Brammer Standard Company, Inc.

Certificate of Analysis BS LF2C

Certified Reference Material for ASTM A350 (LF2) Carbon Steel - UNS Number K03011

	Certified Value ¹	Estimate of Uncertainty ²	Certified Values ³		Certified Value ¹	Estimate of Uncertainty ²
AI	0.029	0.003		Nb	0.0009	0.0004
As	0.0042	0.0008		Ni	0.099	0.009
В	0.0002	0.0001		0	0.0018	0.0003
С	0.21	0.01		Ρ	0.012	0.001
Ca	0.0002	0.0001		Pb	0.0004	0.0002
Со	0.0100	0.0009		S	0.0182	0.0007
Cr	0.152	0.008		Si	0.263	0.009
Cu	0.153	0.007		Sn	0.011	0.001
Fe	98.0	0.1		Ti	0.0019	0.0006
Mn	1.02	0.03		V	0.0014	0.0005
Мо	0.029	0.003		W	0.0023	0.0004
Ν	0.0096	0.0006		Zr	0.0008	0.0004
	Reference Value¹	Estimate of Uncertainty ²	Reference Values	3,4	Reference Value ¹	Estimate of Uncertainty ²
H Mg Sb	<0.005 0.0003 <0.05	0.0002		Ta Zn	<0.05 <0.005	

¹ For each element, the certified value listed is the present best estimate of the true value based on the mean of the weighted results of an interlaboratory testing program. See page 4 for more information on its calculation.

² For each element, the uncertainty listed is based on a statistical evaluation of the contributions of homogeneity and the interlaboratory testing program. See page 4 for more information on its calculation.

³ Values are given in weight percent. Values in brackets are reported by difference.

⁴ Reference values are not certified and are provided for information only.

Trace element information values for Ag, Ce, Cl, Ga, Ge, Li, Na, and Re are shown on page 4.

The requirements of ISO Guides 30, 31, and 35 were followed for the preparation of this Certified Reference Material and certificate of analysis.

Brammer Standard Company, Inc., 14603 Benfer Road, Houston, TX 77069-2895 USA Telephone: (281) 440-9396 Fax (281) 440-4432 Website: <u>www.brammerstandard.com</u> Certificate Number LF2C-040524 Page 1/6 **BS LF2C**

