ARMI | MBH

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Certified Reference Material — Certificate of Analysis

ISO 17034:2016 | ISO/IEC 17025:2017 | ISO 9001:2015

Product ID: IARM-FE12L14-21

Revision No.: 000
Revision Date: 11/15/2022

Product Description: Carbon Steel, Resulfurized, AISI 12L14 / G12144

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

Al	**0.0013**	±0.0005	**Cr**	**0.056**	±0.002	**Ni**	**0.0177**	±0.0007	**Sb**	**0.0033**	±0.0006
As	**0.0027**	±0.0005	**Cu**	**0.0134**	±0.0006	**O**	**0.012**	±0.002	**Sn**	**0.0013**	±0.0004
Bi	**0.0024**	±0.0005	**Mn**	**1.02**	±0.02	**P**	**0.071**	±0.004	**V**	**0.0032**	±0.0004
C	**0.063**	±0.002	**Mo**	**0.0034**	±0.0005	**Pb**	**0.29**	±0.01	**W**	**0.0030**	±0.0009
Co	**0.0035**	±0.0006	**N**	**0.006**	±0.001	**S**	**0.32**	±0.01	**Zr**	**0.0009**	±0.0003

Indicative Values listed in ppm

B (11) Fe (Bal) Nb (5) Si (48) Ti (4)

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 calculated 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.

$$1.\ N_{MIN} = \max\left(10, \sqrt[3]{N_{PROD}}\right) \qquad 2.\ U_{CRM} = \frac{\sqrt{H^2 + S^2}}{\sqrt{n}} * t$$

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-recognised 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.

- AnchorCert Analytical - Birmingham, England
- Applied Technical Services - Marietta, GA
- Cleveland Cliffs - West Chester, OH
- Connecticut Metallurgical, Inc. - East Hartford, CT
- Dirats Laboratories - Westfield, MA
- Eurofins EAG Laboratories - Liverpool, NY
- IMR Test Labs - Louisville, KY
- LGC Standards - Manchester, NH
- Lithea S.R.O. - Brno, Czech Republic
- Luvak Inc - Boylston, MA
- New Hampshire Materials Laboratory - Somersworth, NH
- NSL Analytical Services - Cleveland, OH
- Scrooby's Laboratory Service - Benoni, South Africa
- SGS MSi - Melrose Park, IL
- TCR Engineering Service Pty Ltd - Navi Mumbai, India

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, Certifying Officer

November 15, 2022
Certification Date

ACCREDITED

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

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

	Al	As	B	Bi	C	Co	Cr	Cu	Mn	Mo	N	Nb
1	0.0002	0.0014	0.0002	0.0013	0.0570	0.0015	0.0504	0.0120	0.952	0.0020	0.0032	0.0001
2	0.0005	0.0015	0.0009	0.0015	0.0582	0.0021	0.0510	0.0120	0.956	0.0020	0.0040	0.0001
3	0.0010	0.0016	0.0010	0.0018	0.0590	0.0028	0.0514	0.0120	0.964	0.0020	0.0042	0.0002
4	0.0011	0.0025	0.0010	0.0020	0.0600	0.0030	0.0520	0.0125	0.973	0.0020	0.0047	0.0005
5	0.0012	0.0026	0.0016	0.0020	0.0610	0.0032	0.0531	0.0131	0.977	0.0030	0.0060	0.0006
6	0.0012	0.0026	0.0021	0.0020	0.0614	0.0032	0.0533	0.0132	1.000	0.0030	0.0063	0.0007
7	0.0013	0.0027	<0.00005	0.0024	0.0616	0.0032	0.0539	0.0135	1.020	0.0030	0.0065	0.0013
8	0.0013	0.0027	<0.0001	0.0030	0.0632	0.0034	0.0540	0.0137	1.021	0.0031	0.0066	<0.00005
9	0.0015	0.0029	<0.0005	0.0030	0.0640	0.0040	0.0549	0.0137	1.026	0.0033	0.0069	<0.0002
10	0.0020	0.0032	<0.0010	0.0030	0.0640	0.0040	0.0550	0.0140	1.029	0.0035	0.0071	<0.001
11	0.0030	0.0038	<0.002	0.0030	0.0640	0.0040	0.0559	0.0140	1.034	0.0036		<0.001
12	<0.001	0.0040	<0.002	0.0035	0.0660	0.0040	0.0561	0.0140	1.034	0.0038		<0.0010
13	<0.0010	0.0040	<0.01	<0.002	0.0660	0.0042	0.0570	0.0140	1.035	0.0040		<0.002
14	<0.002	<0.0001	<0.01	<0.005	0.0700	0.0045	0.0576	0.0141	1.036	0.0040		<0.002
15	<0.002	<0.002		<0.01	0.0705	0.0045	0.0590	0.0152	1.037	0.0040		<0.002
16	<0.002	<0.002		<0.01		0.0049	0.0600		1.040	0.0040		<0.002
17	<0.01	<0.002				<0.01	0.0607		1.042	0.0040		<0.01
18	<0.01	<0.0050				<0.01	0.0609		1.044	0.0040		
19		<0.01					0.0610		1.046	0.0040		
20		<0.01							1.046	0.0060		
21									1.070			
22									1.090			
Mean	0.0013	0.0027	0.0011	0.0024	0.0631	0.0035	0.0556	0.0134	1.021	0.0034	0.0056	0.0005
STDV	0.0007	0.0009	0.0007	0.0007	0.0040	0.0009	0.0035	0.0009	0.036	0.0010	0.0014	0.0004
Certified	0.0013	0.0027	(0.0011)	0.0024	0.063	0.0035	0.056	0.0134	1.02	0.0034	0.006	(0.0005)
U_{CRM}	0.0005	0.0005		0.0005	0.002	0.0006	0.002	0.0006	0.02	0.0005	0.001	
Methods	I,G,IM,O,X	I,G,IM,A,O,X	I,G,IM,O	I,G,IM,O,X	C,I,G,O	I,G,IM,O,X	I,G,IM,O,X	I,IM,O,X	I,G,O,X	I,G,IM,O,X	C,F,O,I	I,G,IM,O,X

