

## Certified Reference Material

## Certificate of Analysis

**Product ID:** IARM-FeM4-18



**Product Description:** Tool Steel, Grade M4/ UNS T11304

**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	0.0058	± 0.0007	C	1.42	± 0.02	Co	0.080	± 0.003	Cr	4.16	± 0.06
Cu	0.104	± 0.003	Fe	79.0	± 1.0	Mn	0.298	± 0.006	Mo	5.07	± 0.06
N	0.042	± 0.002	Nb	0.015	± 0.005	Ni	0.127	± 0.005	O	0.009	± 0.003
P	0.013	± 0.002	Pb	0.004	± 0.002	S	0.062	± 0.003	Si	0.60	± 0.02
Sn	0.0050	± 0.0006	Ti	0.0018	± 0.0005	V	3.97	± 0.04	W	5.55	± 0.05

### Indicative Values listed in ppm

Al (100) B (12) Sb (50) Zr (13)

**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	0.0003	0.0041	0.0010	1.3750	0.0650	3.9407	0.0900	76.9000	0.2737	4.8000	0.0360	0.0040	0.1060	0.0032
2	0.0005	0.0055	0.0010	1.3800	0.0687	3.9960	0.0909	78.3000	0.2740	4.9040	0.0386	0.0048	0.1110	0.0040
3	0.0010	0.0056	0.0011	1.3987	0.0720	4.0150	0.0950	78.4000	0.2830	4.9100	0.0391	0.0050	0.1127	0.0062
4	0.0018	0.0059	0.0011	1.4000	0.0736	4.0450	0.0960	78.6533	0.2870	4.9600	0.0407	0.0063	0.1196	0.0080
5	0.0021	0.0060	0.0018	1.4000	0.0760	4.0670	0.1000	78.8167	0.2890	4.9670	0.0410	0.0074	0.1200	0.0080
6	0.0030	0.0060	<0.00005	1.4002	0.0770	4.1000	0.1020	79.3300	0.2910	4.9800	0.0420	0.0080	0.1200	0.0080
7	0.0046	0.0062	<0.0002	1.4100	0.0780	4.1070	0.1041	80.1000	0.2950	5.0040	0.0420	0.0132	0.1250	0.0087
8	0.0050	0.0070	<0.0005	1.4110	0.0790	4.1100	0.1060	80.4100	0.2953	5.0100	0.0421	0.0150	0.1262	0.0105
9	0.0100	<0.001	<0.001	1.4183	0.0800	4.1280	0.1060	80.9800	0.2976	5.0720	0.0425	0.0160	0.1270	0.0162
10	0.0290	<0.002	<0.001	1.4290	0.0810	4.1600	0.1063		0.2990	5.0850	0.0426	0.0161	0.1270	0.0175
11	<0.0005	<0.002	<0.001	1.4333	0.0816	4.2013	0.1070		0.3000	5.1160	0.0460	0.0175	0.1290	
12	<0.001	<0.002	<0.005	1.4560	0.0816	4.2300	0.1070		0.3007	5.1170	0.0460	0.0180	0.1300	
13	<0.001	<0.005		1.4590	0.0830	4.2387	0.1080		0.3010	5.1200		0.0180	0.1300	
14	<0.002			1.4600	0.0830	4.2720	0.1083		0.3020	5.1380		0.0280	0.1320	
15	<0.002			1.4777	0.0836	4.2803	0.1087		0.3053	5.1587		0.0290	0.1337	
16	<0.002				0.0860	4.2870	0.1090		0.3106	5.1616		0.0350	0.1387	
17	<0.002				0.0880	4.3215	0.1100		0.3120	5.1841		<0.001	0.1390	
18	<0.005				0.0940	4.3300	0.1110		0.3200	5.1857		<0.001	0.1392	
19	<0.01						0.1140		0.3220	5.2160		<0.005	0.1400	
20										5.2312			0.1417	
21														
Mean	0.0057	0.0058	0.0012	1.4205	0.0795	4.1572	0.1042	79.099	0.2978	5.0660	0.0415	0.0151	0.1274	0.0090
