

Certified Reference Material

Certificate of Analysis

Product ID: IARM-FeM1-18



Product Description: Tool Steel, Grade M1 / UNS T11301

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	0.007	± 0.001	As	0.009	± 0.008	C	0.85	± 0.01	Co	0.226	± 0.009
Cr	3.67	± 0.04	Cu	0.091	± 0.003	Mn	0.318	± 0.009	Mo	8.0	± 0.1
N	0.037	± 0.002	Nb	0.013	± 0.003	Ni	0.104	± 0.003	O	0.0021	± 0.0007
P	0.013	± 0.002	Si	0.44	± 0.01	Sn	0.0041	± 0.0005	Ta	0.0024	± 0.0008
Ti	0.0044	± 0.0008	V	1.19	± 0.02	W	1.98	± 0.02	Zr	0.0013	± 0.0003

Indicative Values listed in ppm						
B (13)	Fe (83%)	Pb (50)	S (30)	Sb (60)	Zn (<30)	

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.

$$1. N_{MIN} = \max(10, \sqrt[3]{N_{PROD}})$$

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

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
- Dirats Laboratories - Westfield, MA
- NSL Analytical Services - Cleveland, OH
- Laboratory Testing, Inc. - Hatfield, PA
- Element Material Technology - Middlesbrough, UK
- Connecticut Metallurgical, Inc. - East Hartford, CT
- IMR Test Labs - Lansing, NY
- SGS MSI - Melrose Park, IL
- Scrooby's Laboratory Service - Rynfield, South Africa
- AnchorCert Analytical - Birmingham, UK
- Sheffield Assay Office - Sheffield, UK
- EAG Laboratories - Liverpool, NY
- TCR Engineering Services - Maharashtra, India
- Luvak Inc. - Boylston, MA

Instructions for Use: 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. 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

September 30, 2021
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	0.0030	0.0022	0.0002	0.8280	0.2007	3.5300	0.0770	81.4000	0.2760	7.5400	0.0331	0.0030	0.0920	0.0014
2	0.0045	0.0028	0.0010	0.8300	0.2020	3.5563	0.0791	81.9500	0.2850	7.5900	0.0359	0.0078	0.0950	0.0015
3	0.0050	0.0030	0.0011	0.8357	0.2020	3.5880	0.0850	82.8000	0.2947	7.7400	0.0360	0.0085	0.0960	0.0016
4	0.0061	0.0037	0.0011	0.8361	0.2050	3.5970	0.0859	83.2100	0.3000	7.7833	0.0362	0.0090	0.0990	0.0016
5	0.0065	0.0039	0.0021	0.8400	0.2110	3.6170	0.0880	83.2200	0.3060	7.8160	0.0374	0.0090	0.1000	0.0020
6	0.0066	0.0043	0.0022	0.8410	0.2180	3.6210	0.0900	83.2233	0.3100	7.8190	0.0380	0.0091	0.1010	0.0020
7	0.0070	0.0048	<0.0002	0.8410	0.2200	3.6500	0.0920	83.2467	0.3130	7.9170	0.0382	0.0130	0.1010	0.0023
8	0.0071	0.0070	<0.0005	0.8490	0.2278	3.6520	0.0920	84.1900	0.3140	7.9300	0.0390	0.0140	0.1010	0.0040
9	0.0073	0.0290	<0.0005	0.8533	0.2320	3.6533	0.0920	85.4200	0.3185	7.9360	0.0400	0.0151	0.1020	
10	0.0077	0.0320	<0.001	0.8550	0.2356	3.6720	0.0930		0.3210	7.9390	0.0400	0.0151	0.1030	
11	0.0079	<0.001	<0.001	0.8600	0.2360	3.6850	0.0930		0.3210	7.9855		0.0160	0.1033	
12	0.0088	<0.005	<0.005	0.8697	0.2370	3.6900	0.0931		0.3220	7.9940		0.0197	0.1045	
13	0.0100	<0.005	<0.005	0.8765	0.2370	3.7015	0.0937		0.3260	8.0553		0.0198	0.1072	
14	0.0100	<0.005	<0.005	0.8790	0.2400	3.7060	0.0942		0.3269	8.0600		0.0200	0.1090	
15	0.0101	<0.01			0.2430	3.7310	0.0950		0.3320	8.0920		<0.0005	0.1098	
16	<0.01				0.2460	3.7410	0.0951		0.3363	8.1980		<0.0005	0.1101	
17					0.2537	3.7470	0.0970		0.3388	8.2260		<0.01	0.1105	
18						3.8380	0.0990		0.3470	8.3280			0.1120	
19							0.0990		0.3500	8.4010			0.1140	
20														
21														
Mean	0.0072	0.0093	0.0013	0.8496	0.2263	3.6653	0.0912	83.1844	0.3178	7.9658	0.0374	0.0128	0.1037	0.0021
STDV	0.0021	0.0113	0.0008	0.0167	0.0171	0.0752	0.0060	1.1658	0.0197	0.2276	0.0021	0.0052	0.0061	0.0008
Certified	0.007	0.009	(0.0013)	0.85	0.226	3.67	0.091	(83.0)	0.318	8.0	0.037	0.013	0.104	0.0021
U _{CRM}	0.001	0.008		0.01	0.009	0.04	0.003		0.009	0.1	0.002	0.003	0.003	0.0007
Methods	I,IM,O,X	I,IM,O,X	I,IM,O	C,O	I,IM,O,X	I,O,X	I,IM,O,X	I,O,X	I,IM,O,X	I,O,X	F,C	I,IM,O,X	I,IM,O,X	F,C

