

Certified Reference Material **Certificate of Analysis**

Product ID: MBH-11X C9 E



Product Description: Low Alloy Iron

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	0.072	± 0.003	As	0.053	± 0.002
Co	0.169	± 0.004	Cr	1.48	± 0.02
Mo	0.166	± 0.003	Nb	0.077	± 0.002
Pb	0.0023	± 0.0009	S	0.020	± 0.001
Sn	0.047	± 0.001	Te	0.0097	± 0.0007
W	0.31	± 0.01	Zn	0.0091	± 0.0006
			B	0.0047	± 0.0003
			Cu	0.433	± 0.006
			Ni	2.66	± 0.02
			Sb	0.145	± 0.005
			Si	1.39	± 0.02
			V	0.437	± 0.007
			C	3.03	± 0.03
			Mn	1.87	± 0.03
			P	0.045	± 0.001
			Ti	0.116	± 0.003
			Zr	0.0017	± 0.0007

Indicative Values listed in ppm
Fe (<89%) N (<150) O (<50)

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.

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

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.

- LGC Standards - Manchester, NH
- Laboratory Testing, Inc. - Hatfield, PA
- Scrooby's Laboratory Service - Rynfield, South Africa
- Connecticut Metallurgical, Inc. - East Hartford, CT
- Cleveland Cliffs - Middletown, OH
- Element Materials Technology - Middlesbrough, UK
- NSL Analytical Services - Cleveland, OH
- Applied Technical Services - Marietta, GA
- New Hampshire Materials Laboratory - Somersworth, NH
- SGS MSI - Melrose Park, IL
- EAG Laboratories - Liverpool, NY
- RSML - Bengaluru, India
- IMR Test Labs - Lansing, NY
- Sheffield Assay Office - Sheffield, UK
- IMR Test Labs - Louisville, KY

Instructions for Use: The test surface is on the opposite side of the labeled surface, which includes the material identification. This material is individually chill cast per piece. This manner of casting can cause the formation of inhomogeneous segregates in the upper, engraved portion of the disk. Therefore, the certification information above is not applicable to within 3mm of the engraved surface. 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.


Kimberly Halkotis, Global Product Manager

February 7, 2022
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	Co	Cr	Cu	Fe	Mn	Mo	N	Nb	Ni	O
1	0.0580	0.0487	0.0039	2.9840	0.1547	1.3780	0.4110	87.757	1.7300	0.1508	0.0100	0.0690	2.5580	0.0016
2	0.0610	0.0500	0.0041	2.9870	0.1610	1.3900	0.4160	90.700	1.7800	0.1560	0.0100	0.0730	2.5590	0.0040
3	0.0610	0.0511	0.0043	2.9880	0.1638	1.3950	0.4163		1.8110	0.1613		0.0730	2.5867	
4	0.0660	0.0528	0.0044	3.0000	0.1660	1.4203	0.4210		1.8180	0.1620		0.0740	2.6008	
5	0.0667	0.0528	0.0044	3.0000	0.1669	1.4400	0.4230		1.8307	0.1622		0.0744	2.6100	
6	0.0688	0.0530	0.0044	3.0070	0.1670	1.4530	0.4230		1.8440	0.1630		0.0745	2.6490	
7	0.0689	0.0536	0.0046	3.0100	0.1670	1.4560	0.4234		1.8480	0.1630		0.0750	2.6680	
8	0.0707	0.0540	0.0046	3.0180	0.1679	1.4700	0.4310		1.8517	0.1640		0.0762	2.6753	
9	0.0723	0.0554	0.0049	3.0190	0.1680	1.4736	0.4350		1.8520	0.1643		0.0770	2.6840	
10	0.0729	0.0566	0.0050	3.0200	0.1685	1.4769	0.4383		1.8570	0.1650		0.0780	2.6851	
11	0.0730	0.0570	0.0050	3.0230	0.1690	1.4840	0.4393		1.8609	0.1655		0.0785	2.6854	
12	0.0736		0.0050	3.0370	0.1690	1.4870	0.4400		1.8700	0.1665		0.0788	2.6880	
13	0.0744		0.0051	3.1041	0.1700	1.4895	0.4410		1.8723	0.1700		0.0790	2.6900	
14	0.0746		0.0053	3.1070	0.1713	1.5040	0.4432		1.8930	0.1700		0.0790	2.6960	
15	0.0750		0.0060	3.1360	0.1728	1.5112	0.4441		1.9125	0.1700		0.0790	2.6960	
16	0.0760		<0.005		0.1740	1.5270	0.4444		1.9220	0.1730		0.0792	2.6976	
17	0.0770				0.1830	1.5390	0.4480		1.9290	0.1740		0.0796	2.7000	
18	0.0785				0.1900	1.5400	0.4510		1.9500	0.1750		0.0800	2.7010	
19	0.0800					1.5450			1.9680	0.1750			2.7050	
20	0.0800					1.5490			2.0000				2.7210	
21	0.0820					1.5500								
22														
Mean	0.0719	0.0532	0.0047	3.0293	0.1694	1.4799	0.4327	89.228	1.8700	0.1658	0.0100	0.0765	2.6628	0.0028
STDV	0.0066	0.0026	0.0005	0.0475	0.0077	0.0535	0.0123	2.0813	0.0645	0.0064	0.0000	0.0030	0.0507	0.0017
Certified	0.072	0.053	0.0047	3.03	0.169	1.48	0.433	<89	1.87	0.166	<0.015	0.077	2.66	<0.005
U _{CRM}	0.003	0.002	0.0003	0.03	0.004	0.02	0.006		0.03	0.003		0.002	0.02	
Methods	O,I,G,IM,X	O,IM,I,X	O,IM,I,X	C,G,O	O,G,IM,I,X	O,I,G,X,W	O,I,IM,X	O	O,I,G,X	O,I,G,X	F	O,I,X	O,I,X	F

