



Certificate of Analysis

IARM 5I

AISI 316 / UNS S31600

Certified Reference Material

Certified Values listed in wt.% with associated uncertainties

Al	0.004 ± 0.001	As	0.006 ± 0.001	B	0.0006 ± 0.0001	C	0.049 ± 0.001
Co	0.185 ± 0.001	Cr	16.67 ± 0.02	Cu	0.487 ± 0.003	Mn	1.443 ± 0.009
Mo	2.027 ± 0.003	N	0.048 ± 0.001	Nb	0.0133 ± 0.0009	Ni	10.04 ± 0.03
O	0.0057 ± 0.0006	P	0.0279 ± 0.0005	S	0.033 ± 0.001	Si	0.433 ± 0.004
Sn	0.0077 ± 0.0005	Ta	0.005 ± 0.002	Ti	0.0025 ± 0.0009	V	0.064 ± 0.002
W	0.182 ± 0.006						

Indicative Values listed in ppm

Ca (16)	Ce (<50)	Mg (<50)	Pb (1)	Sb (19)	Se (<20)	Zn (40)
Zr (20)						

Description and Intended Use

This CRM may come in the form of a solid disc or chips. The intended use of this CRM may include, but is not limited to, the calibration of instruments and the validation of analytical methods.

Interpretation of Data

1. Certified values listed 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. This material was tested using both the solid disks and chips prepared from individual sections of bar. The certified values are considered representative of the overall average composition of the material.
3. 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.
4. "Provisional Certificate of Analysis" reports values that support a fully certified reference material; it also indicates that values may be in a continued process of statistical evaluation and are subject to change.
5. Chips are not certified for Oxygen analysis.



The following data and accompanying statements represent all pertinent information reported in the ILAP as it applies to the chemical characterization of this material.

	Al	As	B	C	Ca	Ce	Co	Cr	Cu	Mg	Mn	Mo	N	Nb	Ni	O
1	0.0015	0.0051	0.00017	0.0444	0.0005	0.0006	0.1815	16.62	0.479	0.0002	1.416	2.02	0.0458	0.011	9.97	0.004
2	0.0017	0.0056	0.0003	0.046	0.0015	<0.005	0.182	16.63	0.4812	0.0002	1.4175	2.023	0.0459	0.0114	9.98545	0.0055
3	0.0034	0.006	0.0005	0.046	0.0017		0.183	16.64	0.483	<0.005	1.4269	2.023	0.0462	0.012	10.004	0.0057
4	0.0035	0.0061	0.0005	0.048	0.002		0.1831	16.65	0.4847		1.432	2.0235	0.0464	0.012	10.025	0.0057
5	0.0036	0.0061	0.00056	0.048	0.0025		0.1838	16.655	0.4848		1.44	2.025	0.0467	0.013	10.03	0.0059
6	0.0037	0.0072	0.0006	0.04805			0.184	16.656	0.487		1.44	2.025	0.0467	0.0132	10.04	0.0061
7	0.004	0.0082	0.0006	0.0492			0.184	16.6775	0.4877		1.441	2.0251	0.0469	0.0134	10.044	0.0062
8	0.0045		0.0006	0.0493			0.185	16.6792	0.488		1.445	2.027	0.0473	0.0139	10.0533	0.0064
9	0.0048		0.0006	0.0495			0.185	16.6874	0.489		1.448	2.0299	0.049	0.014	10.062	
10	0.005		0.0006	0.0496			0.1853	16.688	0.49		1.453	2.03	0.0491	0.014	10.076	
11	0.0077		0.0006	0.0505			0.186	16.69	0.49		1.456	2.0305	0.0494	0.014	10.084	
12			0.00069	0.051			0.189	16.71	0.4944		1.457	2.033	0.0507	0.0142	10.09	
13			0.001	0.0511			0.19	16.718	0.497		1.4585	2.034	0.051	0.0168	10.1168	
14				0.0512							1.47	2.035				
15																
Mean	0.004	0.006	0.0006	0.049	0.0016		0.185	16.67	0.487		1.443	2.027	0.048	0.0133	10.04	0.0057
STDV.	0.002	0.001	0.0002	0.002	0.0007		0.002	0.03	0.005		0.02	0.005	0.002	0.002	0.04	0.0007
Certified	0.004	0.006	0.0006	0.049	0.0016	<0.005	0.185	16.67	0.487	<0.005	1.443	2.027	0.048	0.0133	10.04	0.0057
95% C.I.	0.001	0.001	0.0001	0.001			0.001	0.02	0.003		0.009	0.003	0.001	0.0009	0.03	0.0006
Methods	O,I	O,IM,A	O,I	O,C	O,I	O,I	X,O,I	X,W,O	X,O,I	O,IM,I	X,O,I	X,O,I	O,F	X,O,I	X,W,O,I	O,F

