

Certified Reference Material

Certificate of Analysis

Product ID: MBH-14X MN4-21

Product Description: High Manganese Steel

ISO
17034:2016

ISO/IEC
17025:2017

ISO
9001:2015

Revision No.: 000
Revision Date: 02/27/2023

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

As	0.007 ± 0.001	Mn	13.80 ± 0.08	P	0.058 ± 0.002	V	0.042 ± 0.002
C	0.897 ± 0.008	Mo	0.832 ± 0.007	S	0.0069 ± 0.0007	W	0.005 ± 0.001
Co	0.014 ± 0.002	N	0.082 ± 0.002	Si	0.95 ± 0.02		
Cr	2.00 ± 0.03	Nb	0.182 ± 0.005	Sn	0.077 ± 0.005		
Cu	0.446 ± 0.007	Ni	1.18 ± 0.02	Ti	0.056 ± 0.003		

Indicative Values listed in ppm

Al 2060 B 29 Fe Balance O 26 Ta 104

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.

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

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.

- Applied Technical Services - Marietta, GA
- Avon Specialty Metals Ltd. - Gloucester, England
- Dirts Laboratories - Westfield, MA
- EAG Laboratories - Liverpool, NY
- Genitest Inc - Montreal, Canada
- IMR Test Labs - Lansing, NY
- Laboratory Testing, Inc. - Hatfield, PA
- LGC Standards - Manchester, NH
- Lucid laboratories Pvt. Ltd. - Hyderabad, India
- Lukasiewicz Instytut Metalurgii Zelaza - Gilwice, Poland
- New Hampshire Materials Laboratory Inc - Somersworth, NH
- NSL Analytical Services - Cleveland, OH
- Scrooby's Laboratory Service Pty Ltd - Benoni, South Africa
- SGS MSI - Melrose Park, IL
- Sheffield Assay Office - Sheffield, England

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.

Chuck Goudreau

Chuck Goudreau, Certifying Officer

February 27, 2023
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
1	0.1760	0.0050	0.0004	0.8710	0.0068	1.872	0.4227	79.22	13.50	0.8010	0.0796	0.1640
2	0.1800	0.0050	0.0004	0.8790	0.0109	1.913	0.4250	79.34	13.53	0.8052	0.0796	0.1700
3	0.1867	0.0057	0.0008	0.8837	0.0119	1.915	0.4277	80.45	13.57	0.8090	0.0800	0.1700
4	0.1901	0.0059	0.0020	0.8850	0.0120	1.917	0.4280		13.63	0.8120	0.0812	0.1700
5	0.1990	0.0064	0.0034	0.8854	0.0121	1.962	0.4300		13.66	0.8140	0.0820	0.1740
6	0.2000	0.0065	0.0036	0.8900	0.0124	1.963	0.4333		13.76	0.8210	0.0820	0.1797
7	0.2000	0.0070	0.0044	0.8930	0.0130	1.968	0.4350		13.78	0.8220	0.0830	0.1800
8	0.2020	0.0085	0.0053	0.8934	0.0140	1.970	0.4368		13.80	0.8220	0.0833	0.1808
9	0.2023	0.0104	0.0054	0.8963	0.0140	2.000	0.4380		13.83	0.8240	0.0888	0.1817
10	0.2033	<0.005	<0.0005	0.8974	0.0140	2.000	0.4405		13.83	0.8300		0.1820
11	0.2053	<0.01	<0.0005	0.8990	0.0140	2.008	0.4410		13.87	0.8357		0.1860
12	0.2073	<0.01	<0.0010	0.9060	0.0144	2.014	0.4460		13.87	0.8360		0.1870
13	0.2100	<0.01	<0.005	0.9100	0.0157	2.030	0.4529		13.90	0.8390		0.1900
14	0.2150		<0.01	0.9170	0.0160	2.048	0.4592		13.96	0.8390		0.1929
15	0.2170		<0.01	0.9179	0.0220	2.048	0.4600		13.96	0.8397		0.1940
16	0.2200			0.9253	0.0250	2.055	0.4602		13.96	0.8400		0.1947
17	0.2280				<0.01	2.063	0.4630		13.98	0.8400		0.1974
18	0.2321					2.076	0.4639		13.99	0.8420		
19	0.2390					2.083	0.4640			0.8480		
20						2.097	0.4640			0.8500		
21						2.098	0.4682			0.8510		
22										0.8537		
23										0.8676		
Mean	0.2060	0.0067	0.0029	0.8968	0.0143	2.0048	0.4457	79.67	13.80	0.8323	0.0822	0.1820
STDV	0.0167	0.0017	0.0020	0.0151	0.0042	0.0659	0.0154	0.678	0.160	0.0171	0.0028	0.0100
Certified	(0.2060)	0.007	(0.0029)	0.897	0.014	2.00	0.446	(79.67)	13.80	0.832	0.082	0.182
U _{CRM}		0.001		0.008	0.002	0.03	0.007		0.08	0.007	0.002	0.005
Methods	I,IM,O,X	I,IM,G,O,X	I,IM,G,O	C,G,O,W	IM,I,O,X	I,O,X	I,IM,O,X	I	I,O,X	I,G,O,X	F,W	I,IM,G,O,X