* Code for method

Certified values listed as weight percent

0.0274333 0.0276333 0.0276667 0.028667 0.0288 0.0281 0.0282 0.0287 0.0289533 0.0289667 0.0299 0.0299 0.0299 0.0291 0.0311 0.0311 0.0314	4 15 4 5 8 5 10 10 3	0.0032 0.0035 0.0035 0.004 0.0040333 0.0040667 0.00408 0.004187 0.0041367 0.0043 0.004333 0.0043667 0.0046 0.0047 0.004733 0.0047333	5 12 4 3 3 7 7 11 4 3 4	0.0001 0.0001083 0.0002 0.0002 0.0002 0.0002 0.0002 0.0002333 0.00029 0.0003667 	1 3 1 3 1 1 1 1 3 1 1 3 1 1 1 1 1 1 1 1	0.1876 0.194 0.195 0.200 0.20 0.2011 0.2013 0.2023667 0.203 0.2038667 0.204 0.2043333 0.2066667 0.206	12 3 4 11 3 4 4 10 4 10 4	0.00039 0.0002 0.0002 0.0002 0.0002 0.0002 0.0002 0.0002 0.0002 0.0002	12 11 14 4 10 3 3 4 3 4 3 4 5 5 5 4 3	0.0087 0.0091 0.0092 0.00967 0.010 0.010 0.010 0.0100 0.010033 0.010033 0.010057 0.0102 0.01023	3 4 3 4 4 10 3 13 4 3	0.14 0.1444667 0.1456667 0.147 0.1486667 0.1486667 0.1499667 0.15 0.15 0.1500667 0.152	10 4 10 3 3 4 4 4 4 4 3 4 3 3 3 3	0.148 0.149967 0.15 0.15 0.150 0.150 0.1501 0.150667 0.1519 0.1529 0.1529 0.154 0.155	4 16 16 14 16 16	97.9433333 97.95 [97.95667] [97.95667] [97.9666334] 97.9656334] 97.9778] [97.9778] [97.99] 98.0 [98]	4 3 11 3 4 4 4 4 4 4 14 4 3 10	0.996333 1.001 1.01 1.01 1.012666 1.014333 1.016 1.018666 1.02 1.02 1.02
0.0278667 0.0278667 0.028 0.028 0.0281 0.0282 0.028533 0.0289667 0.029 0.029 0.029333 0.0291 0.0291 0.0291 0.0297333 0.021 0.0237333 0.031 0.0311667	4 3 3 4 4 15 4 5 8 5 5 10 10 10 3	0.0035 0.0035 0.004 0.0040333 0.0040637 0.00408 0.0041 0.0041367 0.0043 0.0043333 0.0043667 0.0046 0.0047	4 3 3 7 11 4 3	0.0002 0.0002 0.0002 0.0002 0.0002 0.0002333 0.00029	1 3 1 1 1 1 1 3 1 1 1 1 1 1 1 1 1 1	0.195 0.200 0.20 0.2011 0.2013 0.2023667 0.203 0.2036667 0.204 0.204 0.2044333 0.2066667 0.2066667 0.209	4 11 3 4 4 4 10	0.0002 0.0002 0.0002 0.0002 0.0002 0.0002	14 4 10 3 3 4 3 3 4 5 5 5 4	0.0092 0.009967 0.010 0.010 0.010 0.010 0.010 0.0103 0.010033 0.010057 0.0102	4 3 4 3 4 4 10 3 13 4 3	0.1456667 0.147 0.1486667 0.149 0.1496667 0.1496667 0.1499667 0.15 0.15 0.15 0.15	10 3 3 3 4 4 4 4 4 3 3 4	0.15 0.15 0.150 0.1501 0.150667 0.1519 0.1529 0.154 0.1540	16 16 16 16 16 4 4 4 16 16 16 14 16 16	[97.95] [97.95667] [97.966334] 97.9693333 97.97 [97.9778] [97.9778] [97.99] 98.0 [98]	11 3 4 4 4 4 4 4 14 4 3	1.01 1.01 1.012666 1.014333 1.016 1.018666 1.02 1.02 1.02
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0.0281 0.0282 0.0287 0.0289533 0.0289667 0.029 0.029 0.0291 0.0311 0.	4 4 15 4 5 8 5 10 10 10 3	0.0040333 0.0040667 0.00408 0.0041 0.0041367 0.0043333 0.0043667 0.0046 0.0047	7 11 4 3	0.0002 0.0002 0.0002333 0.00029	1 1 1 3 1 11 11 1 1 1 1 1	0.20 0.2011 0.2013 0.2023667 0.203 0.2038667 0.204 0.204333 0.2066667 0.2066667 0.209	4 4 10	0.0002 0.0002 0.0002	3 3 4 3 3 4 5 5 5 4	0.010 0.010 0.0100 0.01003 0.010033 0.010033 0.010057 0.0102	3 4 4 10 3 13 4 3	0.149 0.1496667 0.1499667 0.15 0.15 0.15 0.15	3 4 4 4 4 3 3 4	0.150 0.1501 0.150667 0.1519 0.1529 0.154 0.1540	16 4 16 16 14 16 16	[97.9656334] 97.9693333 97.97 [97.9778] [97.99] 98.0 [98]	4 4 4 4 14 4 3	1.012666 1.014333 1.016 1.018666 1.02 1.02 1.02
