ISO Certified · 9001 · 17025 · 17043 · 17034

Certificate of Analysis

IARM Fe91-18

Low Alloy Steel / Grade 91 / UNS K90901

Certified Reference Material

Certified Values listed in wt.% with associated uncertainties

Al	**0.006** ± 0.003	**C**	**0.099** ± 0.003	**Co**	**0.013** ± 0.001	**Cr**	**8.24** ± 0.09
Cu	**0.041** ± 0.002	**Mn**	**0.453** ± 0.007	**Mo**	**0.94** ± 0.02	**N**	**0.046** ± 0.002
Nb	**0.070** ± 0.003	**Ni**	**0.187** ± 0.004	**O**	**0.003** ± 0.001	**P**	**0.015** ± 0.001
S	**0.002** ± 0.001	**Si**	**0.27** ± 0.01	**Sn**	**0.004** ± 0.001	**Ti**	**0.0021** ± 0.0009
V	**0.198** ± 0.006	**W**	**0.003** ± 0.002				

Indicative Values listed in ppm

As (<50)	B (<50)	Ca (<50)	H (<10)	Hf (<10)	Mg (<10)	Pb (<10)
Pd (<10)	Sb (<10)	Se (<50)	Ta (<70)	Y (<10)	Zn (<10)	Zr (<40)

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

Instructions for Use

1. 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.
2. 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.
3. The material should be stored in a cool, dry location when not in use.
4. Chips are not recommended for gas analysis.

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	H	Hf	Mg	Mn	Mo	N	Nb	Ni
1	0.0005	0.001	0.00013	0.095	0.00021	0.011	7.95	0.036	<0.0001	<0.001	<0.001	0.434	0.876	0.043	0.063	0.179
2	0.0026	0.0027	0.00022	0.0951	<0.005	0.011	8.0845	0.039				0.438	0.91	0.0435	0.0669	0.18
3	0.003	0.00359	0.0005	0.096		0.012	8.15	0.0417				0.446	0.91	0.04382	0.067	0.1814
4	0.003	0.008	0.0047	0.097		0.01293	8.2185	0.042				0.45	0.923	0.045	0.0688	0.182
5	0.0043	<0.005	<0.0005	0.097		0.013	8.253	0.042				0.4521	0.9325	0.045	0.069	0.1849
6	0.005	<0.005	<0.001	0.0992		0.014	8.26	0.0423				0.453	0.933	0.046	0.07	0.187
7	0.00545			0.0996		0.015	8.2702	0.043				0.454	0.934	0.0467	0.072	0.187
8	0.0079			0.10		0.015	8.31	0.043				0.454	0.95	0.0477	0.072	0.19
9	0.008			0.1009		0.016	8.342	0.043				0.456	0.9561	0.049	0.073	0.191
10	0.0166			0.1067			8.351					0.46	0.96	0.0528	0.0774	0.192
11							8.463					0.4611	0.982			0.193
12												0.479	0.9927			0.1958
13																
14																
15																
Mean	0.006	0.004	0.001	0.099		0.013	8.24	0.041				0.453	0.94	0.046	0.07	0.187
STDV.	0.005	0.003	0.002	0.004		0.002	0.1	0.002				0.01	0.03	0.003	0.004	0.006
Certified	**0.006**	**(<0.005)**	**(<0.005)**	**0.099**	**(<0.005)**	**0.013**	**8.24**	**0.041**	**(<0.001)**	**(<0.001)**	**(<0.001)**	**0.453**	**0.94**	**0.046**	**0.070**	**0.187**
U_{CRM}	0.003			0.003		0.001	0.09	0.002				0.007	0.02	0.002	0.003	0.004
Methods	O,IM,I,G,X	IM,I,O,X	IM,I,O	O,C	IM,O	O,IM,I,G,X	W,I,O,X,G	IM,I,O,X,G	F	IM	IM	O,I,X,G	O,I,X,G	F	O,IM,I,G,X	O,I,X,G