	P	Pb	S	Sb	Se	Si	Sn	Ta	Ti	V	W	Zn	Zr			
1	0.0266	0.00003	0.03	0.0013	0.0001	0.4156	0.006	0.0033	0.0003	0.058	0.161	0.0008	0.001			
2	0.0269	0.00004	0.0302	0.0014	0.0007	0.429	0.0064	0.0033	0.001	0.0586	0.164	0.0048	0.0019			
3	0.027	0.00006	0.0303	0.0015	0.0009	0.43	0.0073	0.005	0.0014	0.0609	0.18	0.005	0.0019			
4	0.0271	0.0004	0.0304	0.0021	<0.0020	0.431	0.0074	0.006	0.0015	0.0623	0.18	0.005	0.002			
5	0.02725	<0.001	0.0309	0.003		0.4339	0.0074	0.0067	0.0015	0.0628	0.18	<0.00001	0.0056			
6	0.0276	<0.001	0.0315	<0.004		0.435	0.0075	0.0069	0.0017	0.063	0.18	<0.002	<0.0001			
7	0.0279		0.0328			0.435	0.00775		0.002	0.063	0.186		<0.0001			
8	0.028		0.033			0.435	0.00805		0.002	0.0637	0.1879		<0.0010			
9	0.028		0.03343			0.435	0.0085		0.0029	0.0639	0.1892					
10	0.0283		0.0337			0.4374	0.0085		0.0039	0.065	0.1892					
11	0.02855		0.0347			0.439	0.0085		0.004	0.0653	0.19					
12	0.0288		0.03475			0.439	0.0085		0.005	0.066	0.1914					
13	0.0289		0.0348			0.439	0.00855		0.005	0.069						
14	0.029		0.035							0.07						
15																
Mean	0.0279	0.0001	0.033	0.0019	0.001	0.433	0.0077	0.005	0.0025	0.064	0.182	0.004	0.002			
STDV.	0.0008	0.0002	0.002	0.0007	0.0004	0.006	0.0008	0.002	0.002	0.003	0.01	0.002	0.002			
Certified	0.0279	0.0001	0.033	0.0019	<0.002	0.433	0.0077	0.005	0.0025	0.064	0.182	0.004	0.002			
95% C.I.	0.0005		0.001			0.004	0.0005	0.002	0.0009	0.002	0.006					
Methods	X,O,I	O,IM,A	O,C	O,IM,A	O,IM,A	X,W,O	X,O,IM,A	X,O,I	X,O,I	X,O,I	X,O,I	O,I,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



Participating Laboratories

Certified Alloy Products, Inc.
SPECTRO Analytical Instruments Inc.
AADFW, Inc.
Ellwood National Steel
Cronimet Specialty Metals USA, Inc.
Crucible Industries

Long Beach, CA
Mahwah, NJ
Euleess, TX
Irvine, PA
Wheatland, PA
Syracuse, NY

ATI Specialty Materials, Lockport
Laboratory Testing, Inc.
Laboratorio Prove Materiali S. Marco srl
Davis Alloys Manufacturing, LLC
MetalTek International, Inc.
Exova - Gary

