

# Analytical Reference Materials International

## Certificate of Analysis Certified Reference Material



Grade: **AISI 316 / UNS S31600**

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

Certificate Date: **04/12/2012**

Certificate No.: **5G-04122012-IARM-F**

Revision Date: **01/10/2013**

### 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**.
- 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> 0.004 (0.001)	<u>Arsenic</u> 0.006 (0.001)	<u>Bismuth</u>	<u>Boron</u> 0.0007 (0.0002)	<u>Carbon</u> 0.044 (0.001)	<u>Calcium</u> 0.0007 (0.0003)	<u>Chromium</u> 17.5 (0.04)	<u>Cobalt</u> 0.33 (0.01)	<u>Copper</u> 0.37 (0.01)
<u>Lead</u> (0.0001)	<u>Magnesium</u> (0.0004)	<u>Manganese</u> 1.67 (0.004)	<u>Molybdenum</u> 2.03 (0.01)	<u>Nitrogen</u> 0.033 (0.001)	<u>Niobium</u> 0.007 (0.001)	<u>Nickel</u> 10.48 (0.01)	<u>Oxygen</u> 0.004 (0.0004)	<u>Phosphorus</u> 0.028 (0.001)
<u>Sulfur</u> 0.026 (0.001)	<u>Silicon</u> 0.27 (0.01)	<u>Tantalum</u> (0.004)	<u>Tin</u> 0.010 (0.001)	<u>Titanium</u> 0.002 (0.001)	<u>Vanadium</u> 0.083 (0.002)	<u>Tungsten</u> 0.050 (0.002)	<u>Zinc</u> (0.001)	<u>Zirconium</u> (0.002)

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

Alcoa Howmet, Dover Alloy - Dover, NJ  
Colorado Metallurgical Services - Denver, CO  
Ellwood National Steel - Irvine, PA  
Jorgensen Forge Corp. - Seattle, WA  
MetalTek International, Inc. - Waukesha, WI  
Special Metals IncoTest - Hereford, UK

Anderson Laboratories, Inc. - Greendale, WI  
Crucible Industries - Syracuse, NY  
Huntington Alloys Corporation - Huntington, WV  
Laboratory Testing, Inc. - Hatfield, PA  
NSL Analytical Services - Cleveland, OH  
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 5E, 163C, ALPHA AR669, AR869, LECO 501-643, 501-674, 762-747, NIST 16F, 101C, 368, C1151, C1152, C1153, C1154, 1155, 1161, 1162, 1163, 1164, 1165, 1166, 1167, 1168, 1169, 1185, 1261, 1262, 1263, 1164, 1165, 1166, 1167, 1168, 1169, 1264, 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, 421, 422, 465/1, 466/1, JSS ST01, ST02, ST03, ST04, ST05, ST06, 168-4, 169-4, 170-4, 171-4, 172-4, 173-4, 174-4, 175-4, 190-1, 191-1, 192-1, 193-1, 194-1, 195-1, 651-11, BS CA-1, CA-2, CA-3, CA-4, CA1A, CA3A, CA316-4, XAAS, XCCV, XCCS, 13B, LECO 501-510, 501-645, NIST 121D, 160A, 361, 3101A, 3106, 3107, 3109A, 3113, 3128, 3131A, 3137, 3149, 3155, 3161A, 3162A, 3163, 3168A, 3169, MBH 13X12854K, 13X8110LB, ALPHA AR669, LECO 501-502, 502-102, BCS 336, 351, 454/1, 462/1, HAS 317B, ES 252-1, IH R5657, LECO 501-550, 502-102, NIST 131G, 345A, 1155, BCS 346A, LECO 501-645, NIST 1155, 1185, IARM 5E, SYN 316A, QGFB, ALPHA AR881, LECO 502-102, NIST 170, 339, IARM 2C, 4B, 15B, 21B, 5A, 5B, 5C, 5D, LECO 501-644, 502-062, 502-447, IARM 5E, 163C, ALPHA AR669, AR869, LECO 501-643, 501-674, 762-747, BS 316A, 316B, CA316-1, 84E, 84F, IARM 5B, ALPHA AR646, AR870, IARM 2G, 5C, 163C, MBH 13X12853J, ALPHA AR669.**

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 01/10/2013.

