

## Certificate of Analysis

### IARM FBP-20

Ferroboron Powder

## Certified Reference Material

Certified Values listed in wt.% with associated uncertainties

<b>Al</b>	<b>0.049 ± 0.006</b>	<b>B</b>	<b>18.4 ± 0.3</b>	<b>C</b>	<b>0.39 ± 0.01</b>	<b>Ca</b>	<b>0.04 ± 0.01</b>
<b>Cr</b>	<b>0.13 ± 0.03</b>	<b>Cu</b>	<b>0.010 ± 0.001</b>	<b>Fe</b>	<b>77.0 ± 1.0</b>	<b>Mn</b>	<b>0.25 ± 0.01</b>
<b>Mo</b>	<b>0.008 ± 0.001</b>	<b>N</b>	<b>0.004 ± 0.001</b>	<b>Ni</b>	<b>0.012 ± 0.001</b>	<b>S</b>	<b>0.004 ± 0.001</b>
<b>Si</b>	<b>0.66 ± 0.08</b>	<b>Sn</b>	<b>0.0027 ± 0.0007</b>	<b>Ti</b>	<b>0.28 ± 0.03</b>	<b>V</b>	<b>0.005 ± 0.001</b>
<b>W</b>	<b>0.0022 ± 0.0005</b>	<b>Zr</b>	<b>0.037 ± 0.004</b>				

#### Indicative Values listed in ppm

As (20)	Co (19)	Ga (<5)	H (176)	Hf (<5)	K (<750)	Li (<340)
Mg (40)	Na (<300)	Nb (72)	O (11000)	P (200)	Pb (<2)	Sb (3)
Se (<2)	Ta (<1)	Y (<1)	Zn (<10)			

#### 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** certified laboratories. This CRM comes in a bottle, containing approximately 100 grams of fine powder. The intended use of this CRM may include, but is not limited to, the calibration of instruments and the validation of analytical methods.

#### Instructions for Use

1. The minimum sample size should be individually evaluated based on the analytical technique used; this would typically be greater than 0.1 grams.
2. The material should be stored in a cool, dry location when not in use.
3. The material should be well mixed within the bottle before sampling to ensure a representative sample is obtained.

The following data represents all pertinent information reported as it applies to the chemical characterization of this material.

	Al	As	B	C	Ca	Co	Cr	Cu	Fe	H	K	Li	Mg	Mn	Mo	N
1	0.0360	0.0009	18.03	0.3660	0.0240	0.0016	0.0691	0.0070	75.64	0.0122	0.0750	0.0339	0.0015	0.2188	0.0050	0.0020
2	0.0390	0.0013	18.10	0.3800	0.0366	0.0019	0.0720	0.0080	75.68	0.0161	0.0850	0.0343	0.0046	0.2290	0.0070	0.0020
3	0.0450	0.0018	18.14	0.3860	0.0380	0.0020	0.0950	0.0089	77.05	0.0190	0.0900		0.0050	0.2348	0.0072	0.0029
4	0.0454	0.0023	18.30	0.3875	0.0399	0.0020	0.1293	0.0100	77.84	0.0196			0.0054	0.2408	0.0086	0.0041
5	0.0460	<0.001	18.38	0.3910	0.0480	0.0020	0.1300	0.0100	78.10	0.0210			<0.001	0.2470	0.0088	0.0045
6	0.0510	<0.005	18.66	0.4000	0.0600	<0.005	0.1365	0.0104	78.22				<0.005	0.2477	0.0095	0.0049
7	0.0530	<0.005	18.67	0.4166		<0.005	0.1463	0.0115					<0.01	0.2515	0.0098	0.0060
8	0.0563		18.94				0.1590	0.0116					<0.01	0.2530	0.0100	
9	0.0600						0.1727	0.0117						0.2600		
10	0.0617						0.2010							0.2752		
11																
12																
13																
14																
15																
Mean	0.0493	0.0016	18.4020	0.3896	0.0411	0.0019	0.1311	0.0099	77.09	0.0176	0.0833	0.0341	0.0041	0.2458	0.0082	0.0038
STDV.	0.0086	0.0006	0.3249	0.0158	0.0121	0.0002	0.0426	0.0017	1.18	0.0035	0.0076	0.0003	0.0018	0.0160	0.0017	0.0015
<b>Certified</b>	<b>0.049</b>	<b>(0.002)</b>	<b>18.4</b>	<b>0.39</b>	<b>0.04</b>	<b>(0.0019)</b>	<b>0.13</b>	<b>0.010</b>	<b>77.0</b>	<b>(0.0176)</b>	<b>(0.075)</b>	<b>(0.034)</b>	<b>(0.004)</b>	<b>0.25</b>	<b>0.008</b>	<b>0.004</b>
U <sub>CRM</sub>	0.006		0.3	0.01	0.01		0.03	0.001	1					0.01	0.001	0.001
Methods	I,IM	IM,I	I	C	I,IM	IM,I	I,IM	IM,I	BAL,I	F	I	I	I	I,IM	I,IM	F

