part Number (Q.A. NO.): **IARM 5E**

Certificate Date: **06/20/2008**

Certificate No.: **5E-06202008-IARM-F**

Revision Date: **08/18/2008**

### 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**.
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> 0.003 (0.001)	<u>Boron</u> 0.0021 (0.0001)	<u>Carbon</u> 0.016 (0.0004)	<u>Cobalt</u> 0.159 (0.001)	<u>Chromium</u> 16.92 (0.02)	<u>Copper</u> 0.42 (0.003)	<u>Manganese</u> 1.49 (0.01)
<u>Molybdenum</u> 2.15 (0.01)	<u>Nitrogen</u> 0.043 (0.001)	<u>Niobium</u> 0.011 (0.001)	<u>Nickel</u> 10.64 (0.01)	<u>Oxygen</u> 0.006 (0.0005)	<u>Phosphorus</u> 0.031 (0.001)	<u>Sulfur</u> 0.024 (0.0004)
<u>Silicon</u> 0.25 (0.01)	<u>Tantalum</u> <0.01	<u>Tin</u> 0.011 (0.001)	<u>Titanium</u> (0.001)	<u>Vanadium</u> 0.065 (0.002)	<u>Tungsten</u> 0.044 (0.002)	<u>Zirconium</u> (0.001)

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

Alcoa Howmet, Dover Alloy - Dover, NJ  
ATI Allvac, Monroe - Monroe, NC  
Crucible Specialty Metals - Syracuse, NY  
Laboratory Testing, Inc. - Hatfield, PA  
MetalTek International, Inc. - Waukesha, WI  
NSL Analytical Services - Cleveland, OH

ATI Allvac, Lockport - Lockport, NY  
Carpenter Technology Corporation - Reading, PA  
Kalco Metals, Inc - Farrell, PA  
Latrobe Specialty Steel Co. - Latrobe, PA  
MSI Testing & Engineering, Inc. - Melrose Park, IL  
The Timken Company - 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: **IARM 5D, ALPHA AR660, AR881, AR891, LECO 501-553, IARM 5C, 163B, BS 84J, 316A, HON-T, RV9963, RV7579, LECO 501-644, 501-674, 502-458, ALPHA AR871, NIST 362, IARM 5D, 27D, BS 84J, CA316-1, IS0049A, IC73385, ALPHA AR1648, LECO 502-257, NIST 121D, 160A, 3101A, 3103A, 3106, 3107, 3109A, 3131A, 3137, 3149, 3155, 3162A, 3163, 3168A, 3169, MBH 13X81101B, ALPHA AR669, AR881, BS 84J, CA316-4, NIST 1166, IARM 163B, BS 84G, 84J, 85D, CC22, CA304/1, SS456, ALPHA AR881, AR885, AR1652, AR1655, LECO 501-679, IARM 5D, LECO 501-502, ALPHA AR669, AR879, NIST 160A, 160B, 337A, 1160, 1161, 1162, 1163, 1164, 1754, 1761, 1762, 1763, 1764, 1765, 1766, 1767, BAS 401/1, 401/2, 402/1, 403/1, 404/1, 405/1, 406/1, 407/2, 408/1, 409/1, 410/2, 474, JSS ST01, 168-4, 169-4, 170-4, 171-4, BS CA-1, CA-2, CA-3, CA-4, CA1A, CA3A, , LECO 501-510, 501-645, 502-016, NIST 15H, 72G, 131G, 1152, 1154, 1155, 1185, BS 316A, 316B, ALPHA AR669, BS 84C, 84H, 84J, 316A, 316L, NIST 867, 3106, 3107, 3109A, 3128, 3131A, 3151, 3161A, IARM 5C, LECO 501-147, 502-257, NIST 362, BS 316, ALPHA AR669, AR657, AR869, LECO 501-505, 501-529, NIST 3169, IARM 5C, BS 84F.**

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 08/18/2008.