Lockport, NY
Hatfield, PA
Schio, Italy
Sharpshville, PA
Waukesha, WI
Gary, IN

Traceability

Members of the "Inter-Laboratory Analysis Program" (ILAP) validate test methods and instrument performance utilizing SRMs, CRMs, and RMs produced by recognized Certifying Bodies. The specific SRMs, CRMs, and RMs applicable to the material covered by this certificate are:

ALPHA AR1650	ALPHA AR650	ALPHA AR652	ALPHA AR654	ALPHA AR870	ALPHA AR881	ALPHA AR882	ALPHA AR883	ALPHA AR890
ALPHA AR891	ASTM 0031	ASTM 32	ASTM 341	ASTM 342	BCS 346	BCS SS466	BCS SS474	BS 316A
BS 316B	BS 316C	BS 60C	BS 84C	BS 84E	BS 84F	BS 84G	BS 84J	IARM 163D
IARM 2C	IARM 2F	IARM 5A	IARM 5B	IARM 5C	IARM 5D	IARM 5E	IARM 5G	LECO 501-503
LECO 501-574	LECO 501-674	LECO 502-197	LECO 502-269	LECO 502-328	MBH 13X12854L	MBH 13X12855M	MBH 13X12855-M	LECO 1155
NIST 1184	NIST 1185	NIST 3101A	NIST 3107	NIST 3109A	NIST 3110	NIST 3155	NIST 3162	NIST 3169A
NIST 361	NIST 363	NIST 897	NIST 898	NIST 899				

Homogeneity and Uncertainty

"Uncertainty" values, as reported adjacent to certified concentration values, are based on a 95% Confidence Interval. These estimated uncertainties include the combined effects of method imprecision, material inhomogeneity, and any bias between methods. Homogeneity data from experimental XRF results are reflected in both the overall statistics and certified data. Homogeneity samples are selected by a systematic sampling procedure. The number of samples may be determined by equation 1, where N_{prod} is the number of units produced and N_{min} is the number of samples used for homogeneity testing. These samples are arranged in a simple randomized design such that each sample is analyzed multiple times by XRF. Homogeneity is also determined within sample using an applied version of ASTM E826. A single factor ANOVA is used to calculate uncertainty due to inhomogeneity (U_{hom}). Uncertainty of the material is calculated by equation 2, where $H=U_{hom}$, S = Standard deviation, t = t-value at 95% CI, and n = number of observations.

$$1. N_{min} = \max(10, \sqrt[3]{N_{prod}})$$

$$2. U_{CRM} = \frac{\sqrt{H^2 + S^2}}{\sqrt{n}} * t$$

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 with the information detailed in ISO Guide 31. The only generally accepted certifying body in the United States for primary standards or 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, with one or more property values that 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, with one or more property values 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): ASTM Standard E691-87 applies to inter-laboratory studies to "Determine the Precision of a Single Test Method", but also outlines a well thought out and logical plan for conducting an inter laboratory program involving multiple analytical techniques. Therefore, the guidelines established in ASTM E691-87 were applied to all aspects of this inter laboratory program, including the protocols for planning, handling, analysis and treatment of resulting data.

Methods of Analysis: The "Inter Laboratory Analysis Program" analyzes a wide variety of materials, and as a result, no single analytical method would provide optimum analytical results. Therefore, a combination of ASTM Standard Methods for classical wet chemistry, ICP, AA, Optical Emission, X-Ray spectrometric, and other accepted methods were used to produce analytical data. Carbon, Sulfur, Nitrogen, and Oxygen results were supplied from 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 on 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. The minimum sample size for chips should be individually evaluated based on the analytical technique used; this would typically be greater than 0.1 grams. The material should be stored in a cool, dry location when not in use. **Chips are not to be used for Oxygen analysis.**

Selection of Materials: A "batch" or "series" is defined as a continuous length of bar produced from a single heat. The majority of IARM materials are in wrought condition; other methods of manufacture are utilized if necessary. ILAP samples are removed from equal sections from the total length of the bar. A portion of each section is converted to chips and a 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.



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