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0.031 0.0311667	4	0.0047333			_				3	0.0103	14	0.153	3	0.155			4	1.021333
0.0311667					1				4	0.010397	11	0.154	4	0.155			4	1.0223
						0.21			4	0.0106	4	0.154	4	0.155167			7	1.022666
0.0314					1	0.218			5	0.010667	4	0.154	4	0.155667			3	1.023333
					1	0.2181667			3	0.0108	4	0.1543633	14	0.156			3	1.023333
					3	0.2213			4	0.0109	3	0.155	4	0.157			4	1.026233
					12	0.2300					3	0.157667	4	0.157			8	1.02866
											10	0.158667	3	0.157667			4	1.0294
											4	0.159667	10	0.159333			4	1.03296
											10	0.16	5	0.159333			10	1.04
											5	0.160667					10	1.04333
					_												3	1.05
0.028961		0.00419		0.000213		0.205541		0.0001999		0.01001		0.151997		0.1527		97.984		1.0215
0.000073		0.00015		0.000017		0.000069		0.0000019		0.00034		0.000063		0.0024		0.022		0.0037
0.0017		0.00075		0.00025		0.0046		0.00024		0.0011		0.0039		0.0039		0.19		0.011
0.0017		0.00076		0.00025		0.0046		0.00024		0.0011		0.0039		0.0046		0.19		0.012
2.10		2.13		2.26		2.09		2.31		2.09		2.06		2.07		2.16		2.06
0.0037		0.0016		0.00056		0.010		0.00056		0.0024		0.0081		0.010		0.42		0.024
0.00084		0.00041		0.00018		0.0021		0.00019		0.00053		0.0016		0.0019		0.11		0.0047
0.029		0.0042		0.0002		0.21		0.0002		0.0100		0.152		0.153		98.0		1.02
0.003		0.0008		0.0001		0.01		0.0001		0.0009		0.008		0.007		0.1		0.03
0.009		0.0024		0.0001		0.03		0.0001		0.0027		0.024		0.021		0.4		0.09
0.0 0. 2 0. 0.0 0.0	00073 0017 0017 10037 0084 029 003	00073 00073 00017 00017 00017 00037 00084 0029 0003 003 003 003 003 003 003 003 003 0	00073 0.00015 0017 0.00075 0017 0.00076 1.10 2.13 0037 0.0016 0084 0.00041 029 0.0042 003 0.0008	00073 0.00015 0017 0.00075 0017 0.00076 10 2.13 0037 0.0016 0084 0.00041 029 0.0042 003 0.0008	000073 0.00015 0.00017 0017 0.00075 0.00025 0017 0.00076 0.00025 10 2.13 2.26 0037 0.0016 0.00056 0084 0.00041 0.00012 003 0.00082 0.0002	000073 0.00015 0.000017 0017 0.00075 0.00025 0017 0.00076 0.00025 1.10 2.13 2.26 0037 0.0016 0.00056 0084 0.00041 0.00018 0029 0.0042 0.0002 003 0.0008 0.0001	000073 0.00015 0.00017 0.000069 0017 0.00075 0.00025 0.0046 0017 0.00076 0.00025 0.0046 0.10 2.13 2.26 2.09 0037 0.0016 0.00056 0.010 0084 0.00041 0.00018 0.0021 029 0.0042 0.0002 0.211 003 0.0008 0.0001 0.01	000073 0.00015 0.000017 0.00069 0017 0.00075 0.00025 0.0046 0017 0.00076 0.00025 0.0046 0.10 2.13 2.26 2.09 0037 0.0016 0.00056 0.010 0084 0.00041 0.00018 0.0021 0029 0.0042 0.0002 0.21 003 0.0008 0.0001 0.01	000073 0.00015 0.000017 0.000069 0.000019 0017 0.00075 0.00025 0.0046 0.00024 0017 0.00076 0.00025 0.0046 0.00024 0017 0.00076 0.00025 0.0046 0.00024 10 2.13 2.26 2.09 2.31 0037 0.0016 0.00056 0.010 0.00019 0084 0.00041 0.00018 0.0021 0.00019 029 0.0042 0.0002 0.21 0.0002 003 0.0008 0.0001 0.01 0.0001	000073 0.00015 0.00017 0.00069 0.000019 0017 0.00075 0.00025 0.0046 0.00024 0017 0.00076 0.00025 0.0046 0.00024 0107 0.00076 0.00025 0.0046 0.00024 0107 0.0016 0.00056 0.010 0.00056 0037 0.0016 0.00056 0.010 0.00056 0084 0.00041 0.00018 0.0021 