5E	Al	B	C	Co	Cr	Cu	Mn	Mo	N	Nb	Ni	O	P	S	Se
1	0.0042	0.0022	0.0157	0.1583	16.8906	0.4254	1.5043	2.1778	0.0408	0.0095	10.640	0.0057	0.0308	0.0251	0.0020
2	0.003	0.0021	0.0164	0.162	16.845	0.414	1.495	2.151	0.0427	0.0114	10.635	0.00557	0.0319	0.0237	<0.0010
3	0.0020	0.00207	0.0146	0.1618	16.958	0.417	1.482	2.164	0.04208	0.0110	10.641	0.0043	0.0317	0.0243	
4	0.004	0.0021	0.0150	0.160	16.942	0.4158	1.494	2.136	0.0424	0.0101	10.65	0.0067	0.0320	0.0229	
5	0.0038	0.0019	0.0151	0.1594	16.895	0.420	1.4745	2.118	0.0432	0.0105	10.62	0.0045	0.0293	0.0239	
6	0.0018	0.0018	0.0152	0.1615	16.91	0.414	1.487	2.17	0.0440	0.0100	10.641	0.0054	0.0328	0.0232	
7	0.00355	0.00198	0.0159	0.157	16.95	0.417	1.478	2.156	0.0422	0.0127	10.656	0.0058	0.0317	0.02355	
8	0.003	0.0022	0.0159	0.160	16.875	0.407	1.491	2.141	0.0423	0.0142	10.654	0.00526	0.033	0.0237	
9	0.0034	0.0023	0.0154	0.1553	16.898	0.4256	1.482	2.144	0.04347	0.01485	10.619	0.0054	0.0315	0.0244	
10		0.0021	0.016	0.1585	16.96	0.413	1.501	2.127	0.0447	0.011	10.626	0.0055	0.0307	0.0238	
11		0.0022		0.160	16.963	0.41	1.480	2.1945	0.0431	0.0108		0.0054	0.0321	0.0247	
12		0.0019		0.155	16.948	0.4173	1.481	2.146	0.0426			0.0069	0.0306	0.02395	
13				0.1600	16.88		1.50	2.12	0.043				0.031	0.0234	
14					16.947		1.483	2.156	0.04125				0.0301		
Mean	0.0032	0.0021	0.0155	0.1591	16.9187	0.4163	1.4881	2.1501	0.0427	0.0115	10.6382	0.0055	0.0314	0.0239	0.0020
STDV.	0.0008	0.0001	0.0006	0.0023	0.0383	0.0055	0.0095	0.0218	0.0010	0.0017	0.0133	0.0007	0.0010	0.0006	
Certified	0.003	0.0021	0.016	0.159	16.92	0.42	1.49	2.15	0.043	0.011	10.64	0.006	0.031	0.024	
95% C.I.	0.001	0.0001	0.0004	0.001	0.02	0.003	0.01	0.01	0.001	0.001	0.01	0.0005	0.001	0.0004	
Methods	X,I,O	I,O	C,O	X,A,I,O	X,W,A,I,O	X,A,I,O	X,A,I,O	X,A,I,O	F,O	X,I,O	X,A,I,O	F	X,I,O	X,C,O	

Legend: W = Classical, C = Combustion, F = Fusion, A = AA or GFAA, I = ICP or DCP, D = DC Arc, O = OE, X = XRF, G = GDMS, H = Hollow Cathode OE

5E	Si	Sn	Ta	Ti	V	W	Ag	As	Bi	Ca	Fe	Mg	Pb	Zn	Zr
1	0.2696	0.0099	<0.007	0.0030	0.059	0.037	0.000091	0.0078	0.0125	0.00037	67.718	0.00035	0.0012	0.0017	0.0004
2	0.257	0.0098	0.0054	0.0019	0.0615	0.0441	<0.0010	0.0082	0.0000017	0.0003		0.0002	0.0003	<0.0010	0.0009
3	0.237	0.0120	0.0057	0.0007	0.0666	0.0431		0.0089	<0.00002	0.0004		0.0002	0.0002		0.001
4	0.239	0.0118	<0.0001	0.0011	0.06725	0.0400		0.0100	0.0025	0.00031		<0.0010	0.0007		0.001
5	0.2556	0.010	0.004	0.001	0.066	0.040		0.0092		0.0003			0.000032		0.0015
6	0.249	0.0107	<0.01	0.0018	0.0662	0.0466				0.0003					
7	0.260	0.0128	0.0088	0.0006	0.066	0.0495									
8	0.250	0.0095		0.0008	0.0671	0.0433									
9	0.246	0.0127		0.002	0.0681	0.050									
10	0.2364	0.013		0.0020	0.0635	0.0445									
11	0.2345	0.0100			0.061	0.043									
12	0.253				0.0651	0.045									
13	0.255					0.0432									
14	0.2610														
Mean	0.2502	0.0111	0.0060	0.0015	0.0648	0.0438	0.0001	0.0088	0.0050	0.0003	67.7180	0.0003	0.0005	0.0017	0.0010
STDV.	0.0106	0.0014	0.0020	0.0008	0.0029	0.0036		0.0009	0.0066	0.0000		0.0001	0.0005		0.0004
Certified	0.25	0.011	<0.01	(0.001)	0.065	0.044		(0.009)		0.0003			(0.001)		(0.001)
95% C.I.	0.01	0.001			0.002	0.002				0.00005					
Methods	X,W,A,I,O	X,I,O	X,I,O	X,I,O	X,A,I,O	X,I,O		G,I,O					X,I,O		X,I

Legend: W = Classical, C = Combustion, F = Fusion, A = AA or GFAA, I = ICP or DCP, D = DC Arc, O = OE, X = XRF, G = GDMS, H = Hollow Cathode OE

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 instrument procedures.

**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. Each member of the ILAP is furnished a sample pack from a specific location on the batch bar. 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.

Certified by:   
 William D. Britt, President & General Manager  
 Analytical Reference Materials International Corporation

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