

Certified Reference Material

Certificate of Analysis

Product ID: IARM-FE1144-22

ISO
17034:2016

ISO/IEC
17025:2017

ISO
9001:2015

Product Description: Carbon Steel, Resulfurized, AISI 1144 / G11440

Revision No.: 000
Revision Date: 09/25/2023

Description and Intended Use: This **Certified Reference Material** is covered under the scope of accreditation to **ISO 17034** by LGC Standards - Manchester, NH. As an ISO 17034 certified reference material, appropriate use of this material will fulfill the certified reference material and traceability requirements for use in **ISO 17025** accredited laboratories. This CRM may come in the form of a solid disk, 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.

Certified Values listed in wt.% with associated uncertainties

As	0.0040	± 0.0004	C	0.406	± 0.004	Co	0.0061	± 0.0007	Cr	0.061	± 0.001
Cu	0.115	± 0.002	Mn	1.34	± 0.01	Mo	0.0112	± 0.0006	N	0.0081	± 0.0004
Ni	0.036	± 0.002	O	0.002	± 0.001	P	0.0091	± 0.0007	S	0.323	± 0.009
Sb	0.0017	± 0.0005	Si	0.171	± 0.004	Sn	0.0081	± 0.0005	Ti	0.0007	± 0.0003
V	0.0023	± 0.0003	W	0.0017	± 0.0006						

Indicative Values listed in ppm

Al 17 B 3 Ca 1 Fe Balance Nb 12 Pb 4 Zr 9

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 may also be 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.

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

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

Certification Laboratories: Much of the analytical work performed to assess this material has been carried out by laboratories with proven competence, as indicated by their accreditation to ISO 17025. It is an implicit requirement for this accreditation that analytical work should be performed with due traceability, via an unbroken chain of comparisons, each with stated uncertainty, to primary standards such as the mole, or to nationally- or internationally-recognized reference materials. Of the individual results herein, some have traceability (to the mole) via primary analytical methods. Some are traceable to substances of known stoichiometry. Most have traceability via commercial solutions. Furthermore, some results have additional traceability to NIST standards, as part of the analytical calibration or process control.

- Anderson Laboratories, Inc. - Greendale, WI
- Cleveland Cliffs - Cleveland, OH
- Dirats Laboratories - Westfield, MA
- EAG Laboratories - Liverpool, NY
- IMR Test Labs - Lansing, NY
- Instytut Metalurgii Zelaza - Gliwice, Poland
- Laboratory Testing, Inc. - Hatfield, PA
- LGC Standards - Manchester, NH
- Lithea S.R.O. - Brno, Czech Republic
- NSL Analytical Services - Cleveland, OH
- SGS MSI - Melrose Park, IL
- Sheffield Assay Office - Sheffield, England
- TEC EuroLab - Campogalliano, Italy

Instructions for Use: The test surface is on the opposite side of the labeled surface, which includes the material identification. 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 recommended for gas analysis.

Period of Validity: The certification of this material is valid indefinitely, within the uncertainty specified, provided the material is handled and stored in accordance with the instructions stated on this certificate. The certification is nullified if the material is damaged, contaminated, otherwise modified, or used in a manner for which it was not intended.

Chuck Goudreau

Chuck Goudreau, Certifying Officer

September 25, 2023
Certification Date



ISO 17034 Accredited: Reference Materials
Producer, Certificate # 2848.02
ISO/IEC 17025 Accredited: Chemical
Testing, Certificate # 2848.01



Conditions of Sale and Supply: All CRMs & RMs sold are subject to applicable LGC Standard Terms and Conditions of Sale.

The following data represents all pertinent information reported as it applies to the chemical characterization of this material.

