ARMI | MBH
ANALYTICAL LTD

276 Abby Road, Manchester, NH 03103 USA
Tel: 1+ 603.935.4100
Email: ARMI@lgcgroup.com | Online: ARMI.com

Certified Reference Material | Certificate of Analysis

Product ID: MBH-12X LA5 D

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

Product Description: Low Alloy Steel

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	0.177	± 0.006	As	0.0101	± 0.0006	C	0.681	± 0.009	Co	0.151	± 0.004
Cr	0.291	± 0.005	Cu	0.107	± 0.003	Mn	0.855	± 0.008	Mo	0.206	± 0.003
Nb	0.0039	± 0.0006	Ni	0.409	± 0.006	P	0.040	± 0.001	S	0.016	± 0.001
Si	0.53	± 0.01	Sn	0.0142	± 0.0004	Ti	0.080	± 0.002	V	0.603	± 0.008
W	0.004	± 0.001	Zn	0.005	± 0.001	Zr	0.0013	± 0.0005			

Indicative Values listed in ppm

B	(<10)	Fe	(<95.6%)	Mg	(100)	N	(<100)	Pb	(10)	Sb	(10)

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.

- LGC Standards - Manchester, NH
- Connecticut Metallurgical, Inc. - East Hartford, CT
- IMR Test Labs - Lansing, NY
- Laboratory Testing, Inc. - Hatfield, PA
- NSL Analytical Services - Cleveland, OH
- SGS MSi - Melrose Park, IL
- 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 Halkiotis
Kimberly Halkiotis, Global Product Manager

February 7, 2022
Certification Date

LGC

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	Mg	Mn	Mo	N	Nb
1	0.1590	0.0090	0.0001	0.6580	0.1351	0.2740	0.0941	95.400	0.0017	0.8170	0.1930	0.0094	0.0020
2	0.1620	0.0090	0.0005	0.6630	0.1376	0.2743	0.0970	95.600	0.0124	0.8320	0.1947	0.0100	0.0025
3	0.1670	0.0092	<0.001	0.6663	0.1430	0.2745	0.0987	95.700	0.0180	0.8350	0.1960		0.0032
4	0.1670	0.0093		0.6720	0.1453	0.2790	0.0990		0.0200	0.8443	0.1990		0.0032
5	0.1676	0.0095		0.6730	0.1460	0.2830	0.1020		0.0210	0.8470	0.2030		0.0036
6	0.1690	0.0095		0.6735	0.1500	0.2843	0.1050		<0.00005	0.8490	0.2037		0.0038
7	0.1690	0.0100		0.6743	0.1519	0.2844	0.1052		<0.0005	0.8509	0.2040		0.0040
8	0.1690	0.0105		0.6805	0.1520	0.2852	0.1070		<0.001	0.8522	0.2040		0.0040
9	0.1720	0.0107		0.6840	0.1530	0.2870	0.1071		<0.001	0.8530	0.2050		0.0040
10	0.1720	0.0110		0.6852	0.1530	0.2890	0.1080		<0.001	0.8540	0.2056		0.0050
11	0.1735	0.0116		0.6910	0.1540	0.2900	0.1084		<0.0010	0.8590	0.2070		0.0050
12	0.1747	0.0116		0.7000	0.1570	0.2925	0.1090		<0.0010	0.8608	0.2070		0.0050
13	0.1760			0.7060	0.1585	0.2930	0.1090		<0.005	0.8620	0.2078		0.0050
14	0.1770			0.7100	0.1593	0.2942	0.1097			0.8620	0.2080		<0.0005
15	0.1800				0.1600	0.2950	0.1106			0.8625	0.2080		<0.001
16	0.1840				0.1620	0.2970	0.1110			0.8630	0.2100		<0.005
17	0.1920					0.2980	0.1110			0.8642	0.2110		<0.01
18	0.1950					0.2980	0.1120			0.8690	0.2118		<0.01
19	0.1952					0.2994	0.1120			0.8790	0.2126		
20	0.1970					0.3020	0.1130			0.8851	0.2140		
21	0.2050					0.3130	0.1143				0.2163		
22						0.3140							
Mean	0.1773	0.0101	0.0003	0.6812	0.1511	0.2909	0.1068	95.567	0.0146	0.8550	0.2058	0.0097	0.0039
STDV	0.0127	0.0010	0.0003	0.0159	0.0079	0.0110	0.0056	0.1528	0.0080	0.0156	0.0062	0.0004	0.0010
Certified	**0.177**	**0.0101**	**(<0.001)**	**0.681**	**0.151**	**0.291**	**0.107**	**(<95.6)**	**(0.01)**	**0.855**	**0.206**	**(<0.01)**	**0.0039**
U$_{CRM}$	0.006	0.0006		0.009	0.004	0.005	0.003			0.008	0.003		0.0006
Methods	I,G,IM,O,X	IM,X,O,I	O,I	C,O	I,G,IM,X,O	I,G,IM,O,X	I,G,IM,O,X	I,O,X	I,IM,O,X	I,G,O,X	I,G,O,X	F	I,G,IM,O,X