	Ni	O	P	S	Si	Sn	Ta	Ti	V	W
1	1.103	0.0016	0.0504	0.0048	0.8528	0.0672	0.0006	0.0481	0.0357	0.0030
2	1.127	0.0035	0.0510	0.0053	0.9014	0.0680	0.0015	0.0482	0.0378	0.0035
3	1.137		0.0511	0.0058	0.9150	0.0698	0.0079	0.0487	0.0386	0.0036
4	1.140		0.0520	0.0059	0.9200	0.0725	0.0080	0.0500	0.0390	0.0037
5	1.148		0.0527	0.0060	0.9240	0.0749	0.0110	0.0530	0.0400	0.0039
6	1.150		0.0550	0.0061	0.9380	0.0750	0.0110	0.0540	0.0410	0.0046
7	1.152		0.0559	0.0065	0.9465	0.0760	0.0121	0.0548	0.0411	0.0060
8	1.159		0.0560	0.0066	0.9486	0.0779	0.0133	0.0550	0.0412	0.0065
9	1.185		0.0570	0.0069	0.9500	0.0786	0.0140	0.0550	0.0413	0.0068
10	1.190		0.0570	0.0070	0.9520	0.0790	0.0248	0.0550	0.0427	0.0070
11	1.191		0.0579	0.0070	0.9530	0.0790	<0.00005	0.0552	0.0429	0.0078
12	1.192		0.0600	0.0071	0.9547	0.0875	<0.0010	0.0553	0.0430	0.0080
13	1.200		0.0606	0.0074	0.9556	0.0980	<0.005	0.0569	0.0430	<0.0005
14	1.200		0.0610	0.0086	0.9590		<0.01	0.0570	0.0440	<0.005
15	1.200		0.0612	0.0089	0.9740			0.0580	0.0450	<0.01
16	1.203		0.0626	0.0090	0.9820			0.0592	0.0465	<0.01
17	1.203		0.0640	0.0092	0.9950			0.0608	0.0500	
18	1.206		0.0640		1.0550			0.0617		
19	1.208		0.0656		1.0600			0.0658		
20	1.210		0.0670					0.0690		
21	1.235									
22	1.267									
23										
Mean	1.1821	0.0026	0.0581	0.0069	0.9546	0.0772	0.0104	0.0560	0.0419	0.0054
STDV	0.0383	0.0013	0.0051	0.0013	0.0479	0.0083	0.0068	0.0055	0.0034	0.0018
Certified	1.18	(0.0026)	0.058	0.0069	0.95	0.077	(0.0104)	0.056	0.042	0.005
U _{CRM}	0.02		0.002	0.0007	0.02	0.005		0.003	0.002	0.001
Methods	I,G,O,X	F	I,IM,G,O,X	C,G,O,W,X	I,G,O,X	I,IM,X	I,IM,G,X,O	I,IM,O,X	I,IM,O,X	I,IM,G,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