	Nb	Ni	O	P	Pb	S	Sb	Se	Si	Sn	Ta	Ti	V	W	Zn	Zr
1	0.0063	0.0095	1.0200	0.0010	0.0001	0.0030	0.0003	0.0002	0.4840	0.0020	0.0001	0.2280	0.0030	0.0018	0.0003	0.0290
2	0.0066	0.0103	1.0300	0.0077	0.0002	0.0030	0.0003	<0.0005	0.5305	0.0023	0.0001	0.2530	0.0043	0.0019	0.0007	0.0350
3	0.0073	0.0106	1.0700	0.0090	0.0003	0.0039	0.0003	<0.001	0.5876	0.0025	<0.0001	0.2580	0.0044	0.0020	0.0011	0.0360
4	0.0076	0.0110	1.1190	0.0278	<0.0005	0.0042	0.0004	<0.005	0.6540	0.0026	<0.001	0.2600	0.0050	0.0020	<0.001	0.0386
5	0.0080	0.0116	1.2808	0.0298	<0.001	0.0060	<0.001	<0.005	0.7050	0.0030	<0.001	0.2780	0.0052	0.0023	<0.001	0.0387
6	<0.001	0.0120		0.0350	<0.001	0.0060	<0.005		0.7307	0.0040	<0.005	0.2785	0.0060	0.0030	<0.005	0.0406
7	<0.005	0.0121		0.0432	<0.005	<0.01			0.7320	<0.005		0.2830	0.0073	<0.005		0.0430
8	<0.005	0.0130		<0.005					0.7800			0.3177	<0.005			
9		0.0140		<0.005					0.7800			0.3341				
10		0.0147														
11																
12																
13																
14																
15																
Mean	0.0072	0.0119	1.1040	0.0219	0.0002	0.0044	0.0003	0.0002	0.6649	0.0027	0.0001	0.2767	0.0050	0.0022	0.0007	0.0373
STDV.	0.0007	0.0016	0.1063	0.0160	0.0001	0.0014	0.0000		0.1083	0.0007	0.0000	0.0328	0.0014	0.0004	0.0004	0.0045
<b>Certified</b>	<b>(0.0072)</b>	<b>0.012</b>	<b>(1.1)</b>	<b>(0.02)</b>	<b>(0.0002)</b>	<b>0.004</b>	<b>(0.00034)</b>	<b>(0.0002)</b>	<b>0.66</b>	<b>0.0027</b>	<b>(0.0001)</b>	<b>0.28</b>	<b>0.005</b>	<b>0.0022</b>	<b>(0.001)</b>	<b>0.037</b>
U <sub>CRM</sub>		0.001				0.001			0.08	0.0007		0.03	0.001	0.0005		0.004
Methods	IM,I	I,IM	F	I,IM	IM,I	C	IM,I	IM,I	I	IM,I	IM,I	IM,I	IM,I	IM,I	IM,I	IM,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

### Certification Laboratories

Laboratory Testing, Inc.  
IMR Test Labs  
Applied Technical Services  
LGC Standards  
AGAT Labs

Hatfield, PA  
Lansing, NY  
Marietta, GA  
Manchester, NH  
Canada

NSL Analytical Services  
Dirats Laboratories  
EAG Laboratories  
Scrooby's Laboratory Services

Cleveland, OH  
Westfield, MA  
Liverpool, NY  
Benoni, South Africa

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.

### 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.

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

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

### Expiration

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.



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