5G	Al	B	C	Co	Cr	Cu	Mn	Mo	N	Nb	Ni	O	P	S	Se
1	0.0050	0.0004	0.046	0.352	17.450	0.378	1.680	2.040	0.0360	0.0080	10.4575	0.0042	0.029	0.025	<0.0010
2	0.0073	0.0001	0.0435	0.3425	17.5125	0.3495	1.6825	2.032	0.0317	0.0045	10.504	0.00319	0.0272	0.0269	0.0079
3	0.0025	0.00057	0.0449	0.3372	17.530	0.377	1.666	2.0498	0.0312	0.0059	10.5087	0.0037	0.0269	0.0276	<0.003
4	0.0032	0.0006	0.0445	0.3290	17.4889	0.3783	1.671	2.019	0.03182	0.0080	10.48	0.0035	0.0309	0.026	0.0003
5	0.004	0.0006	0.042	0.3252	17.45	0.367	1.67	2.0440	0.0323	0.0059	10.487	0.0038	0.030	0.0253	0.0001
6	0.0023	0.0007	0.047	0.333	17.59	0.36	1.67	2.01	0.034	0.005	10.4627	0.0041	0.0269	0.0249	0.00002
7	0.0068	0.0009	0.0441	0.328	17.580	0.345	1.6735	2.002	0.0339	0.0066	10.47	0.0051	0.0293	0.0262	<0.0001
8	0.003	0.0011	0.0424	0.325	17.46	0.369	1.671	2.016	0.0301	0.0075	10.515	0.0044	0.0275	0.0273	0.0009
9	0.0039	0.0011	0.0432	0.3233	17.443	0.3818	1.66275	2.014	0.0310	0.0078	10.487	0.0045	0.0318	0.0265	
10	0.0028	0.0006	0.046	0.328	17.62	0.377	1.672	2.031	0.0297	0.0065	10.47	0.0033	0.027	0.0255	
11	0.0046		0.0419	0.3415	17.549	0.3835	1.664	2.034	0.0335	0.0112	10.452		0.0272	0.027	
12	0.003		0.044	0.319	17.41	0.384	1.6674	2.037	0.0330	0.010			0.028	0.0262	
13	0.0031		0.0462	0.3122	17.4943	0.3740		2.02	0.0335	0.0082			0.0264		
14								2.0429	0.0341						
Mean	0.0040	0.0007	0.0443	0.3305	17.5060	0.3711	1.6708	2.0280	0.0326	0.0073	10.4813	0.0040	0.0283	0.0262	0.0018
STDV	0.0016	0.0003	0.0017	0.0107	0.0645	0.0126	0.0059	0.0145	0.0018	0.0018	0.0212	0.0006	0.0017	0.0009	0.0034
Certified	0.004	0.0007	0.044	0.33	17.5	0.37	1.67	2.03	0.033	0.007	10.48	0.004	0.028	0.026	
95% C.I.	0.001	0.0002	0.001	0.01	0.04	0.01	0.004	0.01	0.001	0.001	0.0004	0.0004	0.001	0.001	
Methods	X,I,O	G,I,O	C,O	X,I,O	X,W,I,O	X,I,O	X,I,O	X,I,O	F,O	X,G,I,O	X,W,I,O	F	X,I,O	C,O	

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

5G	Si	Sn	Ta	Ti	V	W	Ag	As	Bi	Ca	H	Mg	Pb	Zn	Zr
1	0.280	0.009	0.0001	0.0020	0.080	0.0538	<0.0001	0.0057	<0.0001	0.00054	<0.0001	0.0007	0.0004	0.0016	0.0020
2	0.2525	0.0111	0.006	0.0005	0.0845	0.0481	0.0001	0.0073	<0.0001	0.0013		0.0001	0.0001	0.0032	0.0026
3	0.2582	0.0118	0.0001	0.0017	0.0775	0.0544	0.0001	0.007	0.00003	0.0004		0.00014	0.00007	0.0002	0.0015
4	0.260	0.0105	0.0032	0.0012	0.0792	0.055	<0.0001	0.0065	0.000003	0.0005		0.0002	0.00004	0.00004	0.0023
5	0.2700	0.010	0.0060	0.002	0.0841	0.048	0.00007	0.0040	0.0031	0.0004		0.0008		0.0010	
6	0.2645	0.0135	0.0060	0.0013	0.085	0.0496		0.0057	<0.0001	0.0006					
7	0.253	0.0109		0.0010	0.0856	0.0466		0.005	0.002	0.0010					
8	0.278	0.0097		0.0022	0.087	0.051		0.0054							
9	0.265	0.0082		0.0032	0.0861	0.0528									
10	0.2752	0.010		0.003	0.0807	0.047									
11	0.274	0.0069		0.0021	0.085	0.049									
12	0.2421	0.007			0.0803										
13	0.274	0.0108			0.081										
14	0.2681				0.0849										
Mean	0.2653	0.0100	0.0036	0.0018	0.0829	0.0505	0.0001	0.0058	0.0013	0.0007	#DIV/0!	0.0004	0.0001	0.0012	0.0021
STDV	0.0111	0.0019	0.0029	0.0008	0.0030	0.0031	0.0000	0.0011	0.0015	0.0003	#DIV/0!	0.0003	0.0000	0.0013	0.0005
Certified	0.27	0.010	(0.004)	0.002	0.083	0.050		0.006		0.0007		(0.0004)	(0.0001)	(0.001)	(0.002)
95% C.I.	0.01	0.001		0.001	0.002	0.002		0.001		0.0003					
Methods	X,W,I,O	X,G,I,O	X,G,I,O	X,I,O	X,I,O	X,I,O		H,G,I,O	G,I,O			H,G,I,O	H,G,I	X,H,G,I,O	X,G,O

Legend: W = Classical, C = Combustion, F = Fusion, A = AA or GFAA, I = ICP or DCP, 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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