	Al	As	B	C	Ca	Co	Cr	Cu	Mn	Mo	N	Nb	Ni
1	0.0001	0.0030	0.0001	0.3980	0.0001	0.0045	0.0585	0.1030	1.295	0.0101	0.0071	0.0001	0.0296
2	0.0011	0.0033	0.0001	0.4000		0.0046	0.0590	0.1110	1.311	0.0101	0.0080	0.0009	0.0310
3	0.0015	0.0035	0.0003	0.4040		0.0047	0.0591	0.1116	1.319	0.0103	0.0080	0.0012	0.0313
4	0.0015	0.0036	0.0007	0.4050		0.0051	0.0592	0.1120	1.320	0.0104	0.0080	0.0015	0.0322
5	0.0018	0.0038	0.0008	0.4055		0.0052	0.0595	0.1120	1.321	0.0105	0.0082	0.0015	0.0332
6	0.0021	0.0038	<0.0005	0.4060		0.0052	0.0600	0.1120	1.327	0.0105	0.0082	0.0017	0.0343
7	0.0022	0.0039	<0.0001	0.4080		0.0055	0.0601	0.1136	1.329	0.0106	0.0082	<0.0005	0.0357
8	0.0026	0.0040	<0.0010	0.4090		0.0056	0.0605	0.1140	1.335	0.0110	0.0088	<0.0010	0.0368
9	0.0038	0.0041	<0.0005	0.4120		0.0060	0.0606	0.1150	1.340	0.0110		<0.0005	0.0370
10	<0.0020	0.0041	<0.0005	0.4154		0.0061	0.0609	0.1154	1.340	0.0111		<0.0005	0.0371
11	<0.0005	0.0046				0.0062	0.0609	0.1160	1.345	0.0111			0.0380
12	<0.0010	0.0051				0.0070	0.0618	0.1160	1.355	0.0114			0.0383
13	<0.005	0.0052				0.0070	0.0620	0.1162	1.356	0.0115			0.0387
14	<0.005	<0.005				0.0077	0.0630	0.1166	1.360	0.0117			0.0390
15		<0.005				0.0081	0.0649	0.1170	1.367	0.0126			0.0394
16		<0.0050				0.0083	0.0649	0.1175	1.368	0.0130			0.0395
17						<0.0005	0.0650	0.1200	1.377	0.0141			0.0400
18						<0.005	0.0670	0.1230	1.387	<0.01			0.0410
19								0.1240	1.391				0.0411
Avg	0.0017	0.0040	0.0003	0.4063	0.0001	0.0061	0.0615	0.1150	1.344	0.0112	0.0081	0.0012	0.0365
SD	0.0011	0.0006	0.0003	0.0052		0.0012	0.0025	0.0046	0.026	0.0011	0.0005	0.0006	0.0036
Certified	(0.0017)	0.0040	(0.0003)	0.406	(0.0001)	0.0061	0.061	0.115	1.34	0.0112	0.0081	(0.0012)	0.036
Uncertainty		0.0004		0.004		0.0007	0.001	0.002	0.01	0.0006	0.0004		0.002
Methods	I,O,IM	I,O,IM,X	IM,I	C	O	I,O,IM,X	I,O,IM,X	I,O,X,IM	I,O,X	I,O,X,IM	F	I,IM	I,O,X,IM

	O	P	Pb	S	Sb	Si	Sn	Ti	V	W	Zr
1	0.0012	0.0062	0.0001	0.2988	0.0010	0.1580	0.0067	0.0002	0.0016	0.0008	0.0004
2	0.0016	0.0080	0.0002	0.3070	0.0011	0.1600	0.0070	0.0002	0.0017	0.0009	0.0004
3	0.0017	0.0081	0.0002	0.3079	0.0011	0.1611	0.0072	0.0003	0.0018	0.0016	0.0009
4	0.0017	0.0081	0.0003	0.3173	0.0013	0.1650	0.0076	0.0003	0.0019	0.0017	0.0010
5	0.0023	0.0083	0.0007	0.3258	0.0016	0.1660	0.0076	0.0004	0.0020	0.0018	0.0016
6	0.0038	0.0083	0.0007	0.3270	0.0019	0.1664	0.0077	0.0004	0.0020	0.0019	<0.0005
7	0.0046	0.0087	<0.0010	0.3290	0.0023	0.1678	0.0079	0.0009	0.0020	0.0020	<0.00005
8		0.0089	<0.005	0.3300	0.0024	0.1699	0.0079	0.0011	0.0022	0.0030	<0.0010
9		0.0089	<0.005	0.3331	0.0025	0.1710	0.0080	0.0013	0.0023	<0.0010	<0.005
10		0.0090		0.3350	<0.005	0.1720	0.0082	0.0014	0.0025	<0.0010	<0.005
11		0.0097		0.3367		0.1730	0.0084	<0.0005	0.0025	<0.005	
12		0.0097				0.1730	0.0084	<0.0010	0.0025	<0.005	
13		0.0099				0.1743	0.0086	<0.005	0.0027		
14		0.0108				0.1743	0.0086	<0.005	0.0030		
15		0.0111				0.1750	0.0090		0.0031		
16		0.0116				0.1760	0.0092		0.0033		
17		<0.005				0.1800	0.0105		<0.005		
18		<0.01				0.1820	<0.005		<0.005		
19						0.1890					
Avg	0.0024	0.0091	0.0004	0.3225	0.0017	0.1713	0.0081	0.0007	0.0023	0.0017	0.0009
SD	0.0013	0.0014	0.0003	0.0128	0.0006	0.0077	0.0009	0.0005	0.0005	0.0007	0.0005
Certified	0.002	0.0091	(0.0003)	0.323	0.0017	0.171	0.0081	0.0007	0.0023	0.0017	(0.0009)
Uncertainty	0.001	0.0007		0.009	0.0005	0.004	0.0005	0.0003	0.0003	0.0006	
Methods	F	I,O,X,IM	IM,I	C,O,I	O,IM,I	I,O,X,IM	I,O,X,IM	I,O,X,IM	I,O,X,IM	I,IM	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