



Certificate of Analysis

IARM 154C

AISI 420 / UNS S42000

Certified Reference Material

Certified Values listed in wt.% with associated uncertainties

Al	0.0034 ± 0.0009	B	0.0007 ± 0.0003	C	0.339 ± 0.005	Co	0.016 ± 0.001
Cr	12.41 ± 0.04	Cu	0.120 ± 0.002	Mn	0.423 ± 0.005	Mo	0.036 ± 0.001
N	0.054 ± 0.002	Nb	0.014 ± 0.003	Ni	0.215 ± 0.004	O	0.0042 ± 0.0009
P	0.0174 ± 0.0004	S	0.0043 ± 0.0004	Si	0.37 ± 0.01	Sn	0.0058 ± 0.0005
Ti	0.0015 ± 0.0004	V	0.043 ± 0.001	W	0.005 ± 0.002		

Indicative Values listed in ppm

As (40)	Ca (<10)	Mg (<10)	Pb (<100)	Sb (10)	Se (3)	Ta (<50)
Zn (<50)	Zr (14)					

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	Co	Cr	Cu	Mg	Mn	Mo	N	Nb	Ni	O	P
1	0.001	0.003	0.0003	0.3187	0.00054	0.013	12.266	0.114	0.0001	0.41	0.032	0.0465	0.0028	0.2036	0.0031	0.016
2	0.0019	0.0035	0.0004	0.3331	0.0008	0.0138	12.3182	0.115	0.0001	0.41	0.0324	0.049	0.007	0.209	0.0033	0.0164
3	0.002	0.0039	0.0006	0.3353	<0.0001	0.015	12.34	0.115	0.0008	0.411	0.0337	0.0515	0.0084	0.21	0.0033	0.0165
4	0.0026	0.005	0.0007	0.3354	<0.0001	0.015	12.358	0.116	<0.0001	0.417	0.0338	0.0527	0.0122	0.21	0.0034	0.017
5	0.0033	<0.003	0.0009	0.336	<0.005	0.015	12.38	0.117		0.419	0.034	0.053	0.015	0.21	0.004	0.017
6	0.0038	<0.005	0.001	0.337		0.016	12.38	0.118		0.421	0.0349	0.053	0.015	0.2112	0.0043	0.017
7	0.004			0.3378		0.016	12.41	0.1192		0.421	0.0353	0.0546	0.016	0.2115	0.0045	0.0174
8	0.004			0.34		0.0163	12.42	0.12		0.423	0.036	0.0558	0.0166	0.213	0.0046	0.0175
9	0.0041			0.341		0.017	12.43	0.121		0.4235	0.036	0.056	0.017	0.214	0.0069	0.0176
10	0.0042			0.341		0.0175	12.441	0.1212		0.426	0.036	0.0564	0.0173	0.215		0.018
11	0.0042			0.345		0.019	12.47	0.122		0.426	0.038	0.0565	0.018	0.22		0.018
12	0.006			0.346		0.0194	12.471	0.125		0.4282	0.039	0.0568	0.02	0.22		0.018
13				0.346		0.0213	12.499	0.125		0.433	0.0394	0.058	0.021	0.22		0.018
14				0.358			12.55	0.126		0.4397	0.04			0.224		0.0186
15										0.4414				0.2277		
Mean	0.0034	0.004	0.0007	0.339	0.001	0.016	12.41	0.12	0.0003	0.423	0.036	0.054	0.014	0.215	0.0042	0.0174
STDV.	0.001	0.0009	0.0003	0.009	0.0002	0.002	0.08	0.004	0.0004	0.01	0.003	0.003	0.005	0.006	0.001	0.0007
Certified	0.0034	(0.004)	0.0007	0.339	(0.001)	0.016	12.41	0.120	(<0.001)	0.423	0.036	0.054	0.014	0.215	0.0042	0.0174
95% C.I.	0.0009		0.0003	0.005		0.001	0.04	0.002		0.005		0.002	0.003	0.004	0.0009	0.0004
Methods	X,O,I	O,IM,I,H	O,I	O,C	O,I	X,O,I	X,O,I	X,O,I	O,IM,I,H	X,O,I	X,O,I	O,F	X,O,I	X,O,I	O,F	X,O,I

