

**Certified Reference Material**

**Certificate of Analysis**

**Product ID:** MBH-11X 15295 S



**Product Description:** Cast Iron with Chromium

**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											
<b>Al</b>	<b>0.122</b>	± 0.005	<b>C</b>	<b>2.58</b>	± 0.03	<b>Co</b>	<b>1.55</b>	± 0.04	<b>Cr</b>	<b>28.5</b>	± 0.2
<b>Cu</b>	<b>0.213</b>	± 0.005	<b>Mn</b>	<b>1.02</b>	± 0.01	<b>Mo</b>	<b>0.363</b>	± 0.005	<b>Nb</b>	<b>0.091</b>	± 0.006
<b>Ni</b>	<b>0.326</b>	± 0.006	<b>P</b>	<b>0.059</b>	± 0.004	<b>Pb</b>	<b>0.008</b>	± 0.001	<b>S</b>	<b>0.048</b>	± 0.002
<b>Si</b>	<b>0.783</b>	± 0.009	<b>Sn</b>	<b>0.026</b>	± 0.001	<b>Ti</b>	<b>0.008</b>	± 0.001	<b>V</b>	<b>0.270</b>	± 0.008
<b>W</b>	<b>0.202</b>	± 0.007	<b>Zr</b>	<b>0.0012</b>	± 0.0007						

Indicative Values listed in ppm													
As	(100)	B	(<2.1)	Mg	(200)	N	(<600)	O	(<40)	Sb	(<300)	Zn	(90)

**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-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.

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

**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 2, 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.

Lab	Al	As	B	C	Co	Cr	Cu	Mg	Mn	Mo	N	Nb	Ni
1	0.0970	0.0005	0.0002	2.4760	1.3680	27.7800	0.1960	0.0021	0.9629	0.3450	0.0550	0.0690	0.3016
2	0.1030	0.0011	0.0002	2.5370	1.4450	27.9600	0.1966	0.0040	0.9890	0.3550	0.0600	0.0720	0.3100
3	0.1050	0.0013	<0.00010	2.5400	1.4820	27.9800	0.2050	0.0130	1.0000	0.3552		0.0765	0.3120
4	0.1124	0.0014		2.5401	1.4930	28.0800	0.2050	0.0720	1.0030	0.3560		0.0860	0.3120
5	0.1130	0.0064		2.5440	1.5026	28.0833	0.2060	<0.00005	1.0083	0.3586		0.0866	0.3180
6	0.1140	0.0224		2.5498	1.5040	28.2100	0.2070	<0.0001	1.0100	0.3600		0.0870	0.3190
7	0.1200	<0.002		2.5539	1.5220	28.3100	0.2088	<0.0005	1.0100	0.3613		0.0880	0.3194
8	0.1210	<0.002		2.5596	1.5440	28.3600	0.2090	<0.001	1.0100	0.3620		0.0901	0.3209
9	0.1240	<0.005		2.5750	1.5460	28.4570	0.2130	<0.0010	1.0240	0.3630		0.0920	0.3210
10	0.1250	<0.0050		2.5970	1.5493	28.6146	0.2137	<0.0010	1.0270	0.3630		0.0920	0.3240
11	0.1252			2.5990	1.5519	28.6630	0.2140	<0.005	1.0335	0.3670		0.0930	0.3252
12	0.1254			2.6000	1.5660	28.7800	0.2148	<0.01	1.0340	0.3700		0.0940	0.3300
13	0.1258			2.6230	1.5750	28.8030	0.2149		1.0420	0.3740		0.0951	0.3309
14	0.1260			2.6363	1.5910	28.8380	0.2180		1.0440	0.3780		0.0957	0.3370
15	0.1270			2.6820	1.5970	29.0020	0.2232		1.0480	0.3804		0.1062	0.3370
16	0.1294			2.7000	1.6220	29.1770	0.2260					0.1100	0.3380
17	0.1300				1.6230	29.2070	0.2320					0.1155	0.3400
18	0.1300				1.6341		0.2340						0.3450
19	0.1320				1.6800								0.3460
20	0.1360												
21	0.1370												
Mean	0.1218	0.0055	0.0002	2.5820	1.5472	28.4885	0.2132	0.0228	1.0164	0.3632	0.0575	0.0911	0.3256
STDV	0.0107	0.0085	0.0000	0.0577	0.0732	0.4405	0.0106	0.0332	0.0230	0.0094	0.0035	0.0122	0.0126
<b>Certified</b>	<b>0.122</b>	<b>(0.01)</b>	<b>(&lt;0.00021)</b>	<b>2.58</b>	<b>1.55</b>	<b>28.5</b>	<b>0.213</b>	<b>(0.02)</b>	<b>1.02</b>	<b>0.363</b>	<b>(&lt;0.06)</b>	<b>0.091</b>	<b>0.326</b>
U <sub>CRM</sub>	0.005			0.03	0.04	0.2	0.005		0.01	0.005		0.006	0.006
Methods	I,O,G,IM,X	IM,O,I,X	IM,O,I	C,G,O	I,O,G,X	I,O,G,W,X	I,O,G,IM,X	I,O,G,IM	O,I,X	O,IM,I,X	F	I,O,G,IM,X	I,O,G,IM,X