0.00019 003 0.0008 0.0001 0.01 0.0001	000073 0.00015 0.000017 0.000069 0.000019 0.0003 0017 0.00075 0.00025 0.0046 0.00024 0.0011 0017 0.00076 0.00025 0.0046 0.00024 0.0011 0017 0.00076 0.00025 0.0046 0.00024 0.0011 10 2.13 2.26 2.09 2.31 2.09 0037 0.0016 0.00056 0.010 0.00056 0.0024 0084 0.00041 0.00018 0.0021 0.00019 0.00053 029 0.0042 0.0002 0.21 0.0002 0.0100 003 0.0008 0.0001 0.01 0.0001 0.0009	000073 0.00015 0.00017 0.00069 0.000019 0.00034 0017 0.00075 0.00025 0.0046 0.00024 0.0011 0017 0.00076 0.00025 0.0046 0.00024 0.0011 0.017 0.00076 0.00025 0.0046 0.00024 0.0011 0.10 2.13 2.26 2.09 2.31 2.09 0.0037 0.0016 0.00056 0.010 0.00056 0.0024 0.0084 0.00041 0.00018 0.0021 0.00019 0.00053 029 0.0042 0.0001 0.21 0.0002 0.0100 003 0.0088 0.0001 0.01 0.0001 0.0009	000073 0.00015 0.000017 0.000069 0.000019 0.00034 0.000063 0017 0.00075 0.00025 0.0046 0.00024 0.0011 0.0039 0017 0.00076 0.00025 0.0046 0.00024 0.0011 0.0039 0017 0.00076 0.00025 0.0046 0.00024 0.0011 0.0039 0.01 2.13 2.26 2.09 2.31 2.09 2.06 0037 0.0016 0.00056 0.010 0.00056 0.0024 0.0016 0084 0.00041 0.00018 0.0021 0.00019 0.00053 0.0016 029 0.0042 0.0001 0.0100 0.0100 0.152 003 0.0008 0.0001 0.01 0.0001 0.0009 0.008	000073 0.00015 0.00017 0.00069 0.000019 0.00034 0.00063 0017 0.00075 0.00025 0.0046 0.00024 0.0011 0.0039 0017 0.00076 0.00025 0.0046 0.00024 0.0011 0.0039 0017 0.00076 0.00025 0.0046 0.00024 0.0011 0.0039 0.10 2.13 2.26 2.09 2.31 2.09 2.06 0037 0.0016 0.00056 0.010 0.00056 0.0024 0.0024 0084 0.00041 0.00018 0.0021 0.00019 0.00053 0.016 029 0.0042 0.0001 0.01 0.0001 0.009 0.008 003 0.0088 0.0001 0.01 0.0001 0.0099 0.008	000073 0.00015 0.00017 0.00069 0.000019 0.00034 0.00063 0.0024 0017 0.00075 0.00025 0.0046 0.00024 0.0011 0.0039 0.0039 0017 0.00076 0.00025 0.0046 0.00024 0.0011 0.0039 0.0046 0.17 0.00076 0.00025 0.0046 0.00024 0.0011 0.0039 0.0046 0.10 2.13 2.26 2.09 2.31 2.09 2.06 2.07 0.0037 0.0016 0.00056 0.010 0.0024 0.0024 0.0081 0.010 0.0084 0.00041 0.00018 0.0021 0.00019 0.00053 0.016 0.0019 0029 0.0042 0.001 0.0010 0.0099 0.0088 0.007 003 0.0088 0.001 0.01 0.0001 0.0099 0.0088 0.007	000073 0.00015 0.000017 0.000069 0.000019 0.00034 0.00063 0.0024 0017 0.00075 0.00025 0.0046 0.0024 0.0011 0.0039 0.0039 0017 0.00076 0.00025 0.0046 0.0024 0.0011 0.0039 0.0039 0.017 0.00076 0.00025 0.0046 0.0024 0.0011 0.0039 0.0046 0.010 2.13 2.26 2.09 2.31 2.09 2.06 2.07 0037 0.0016 0.00056 0.0010 0.0056 0.0024 0.0081 0.010 0084 0.00041 0.00018 0.0021 0.00053 0.0016 0.0019 0029 0.0042 0.010 0.0001 0.0009 0.008 0.007 003 0.0088 0.0001 0.01 0.0001 0.0099 0.008 0.007	000073 0.00015 0.000017 0.000069 0.000019 0.00034 0.00063 0.0024 0.0022 0017 0.00075 0.00025 0.0046 0.00024 0.0011 0.0039 0.0039 0.19 0017 0.00076 0.00025 0.0046 0.00024 0.0011 0.0039 0.0039 0.19 0017 0.00076 0.00025 0.0046 0.00024 0.0011 0.0039 0.0046 0.19 1.10 2.13 2.26 2.09 2.31 2.09 2.06 2.07 2.16 0037 0.0014 0.00056 0.0012 0.00053 0.0016 0.0019 0.42 0084 0.00041 0.00018 0.00053 0.0016 0.0019 0.11 029 0.0042 0.001 0.0001 0.0009 0.088 0.007 0.1	Image: Note of the state of the st