	Ni	O	P	Pb	S	Sb	Si	Sn	Ti	V	W	Zr
1	0.0150	0.0100	0.0530	0.2600	0.2870	0.0016	0.0010	0.0004	0.0001	0.0020	0.0010	0.0002
2	0.0150	0.0105	0.0570	0.2700	0.2950	0.0019	0.0010	0.0006	0.0001	0.0020	0.0011	0.0003
3	0.0160	0.0120	0.0599	0.2700	0.2955	0.0020	0.0010	0.0006	0.0001	0.0020	0.0014	0.0005
4	0.0164	0.0130	0.0610	0.2710	0.3001	0.0020	0.0012	0.0010	0.0003	0.0028	0.0020	0.0006
5	0.0166	0.0130	0.0630	0.2764	0.3025	0.0027	0.0012	0.0011	0.0003	0.0030	0.0027	0.0008
6	0.0170	0.0143	0.0632	0.2780	0.3031	0.0030	0.0022	0.0012	0.0005	0.0030	0.0029	0.0009
7	0.0170		0.0640	0.2790	0.3070	0.0031	0.0030	0.0012	0.0007	0.0030	0.0030	0.0009
8	0.0171		0.0648	0.2790	0.3100	0.0035	0.0040	0.0017	0.0008	0.0030	0.0040	0.0010
9	0.0173		0.0670	0.2830	0.3132	0.0035	0.0070	0.0018	0.0010	0.0032	0.0040	0.0010
10	0.0176		0.0720	0.2910	0.3140	0.0036	0.0082	0.0020	<0.001	0.0032	0.0040	0.0014
11	0.0180		0.0730	0.2935	0.3210	0.0039	0.0096	0.0020	<0.0010	0.0032	0.0044	0.0015
12	0.0180		0.0733	0.2940	0.3230	0.0039	0.0180	0.0021	<0.002	0.0035	0.0050	0.0017
13	0.0180		0.0735	0.2986	0.3335	0.0040	<0.001	<0.001	<0.002	0.0036	<0.01	<0.00005
14	0.0182		0.0746	0.3170	0.3430	0.0050	<0.002	<0.0010	<0.002	0.0039	<0.01	<0.001
15	0.0186		0.0750	0.3170	0.3480	0.0055	<0.002	<0.002	<0.01	0.0040		<0.0010
16	0.0190		0.0751	0.3300	0.3500	<0.01	<0.002	<0.002	<0.01	0.0040		<0.002
17	0.0191		0.0758	0.3300	0.3660	<0.01	<0.0050	<0.002		0.0041		<0.01
18	0.0200		0.0811	0.3300	0.3744			<0.01		0.0046		
19	0.0200		0.0820	0.3310						<0.002		
20	0.0201		0.0823							<0.002		
21			0.0830							<0.002		
22			0.0830									
Mean	0.0177	0.0121	0.0708	0.2947	0.3215	0.0033	0.0048	0.0013	0.0004	0.0032	0.0030	0.0009
STDV	0.0015	0.0016	0.0090	0.0239	0.0255	0.0011	0.0052	0.0006	0.0003	0.0007	0.0014	0.0005
Certified	0.0177	0.012	0.071	0.29	0.32	0.0033	(0.0048)	0.0013	(0.0004)	0.0032	0.003	0.0009
U_{CRM}	0.0007	0.002	0.004	0.01	0.01	0.0006		0.0004		0.0004	0.0009	0.0003
Methods	I,G,IM,O,X	C,F	I,G,IM,O,X	I,G,IM,O,X	C,I,G,O,X	I,G,IM,A,O,X	I,G,IM,O,X	I,G,IM,O,X	I,G,IM,A,O,X	I,IM,O,X	I,G,IM,O	I,G,IM,O,X

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