	P	Pb	S	Sb	Si	Sn	Te	Ti	V	W	Zn	Zr
1	0.0401	0.0005	0.0166	0.1283	1.3210	0.0423	0.0080	0.1030	0.4200	0.2630	0.0081	0.0006
2	0.0409	0.0010	0.0170	0.1320	1.3250	0.0430	0.0085	0.1059	0.4228	0.2820	0.0082	0.0015
3	0.0413	0.0010	0.0170	0.1358	1.3376	0.0435	0.0090	0.1080	0.4231	0.2870	0.0088	0.0015
4	0.0420	0.0017	0.0170	0.1420	1.3440	0.0442	0.0092	0.1100	0.4250	0.2890	0.0091	0.0016
5	0.0427	0.0020	0.0172	0.1430	1.3520	0.0450	0.0093	0.1100	0.4260	0.2970	0.0095	0.0024
6	0.0432	0.0020	0.0180	0.1440	1.3530	0.0470	0.0095	0.1108	0.4310	0.3040	0.0097	0.0025
7	0.0440	0.0024	0.0180	0.1459	1.3634	0.0474	0.0098	0.1113	0.4310	0.3090	0.0097	<0.0005
8	0.0445	0.0026	0.0195	0.1500	1.3750	0.0477	0.0103	0.1120	0.4320	0.3100	0.0099	<0.001
9	0.0450	0.0034	0.0197	0.1518	1.3793	0.0480	0.0109	0.1127	0.4338	0.3100	<0.01	<0.001
10	0.0460	0.0041	0.0198	0.1524	1.3850	0.0480	0.0110	0.1170	0.4370	0.3125		<0.001
11	0.0470	0.0046	0.0200	0.1526	1.4000	0.0483	0.0113	0.1173	0.4370	0.3187		<0.0010
12	0.0471	<0.005	0.0202	0.1529	1.4100	0.0493		0.1180	0.4380	0.3230		<0.005
13	0.0473		0.0208	0.1590	1.4100	0.0495		0.1180	0.4384	0.3299		
14	0.0477		0.0218		1.4270	0.0500		0.1190	0.4406	0.3304		
15	0.0479		0.0223		1.4390	0.0500		0.1191	0.4410	0.3330		
16	0.0489		0.0240		1.4400	0.0504		0.1200	0.4510	0.3440		
17	0.0490		0.0260		1.4500	0.0512		0.1200	0.4646	0.3520		
18	0.0490				1.4575			0.1200	0.4685	0.3610		
19	0.0496							0.1205				
20								0.1240				
21								0.1270				
22								0.1290				
Mean	0.0454	0.0023	0.0197	0.1454	1.3872	0.0473	0.0097	0.1160	0.4367	0.3142	0.0091	0.0017
STDV	0.0031	0.0013	0.0027	0.0091	0.0440	0.0028	0.0011	0.0067	0.0134	0.0254	0.0007	0.0007
Certified	0.045	0.0023	0.020	0.145	1.39	0.047	0.0097	0.116	0.437	0.31	0.0091	0.0017
U _{CRM}	0.001	0.0009	0.001	0.005	0.02	0.001	0.0007	0.003	0.007	0.01	0.0006	0.0007
Methods	O,G,IM,I,X	O,IM,I	C,G,O,X,I	O,IM,I,X	O,I,G,X,W	O,IM,I,X	IM,X,O,I	O,I,G,IM,X	O,G,IM,I,X	O,I,G,IM,X	O,IM,I	O,IM,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