Analysis	*	Mo	*	N	*	Nb	*	Ni	*	0	*	P	*	Pb	*	S	*	Si	*	Sn
1	4	0.0216667	2	0.0087333	12	0.0002333	3	0.09	2	0.00146667	4	0.008	12	0.00020	1	0.017	10	0.24233333	3	0.0078
2	12	0.0226667	2	0.0090	5	0.0004633	3	0.093	2	0.00153333	12	0.009333	5	0.0002367	1	0.0174	4	0.25166667	4	0.0083333
3	3	0.028	2	0.0093333	4	0.0006667	4	0.0936667	2	0.00154667	5	0.010933	5	0.0002867	1	0.017467	3	0.255	11	0.0084
4	11	0.0282	2	0.0093667	3	0.0007	4	0.0953	2	0.0016	3	0.011	11	0.0004	11	0.0175	4	0.25623333	12	0.0084333
5	4	0.0286	2	0.0094667	3	0.0009	11	0.0974	2	0.00166667	3	0.011	3	0.0004333	4	0.017733	14	0.25833333	4	0.010
6	7	0.0288333	2	0.0094933	4	0.0009	3	0.0976667	2	0.00166667	3	0.0111	4	0.0005	1	0.017817	3	0.259	3	0.0100
7	4	0.0291	2	0.0096333	3	0.0009333	4	0.098	2	0.0017	7	0.011133	3	0.0005	3	0.018	4	0.25996667	4	0.0100667
8	4	0.0291	4	0.0097	4	0.0010333	3	0.0989	2	0.0018	11	0.0112	9	0.0005	1	0.0180	3	0.26	4	0.0102667
9	3	0.0292	2	0.0097667	5	0.0019667	7	0.099	2	0.001875	14	0.011667	4	0.0005	3	0.018	3	0.26	9	0.0103
10	4	0.0297	2	0.0098333	4	0.0031	10	0.0991333	2	0.00190333	4	0.011733	4	0.0006	1	0.018	6	0.26	3	0.0103333
11	4	0.030	2	0.0098467			14	0.0993	2	0.00193333	4	0.011803			1	0.018	10	0.26	4	0.0105
12	3	0.030	2	0.0098533			3	0.0994	2	0.00247	4	0.011833			1	0.018067	3	0.26	3	0.0108
13	10	0.030	2	0.0099			8	0.0997667	2	0.0027	3	0.0119			3	0.0181	11	0.26	10	0.0109667
14	10	0.030	2	0.0099333			4	0.0999667			13	0.012			1	0.0181	4	0.26014333	3	0.011
15	3	0.0300	2	0.010			10	0.10			10	0.012			1	0.018133	7	0.26033333	5	0.0111667
16	14	0.030					3	0.10			4	0.0120			1	0.0183	3	0.263	4	0.0115667
17	4	0.0301					3	0.10			3	0.012			1	0.018333	3	0.263	3	0.0117
18	3	0.0303333					4	0.1000333			6	0.012067			3	0.0184	4	0.2641	4	0.0118
19	3	0.0304					4	0.1004			3	0.0123			1	0.0184	4	0.265	5	0.0118667
20	4	0.0307333					4	0.1005			4	0.012467			1	0.018833	4	0.26693333	5	0.012
21	5	0.030767					4	0.100667			4	0.012533			1	0.018967	4	0.274333	3	0.012
22	10	0.030833					4	0.100667			5	0.012867			10	0.019	4	0.276	10	0.012
23	4	0.0316					7	0.101333			4	0.012933					4	0.277333	4	0.0120
24	3	0.0326					4	0.101333			10	0.013					4	0.297		
25	4	0.034367					5	0.102333			4	0.0136								
											3	0.014								
Average		0.02949	_	0.00959		0.000874		0.0986	_	0.001836		0.01176		0.000439		0.01815	_	0.2627		0.010578
Std Dev		0.00084		0.00031		0.000048		0.0018		0.000088		0.00039		0.000026		0.00053		0.0030		0.000066
Н		0.0018		0.0011		0.00041		0.0032		0.00054		0.0012		0.00032		0.0014		0.0052		0.0011
U1		0.0020		0.0011		0.00041		0.0037		0.00054		0.0012		0.00032		0.0015		0.0060		0.0011
t-statistic		2.06		2.14		2.26		2.06		2.18		2.06		2.26		2.08		2.07		2.07
U2	-	0.0040		0.0024		0.00092		0.0075		0.0012		0.0025		0.00072		0.0031		0.012		0.0023
U ₃		0.00081		0.00061		0.00029		0.0015		0.00033		0.00049		0.00023		0.00067		0.0025		0.00048
Certified		0.029		0.0096		0.0009		0.099		0.0018		0.012		0.0004		0.0182		0.263		0.011
Uncertainty	1	0.003		0.0006		0.0004		0.009		0.0003		0.001		0.0002		0.0007		0.009		0.001
Tolerance		0.009		0.0024		0.0008		0.027		0.0009		0.003		0.0003		0.0021		0.027		0.003