	P	Pb	S	Sb	Si	Sn	Ta	Ti	V	W	Zn	Zr		
1	0.0067	0.0001	0.0002	0.0009	0.3964	0.0030	0.0010	0.0030	1.1140	1.9210	0.0005	0.0010		
2	0.0092	0.0014	0.0003	0.0010	0.4000	0.0031	0.0018	0.0030	1.1160	1.9260	0.0030	0.0010		
3	0.0093	0.0031	0.0004	0.0010	0.4080	0.0031	0.0019	0.0030	1.1200	1.9310		0.0010		
4	0.0107	0.0050	0.0025	0.0010	0.4140	0.0039	0.0029	0.0030	1.1680	1.9430		0.0012		
5	0.0109	0.0095	0.0030	0.0014	0.4237	0.0040	0.0030	0.0031	1.1690	1.9500		0.0013		
6	0.0110	0.0100	0.0031	0.0042	0.4300	0.0040	0.0030	0.0033	1.1789	1.9550		0.0017		
7	0.0120	<0.00005	0.0043	0.0050	0.4320	0.0040	0.0031	0.0036	1.1800	1.9560		0.0019		
8	0.0120	<0.0005	0.0055	0.0080	0.4337	0.0040	<0.0005	0.0040	1.1860	1.9700		<0.00005		
9	0.0140	<0.0005	0.0060	0.0080	0.4367	0.0042	<0.001	0.0040	1.1927	1.9720		<0.0005		
10	0.0146	<0.001	0.0060	0.0197	0.4430	0.0043	<0.002	0.0051	1.1933	1.9800		<0.001		
11	0.0150	<0.001	0.0060	0.0210	0.4610	0.0044	<0.005	0.0052	1.1980	1.9870		<0.002		
12	0.0157	<0.001	<0.0003	<0.005	0.4619	0.0048	<0.005	0.0060	1.1997	1.9890		<0.005		
13	0.0168	<0.005	<0.0005		0.4660	0.0050		0.0060	1.2000	1.9900		<0.005		
14	0.0170		<0.001		0.4670	0.0050		0.0061	1.2001	2.0133				
15	0.0176		<0.001		0.4710	<0.005		0.0070	1.2002	2.0140				
16	0.0191		<0.003		0.4740			<0.005	1.2040	2.0150				
17	<0.005				0.4770				1.2200	2.0300				
18					0.4870				1.2300	2.0680				
19									1.2730	2.0801				
20														
21														
Mean	0.0132	0.0049	0.0034	0.0065	0.4435	0.0041	0.0024	0.0044	1.1865	1.9837	0.0018	0.0013		
STDV	0.0035	0.0041	0.0024	0.0074	0.0282	0.0007	0.0008	0.0014	0.0388	0.0448	0.0018	0.0004		
Certified	0.013	(0.005)	(0.003)	(0.006)	0.44	0.0041	0.0024	0.0044	1.19	1.98	(<0.003)	0.0013		
U _{CRM}	0.002				0.01	0.0005	0.0008	0.0008	0.02	0.02		0.0003		
Methods	I,IM,O,X ,W	I,IM,O,X	C,O,X	I,IM,O,X	I,IM,O, X	I,IM,O,X	I,IM,O	I,IM,O,X	I,O,X	I,O,X	O	I,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