	Pb	S	Sb	Se	Si	Sn	Ta	Ti	V	W	Zn	Zr				
1	0.00003	0.0029	0.0008	0.00001	0.337	0.0042	0.0013	0.0006	0.0393	0.0009	0.0027	0.0004				
2	0.001	0.0037	0.001	0.0001	0.34	0.0053	0.003	0.001	0.04	0.0025	<0.0001	0.0007				
3	0.0094	0.0037	0.0011	0.0001	0.3474	0.0053	<0.0001	0.001	0.0418	0.003	<0.0001	0.0017				
4	<0.0001	0.0038	0.0012	0.0005	0.361	0.0056	<0.0001	0.001	0.042	0.0037	<0.005	0.002				
5	<0.003	0.004	<0.005	0.0006	0.3673	0.0058	<0.001	0.0013	0.042	0.0049		0.002				
6		0.0041		<0.003	0.369	0.0058	<0.003	0.0015	0.042	0.005		<0.0010				
7		0.0043		<0.005	0.371	0.0059	<0.0030	0.0015	0.0421	0.0073		<0.005				
8		0.0044		<0.005	0.3785	0.006	<0.005	0.0016	0.0425	0.0076						
9		0.0046			0.379	0.006	<0.005	0.0017	0.043	0.008						
10		0.0046			0.383	0.006		0.002	0.043	0.011						
11		0.005			0.383	0.007		0.0028	0.0432							
12		0.0051			0.385	0.007			0.0432							
13		0.0057			0.388				0.044							
14					0.395				0.0449							
15					0.4306				0.047							
Mean	0.003	0.0043	0.001	0.0003	0.37	0.0058	0.002	0.0015	0.043	0.005		0.0014				
STDV.	0.005	0.0007	0.0002	0.0003	0.02	0.0007	0.001	0.0006	0.002	0.003		0.0008				
Certified	(<0.01)	0.0043	(0.001)	(0.0003)	0.37	0.0058	(<0.005)	0.0015	0.043	0.005	(<0.005)	(0.0014)				
95% C.I.		0.0004			0.01	0.0005		0.0004	0.001	0.002						
Methods	O,IM,A	O,C	O,IM,I,H,A	O,IM,I,H,A	X,O,I	X,O,IM,I,A	X,O,IM,I	X,O,IM,I	X,O,I	X,O,IM,I	IM,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

Exova - Burlington
Crucible Industries
Microlab
Anderson Laboratories, Inc.
Laboratorio Prove Materiali S. Marco srl
Cronimet Specialty Metals USA, Inc.

Burlington, ON
Syracuse, NY
TamilNadu, India
Greendale, WI
Schio, Italy
Wheatland, PA

Keywell Metals LLC
Laboratory Testing, Inc.
SPECTRO Analytical Instruments Inc.
Special Metals IncoTest
IMR Test Labs
AK Steel, Research Center

Falconer, NY
Hatfield, PA
Mahwah, NJ
Hereford, UK
Lansing, NY
Middletown, OH

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 AR511	ALPHA AR653	ALPHA AR654	ALPHA AR656	ALPHA AR878	ASTM 1121	ASTM 1122	ASTM 9731
BCS 345	BCS 346	BS 151	BS 156	BS 84J	BS 89C	BS 89E	BS 90E	BS 90F
BS 91E	BS 93E	BS 94C	BS 94E	BS 98	IARM 10A	IARM 13C	IARM 154A	IARM 154B
IARM 15A	IARM 15B	IARM 16B	IARM 18C	IARM 19C	IARM 205A	IARM 205B	IARM 21B	IARM 2B
IARM 2C	IARM 2F	IARM 301A	IARM 4B	IH AKS 584	IH AKS 585	IH AKS 598	IH AKS 669	LECO 501-503
LECO 501-504	LECO 501-644	LECO 501-991	LECO 501-992	LECO 502-102	LECO 502-106	LECO 502-257	LECO 502-414	LECO 502-494
MBH 13X12547L	MBH 13X41001A	NIST 101E	NIST 101G	NIST 1249	NIST 12H	NIST 2165	NIST 3101A	NIST 3107
NIST 3109A	NIST 3137	NIST 3149	NIST 3155	NIST 3168A	NIST 3169	NIST 343	NIST 361	NIST 363
NIST 73B	NIST 73C	SS4951	SS4952					

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.



David Coler, General Manager

Analytical Reference Materials International



Analytical Reference Materials International • 276 Abby Road • Manchester, NH 03103
Telephone (603) 935-4100 • Fax (603) 935-4101 • www.ARMIL.com • ARMI@LGCgroup.com



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