STDV	0.0087	0.0008	0.0003	0.0310	0.0069	0.1185	0.0068	1.2527	0.0133	0.1184	0.0028	0.0093	0.0102	0.0046
<b>Certified</b>	<b>(0.01)</b>	<b>0.0058</b>	<b>(0.0012)</b>	<b>1.42</b>	<b>0.080</b>	<b>4.16</b>	<b>0.104</b>	<b>79.0</b>	<b>0.298</b>	<b>5.07</b>	<b>0.042</b>	<b>0.015</b>	<b>0.127</b>	<b>0.009</b>
U <sub>CRM</sub>		<b>0.0007</b>		<b>0.02</b>	<b>0.003</b>	<b>0.06</b>	<b>0.003</b>	<b>1.0</b>	<b>0.006</b>	<b>0.06</b>	<b>0.002</b>	<b>0.005</b>	<b>0.005</b>	<b>0.003</b>
Methods	I,IM,O,X	IM,O,I,X	IM,O,I	C,O	I,IM,O,X	I,O,X	I,O,X,IM	O,I,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	Ti	V	W	Zr				
1	0.0080	0.0020	0.0520	0.0009	0.5560	0.0040	0.0010	3.8480	5.2950	0.0008				
2	0.0083	0.0032	0.0550	0.0010	0.5637	0.0040	0.0010	3.8700	5.3500	0.0010				
3	0.0084	0.0040	0.0575	0.0011	0.5760	0.0041	0.0010	3.8840	5.4733	0.0016				
4	0.0096	0.0050	0.0584	0.0011	0.5913	0.0042	0.0012	3.8900	5.4830	0.0019				
5	0.0110	0.0050	0.0590	0.0054	0.5920	0.0043	0.0020	3.8910	5.4959	<0.00005				
6	0.0120	0.0063	0.0594	0.0055	0.5943	0.0044	0.0020	3.8967	5.5000	<0.0005				
7	0.0127	<0.00005	0.0600	0.0060	0.5950	0.0046	0.0020	3.9070	5.5130	<0.001				
8	0.0130	<0.0005	0.0600	0.0061	0.5970	0.0048	0.0022	3.9300	5.5300	<0.001				
9	0.0140	<0.001	0.0605	0.0170	0.5970	0.0048	0.0025	3.9350	5.5300	<0.002				
10	0.0148	<0.001	0.0625	<0.002	0.6000	0.0050	0.0027	3.9720	5.5380	<0.002				
11	0.0149	<0.001	0.0630	<0.002	0.6000	0.0050	<0.002	3.9770	5.5530	<0.005				
12	0.0150	<0.005	0.0630	<0.005	0.6020	0.0050	<0.005	4.0100	5.5548	<0.01				
13	0.0160	<0.005	0.0643	<0.01	0.6110	0.0060	<0.01	4.0160	5.5770					
14	0.0160	<0.005	0.0650		0.6233	0.0067		4.0165	5.5880					
15	0.0162		0.0650		0.6500	0.0080		4.0500	5.5960					
16	0.0163		0.0650		0.6700	<0.005		4.0720	5.6091					
17	0.0180		0.0700			<0.005		4.0900	5.6500					
18	<0.005		0.0710			<0.005		4.0930	5.6720					
19	<0.01					<0.005		4.1200	5.7220					
20									5.7900					
21														
Mean	0.0132	0.0043	0.0617	0.0049	0.6012	0.0050	0.0018	3.9720	5.5510	0.0013				
STDV	0.0032	0.0015	0.0048	0.0051	0.0284	0.0011	0.0006	0.0856	0.1131	0.0005				
<b>Certified</b>	<b>0.013</b>	<b>0.004</b>	<b>0.062</b>	<b>(0.005)</b>	<b>0.60</b>	<b>0.005</b>	<b>0.0018</b>	<b>3.97</b>	<b>5.55</b>	<b>(0.0013)</b>				
U <sub>CRM</sub>	<b>0.002</b>	<b>0.002</b>	<b>0.003</b>		<b>0.02</b>	<b>0.0006</b>	<b>0.0005</b>	<b>0.04</b>	<b>0.05</b>					
Methods	I,IM,O,X,W	I,IM,O,X	C,O,X	IM,O,I,X	I,O,X,W	I,IM,O,X	I,IM,O	I,O,X	I,O,X	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