Brammer Standard Company, Inc., 14603 Benfer Road, Houston, TX 77069-2895 USA Telephone: (281) 440-9396 Fax (281) 440-4432 Website: www.brammerstandard.com Certificate Number LF2C-040524 Page 2/6 **BS LF2C**

* Code for method

Analysis	5	*	Ti		* V	*	W	*	Zr							
1		12	0.0008633		4 0.0008	4	0.0019667	12	0.000044							
2		14	0.0010	1	2 0.0008033	3	0.002	3	0.0002							
3		11	0.0014		4 0.0010333	3	0.002	4	0.0007							
4		3	0.0016	4	4 0.0011667	4	0.0020667	4	0.0007							
5		3	0.0016		3 0.0013	12	0.0022	4	0.0008333							
6		5	0.0017867	1	5 0.00135	3	0.0022	11	0.0009							
7		4	0.0018667	1	5 0.0014	4	0.0023333	3	0.0011							
8		3	0.0019		3 0.0014	11	0.0025	4	0.0019							
9		4	0.0019333	1	5 0.0014667	14	0.0026									
10		5	0.0019333	- 4	4 0.0015	5	0.0026667									
11		5	0.0019667		3 0.0016	5	0.0027333									
12		4	0.0019667	1	1 0.0018	5	0.0028333									
13		3	0.0020	- 4	4 0.0018667											
14		4	0.0020	1	4 0.0019333											
15		4	0.0021													
16		4	0.00235													
Average			0.001949		0.001387		0.002342		0.00080							
Std Dev			0.000075		0.000085		0.000091		0.00011							
Н			0.00055		0.00048		0.00059		0.00059							
U1			0.00055		0.00049		0.00060		0.00060							
t-statistic			2.13		2.16		2.20		2.36							
U2			0.0012		0.0011		0.0013		0.0014							
U ₃			0.00030		0.00028		0.00038		0.00050							
Certified			0.0019		0.0014		0.0023		0.0008							
Uncertain	ty		0.0006		0.0005		0.0004		0.0004							
Tolerance	•		0.0018		0.0013		0.0012		0.0007							