	Ni	P	Pb	S	Sb	Si	Sn	Ti	V	W	Zn	Zr
1	0.3826	0.0340	0.0020	0.0143	0.0005	0.4926	0.0128	0.0699	0.5690	0.0009	0.0028	0.0023
2	0.3830	0.0349	0.0002	0.0145	0.0009	0.5058	0.0130	0.0704	0.5780	0.0009	0.0040	0.0005
3	0.3900	0.0350	0.0002	0.0151	0.0013	0.5140	0.0132	0.0730	0.5930	0.0030	0.0042	0.0006
4	0.4000	0.0358	0.0002	0.0156	0.0014	0.5140	0.0135	0.0750	0.5948	0.0034	0.0043	0.0007
5	0.4034	0.0373	0.0004	0.0157	<0.0005	0.5240	0.0138	0.0754	0.5950	0.0042	0.0050	0.0012
6	0.4040	0.0374	0.0010	0.0160	<0.001	0.5260	0.0140	0.0770	0.5975	0.0045	0.0050	0.0014
7	0.4059	0.0385	0.0020	0.0160	<0.0010	0.5260	0.0140	0.0772	0.6000	0.0045	0.0050	0.0016
8	0.4059	0.0399	0.0032	0.0160	<0.0010	0.5266	0.0140	0.0784	0.6010	0.0050	0.0057	0.0017
9	0.4060	0.0400	<0.0005	0.0160	<0.002	0.5280	0.0140	0.0790	0.6020	0.0050	0.0080	<0.0005
10	0.4116	0.0401	<0.002	0.0165	<0.005	0.5340	0.0140	0.0799	0.6026	0.0050	0.0081	<0.001
11	0.4120	0.0407	<0.002	0.0168		0.5420	0.0142	0.0800	0.6036	0.0050	<0.005	<0.001
12	0.4120	0.0408	<0.002	0.0170		0.5465	0.0143	0.0808	0.6071	<0.0005	<0.0050	<0.001
13	0.4153	0.0410	<0.002	0.0170		0.5468	0.0147	0.0820	0.6119	<0.001		<0.002
14	0.4160	0.0410	<0.0020	0.0170		0.5470	0.0150	0.0820	0.6130	<0.001		<0.005
15	0.4180	0.0410	<0.005	0.0180		0.5540	0.0150	0.0828	0.6130	<0.001		
16	0.4181	0.0430	<0.01	0.0180		0.5600	0.0155	0.0830	0.6174	<0.001		
17	0.4200	0.0430		0.0187		0.5601	0.0160	0.0840	0.6289	<0.001		
18	0.4220	0.0440				0.5710		0.0840	0.6300	<0.005		
19	0.4220	0.0440						0.0840		<0.01		
20	0.4240							0.0870				
21								0.0870				
22												
Mean	0.4086	0.0395	0.0012	0.0164	0.0010	0.5344	0.0142	0.0796	0.6032	0.0038	0.0052	0.0013
STDV	0.0123	0.0031	0.0011	0.0012	0.0004	0.0207	0.0009	0.0049	0.0153	0.0016	0.0017	0.0006
Certified	**0.409**	**0.040**	**(0.001)**	**0.016**	**(0.001)**	**0.53**	**0.0142**	**0.080**	**0.603**	**0.004**	**0.005**	**0.0013**
U$_{CRM}$	0.006	0.001		0.001		0.01	0.0004	0.002	0.008	0.001	0.001	0.0005
Methods	G,I,O,X	I,G,IM,O,X	I,IM,O,X	C,O,X,I	IM,X,O,I	I,G,O,X	IM,I,X,O	I,G,IM,O,X	G,I,X,O	I,G,IM,O,X	IM,X,O,I	IM,X,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

LGC