	O	P	Pb	Pd	S	Sb	Se	Si	Sn	Ta	Ti	V	W	Y	Zn	Zr
1	0.002	0.0116	0.0001	<0.001	0.0001	0.00055	0.002	0.237	0.003	0.00029	0.00076	0.177	0.00093	<0.001	0.0004	0.00007
2	0.00216	0.013	0.00053		0.0002	0.00087	<0.001	0.2539	0.003	0.007	0.00158	0.1893	0.001		0.0006	0.00145
3	0.00228	0.014	<0.001		0.00048	<0.001	<0.005	0.27	0.0031	<0.001	0.0019	0.192	0.002		<0.001	0.002
4	0.0034	0.015	<0.001		0.001			0.272	0.00348	<0.001	0.002	0.198	0.003			0.0032
5	0.005	0.015			0.001			0.274	0.004		0.002	0.199	0.00443			<0.001
6	0.005	0.015			0.001			0.2772	0.0056		0.0023	0.199	0.006			
7		0.01605			0.002			0.278	0.006		0.004	0.20				
8		0.0161			0.0032			0.28				0.202				
9		0.0169			0.0046			0.28				0.20244				
10		0.017						0.28				0.208				
11		0.017						0.2852				0.2131				
12		0.019						0.30								
13																
14																
15																
Mean	0.003	0.015			0.002			0.27	0.004		0.0021	0.198	0.003			0.002
STDV.	0.001	0.002			0.002			0.02	0.001		0.001	0.01	0.002			0.001
Certified	**0.003**	**0.015**	**(<0.001)**	**(<0.001)**	**0.002**	**(<0.001)**	**(<0.005)**	**0.27**	**0.004**	**(<0.007)**	**0.0021**	**0.198**	**0.003**	**(<0.001)**	**(<0.001)**	**(<0.004)**
U_{CRM}	0.001	0.001			0.001			0.01	0.001		0.0009	0.006	0.002			
Methods	F	O,IM,I,G,X	IM,O	IM	O,I,C	IM,O,X	IM,X	O,I,X,G	O,IM,I,G,X	IM,O,X	O,IM,I,G,X	O,I,X,G	IM,I,O,X	IM	IM,X	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

Certification Laboratories

Laboratory Testing, Inc.	Hatfield, PA
Cronimet Specialty Metals USA, Inc.	Wheatland, PA
TimkenSteel Corporation	Canton, OH
LECO Corporation	St. Joseph, MI
EAG Laboratories, Inc.	Liverpool, NY
NSL Analytical Services, Inc.	Cleveland, OH
Exova - Burlington	Burlington, ON
Anderson Laboratories, Inc.	Greendale, WI
Laboratorio Prove Materiali S. Marco srl	Schio, Italy
LGC Standards	Manchester, NH
Dirats Laboratories	Westfield, MA

Certification laboratories have demonstrated performance and traceability by utilizing a variety of test methods all under the scope of ISO 17025. Some of the specific CRMs and SRMs used in the analysis of the material covered by this certificate are:

NIST 1263A NIST 1754 NIST 1763 NIST 1765 NIST 361 NIST 362 NIST 363 NIST 364 NIST 368 IARM 38B IARM 32D IARM 255A

Homogeneity and Uncertainty

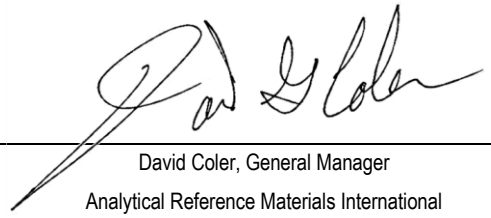
"Uncertainty" values, as reported adjacent to certified concentration values, are based on a 95% Confidence Interval. These estimated uncertainties include the combined effects of method imprecision, material inhomogeneity, and any bias between methods. Homogeneity data from experimental XRF results 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. $$N_{min} = \max(10, \sqrt[3]{N_{prod}})$$

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

Expiration

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.



David Coler, General Manager

Analytical Reference Materials International