BS LF2C

* Code for method

Reference values listed as weight percent

Analysis	*	H	*	Mg	*	Sb	*	Та	*	Zn	
1	2	0.000090	12	0.000080	3	0.0005	3	0.0007	12	0.00253333	
2	2	0.000207	4	0.0003	11	0.0008	5	0.00080	5	0.00275333	
3			3	0.0003	12	0.0015667	4	0.0040333			
4			4	0.0003	4	0.0018	4	0.0040333			
5			4	0.0004633	5	0.0018	4	0.0043333			
6					5	0.00182	3	0.0084			
7					9	0.0019					
8					5	0.0021					
9					4	0.0040667					
10					4	0.0041333					
11					4	0.0042667					
Average		0.000136		0.0003000		0.002250		0.00403		0.00275	
Std Dev		0.000031		0.0000032		0.000095		0.00026		0.00050	
н		0.00021		0.00028		0.00058		0.00074		0.00059	
U1		0.00022		0.00028		0.00059		0.00078		0.00077	
t-statistic		12.71		2.78		2.23		2.57		12.7062047	
U2		0.0027		0.00077		0.0013		0.0020		0.010	
U ₃		0.00190		0.00034		0.00040		0.00082		0.0070	
Referenc	e	<0.005		0.0003		<0.05		<0.05		<0.005	
Uncertaint	y			0.0002							
Tolerance				0.0002							

Analytical Method Codes:

- 1 Combustion (ASTM E1019)
- 2 Fusion (ASTM E1019)
- 3 Spark Atomic Emission
- 4 ICP Atomic Emission
- 5 ICP Mass Spectrometry
- 6 Gravimetric

- 7 Photometric
- 8 Flame Atomic Absorption
- 9 GF Atomic Absorption
- 10 X-Ray Fluorescence
- 11 GD Atomic Emission
- 12 GD Mass Spectrometry
- 13 Titrimetric
- 14 DCP Atomic Emission
- 15 HG Atomic Fluorescence
- 16 Difference
- ICP = Inductively Coupled Plasma GF = Graphite Furnace GD = Glow Discharge DCP = Direct Current Plasma HG = Hydride Generation

Brammer Standard Company, Inc., 14603 Benfer Road, Houston, TX 77069-2895 USA Telephone: (281) 440-9396 Fax (281) 440-4432 Website: <u>www.brammerstandard.com</u> Certificate Number LF2C-040524 Page 3/6 For each element, in accordance with the requirements of ISO 17034 and Guide 35, an effort must be made to account for the effects on the certified value of the uncertainty estimate from homogeneity testing (H) and the uncertainties of the contributing laboratories. The average (A) is calculated using a weighted mean where the reciprocal of the square of each laboratory's combined uncertainty (C_L), calculated from its standard deviation (S_L) and its uncertainty estimate (U_L), is used as the weight (W_L) for its mean (M_L). The standard deviation (S) is calculated as the square root of the reciprocal of the sum of the weights. U_1 is the combined uncertainty from homogeneity and labs. U_2 is U_1 multiplied by the coverage factor (95 % t-statistic). U_3 is U_2 divided by the square root of the number of determinations (n). Thus:

$$C_{L} = \sqrt{S_{L}^{2} + U_{L}^{2}} \qquad W_{L} = \frac{1}{C_{L}^{2}} \qquad A = \frac{\sum_{i=1}^{n} W_{L} M_{L}}{\sum_{i=1}^{n} W_{L}} \qquad S = \frac{1}{\sqrt{\sum_{i=1}^{n} W_{L}}} \qquad U_{1} = \sqrt{H^{2} + S^{2}} \qquad U_{2} = t \times U_{1} \qquad U_{3} = \frac{U_{2}}{\sqrt{n}}$$

n

All but the final reported values are taken to two significant figures as determined by each quantity's uncertainty estimate. The final reported Uncertainty is U_3 rounded to one significant figure and represents the half width of the 95 % confidence interval for the **Certified** value. The final reported **Certified** value is A rounded to the same decimal place as the Uncertainty. The Uncertainty is a measure of the quality of the **Certified** value.

The Tolerance is a measure of the expected performance of an analysis. This involves further expanding the sample uncertainty to include instrument and operator uncertainty, for those without access to such calculations.

For further information regarding the confidence interval for the certified value see ISO Guide 35:2006 section 6.