Lab	O	P	Pb	S	Sb	Si	Sn	Ti	V	W	Zn	Zr
1	0.0034	0.0415	0.0063	0.0410	0.0001	0.7616	0.0229	0.0100	0.2501	0.1700	0.0026	0.0010
2	0.0040	0.0450	0.0073	0.0431	0.0250	0.7639	0.0229	0.0025	0.2520	0.1840	0.0034	0.0004
3		0.0460	0.0077	0.0440		0.7650	0.0240	0.0042	0.2558	0.1850	0.0061	0.0010
4		0.0470	0.0081	0.0451		0.7669	0.0240	0.0050	0.2613	0.1890	0.0076	0.0010
5		0.0527	0.0085	0.0459		0.7720	0.0240	0.0061	0.2640	0.1930	0.0085	0.0020
6		0.0527	0.0085	0.0460		0.7750	0.0245	0.0062	0.2650	0.1943	0.0120	0.0021
7		0.0560	0.0086	0.0470		0.7808	0.0248	0.0070	0.2660	0.1986	0.0150	<0.0001
8		0.0581	0.0093	0.0470		0.7810	0.0255	0.0070	0.2706	0.2000	0.0174	<0.0005
9		0.0587	0.0110	0.0473		0.7820	0.0258	0.0070	0.2712	0.2020	<0.0005	<0.0010
10		0.0592	<0.005	0.0483		0.7820	0.0270	0.0071	0.2750	0.2037	<0.001	<0.002
11		0.0597		0.0485		0.7830	0.0270	0.0072	0.2825	0.2040	<0.001	<0.01
12		0.0613		0.0490		0.7850	0.0285	0.0078	0.2840	0.2100	<0.005	
13		0.0620		0.0490		0.7990	0.0296	0.0080	0.2890	0.2109	<0.01	
14		0.0630		0.0495		0.8010	0.0300	0.0080	0.2910	0.2124		
15		0.0630		0.0499		0.8100		0.0086		0.2160		
16		0.0640		0.0540		0.8200		0.0094		0.2200		
17		0.0650		0.0559				0.0111		0.2250		
18		0.0669						0.0130		0.2260		
19		0.0710						<0.01				
20		0.0750										
21		0.0800										
Mean	0.0037	0.0594	0.0084	0.0477	0.0126	0.7830	0.0258	0.0075	0.2698	0.2024	0.0091	0.0012
STDV	0.0004	0.0098	0.0013	0.0036	0.0176	0.0169	0.0023	0.0024	0.0132	0.0150	0.0053	0.0007
<b>Certified</b>	<b>(&lt;0.004)</b>	<b>0.059</b>	<b>0.008</b>	<b>0.048</b>	<b>(&lt;0.03)</b>	<b>0.783</b>	<b>0.026</b>	<b>0.008</b>	<b>0.270</b>	<b>0.202</b>	<b>(0.009)</b>	<b>0.0012</b>
U <sub>CRM</sub>		0.004	0.001	0.002		0.009	0.001	0.001	0.008	0.007		0.0007
Methods	F	I,O,G,IM,X	IM,O,I	C,O,X,I	X,IM	I,O,G,X,W	I,O,IM,X	I,O,G,IM,X	IM,O,X,I	I,O,G,IM,X	I,O,IM,X	I,O,IM,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