F2C

* Code for analytical method

Trace analysis listed as mg/kg (ppm)

Analysis	*	Ag	*	Се	*	CI	*	Ga		*	Ge	*	Li	*	Na	*	Re
1	12	0.85	12	0.06	12	0.02	12	6.5	1	2	12	12	0.02	12	0.01	12	0.02
2	12	0.86	12	0.09	12	0.03	12	6.6	1	2	13			12	0.02	12	0.02
3	12	0.92	12	0.1	12	0.05	12	6.7	1	2	14			12	0.02	12	0.06

Lab Name	Location	Registrar	Accreditation
Brammer Standard Company, Inc.	Houston, TX	A2LA	17025, 17034
NSL Analytical	Cleveland, OH	ANAB	17025
Element Materials Technology	Glendale Heights, IL	A2LA	17025
Elemental Analysis, Inc.	Lexington, KY	A2LA	17025
TUV Rheinland Pvt Ltd	Bangalore, India	NABL	17025
Shiva Analyticals Private Limited	Hoskote, Bangalore	NABL	17025
Dirats Laboratories	Westfield,MA	ANAB	17025
Luvak Inc.	Boylston, MA	PRI	17025
Laboratory Testing, Inc.	Hatfield, PA	A2LA	17025
Raghavendra Spectro Metallurgical Laboratory	Karnataka, India	NABL	17025
National Analysis Center For Iron And Steel	Beijing, China	CNAS	17025
Instytut Metalurgii Zelaza	Gliwice, Poland	PCA	17025
APL, Inc	Milwaukee, WI	A2LA	17025

A2LA = American Association for Laboratory Accreditation

ANAB = ANSI-ASQ National Accreditation Board

CNAS = China National Accreditation Service

NABL = National Accreditation Board for Testing and Calibration Laboratories

PCA = Polish Center for Accreditation

PRI =Performance Review Institute

<u>Analysis:</u> Chemical analyses were made on solid pieces and chips prepared by an end mill from representative samples for the certified portion of the lot in accordance with ASTM Standard Practice E1806. The laboratories participating in the testing followed the requirements of ISO Standard 17025.

Traceability: The following Certified Reference Materials were used to validate the analytical data: 12X353E, 12X357B; AR612B, 614A, 645, 660, 662, 673, 675, 868, 878, 883, 888, 966; BAS 254/1, 432, 433/1, 454/1, 456, 458/1, 461, 464/1; BS D6A, HON U, LF2B, 13B, 50D, 52D, 54J, 56H, 61D, 61G, 74C, 1018, 1932, 2931, 2931A, 2932, 3011, 3942, 3981, 4130, 4340A, 4820B, 5620F, 8620A; CKD 165D, 181A, 181B; ECRM 082-1, 096-1, 85-1, 86-1, 87-1, 405/2; IARM 20A, 28H, 29D, 30C, 156A, 156C, 323A; IMZ 74, 112A, 114, 132; IPT 5/2, 29-1; JSS GS-1d, 170-6; LECO 501-506, 502-503, 502-712, 502-868, 502-913, 502-916, 502-963, 502-990, 503-514; NCS NS21006; SRM 111B, 160B, 178, 361, 362, 363, 1163, 1269, 1765, 3131, 3155, 3163, 3165; Y TSN 013, 41340b.

Homogeneity: This Certified Reference Material (CRM) was tested for homogeneity using ASTM Standard Method E826 and found acceptable. It was also examined by spark atomic emission spectrometry and found to be compatible with the following Reference Materials: BAS 454/1; BS LF2B, 52D, 1932, 2931A, 2932, 3011, 3981, 8620A; SRM 1163.

<u>Validity statement:</u> ISO Guide 31 states that the certification should contain an expiration date for all materials where instability has been demonstrated or is considered possible, after which the certified value is no longer guaranteed by the certifying body. The certification of BS LF2B is valid indefinitely. The certification is nullified if this CRM is damaged, contaminated, or otherwise modified.

Storage: This CRM must be stored in a cool, dry, non-corrosive environment.

Source: The bar stock for this CRM was produced by CSC, Warren, OH.

Form: This CRM is machined in the form of a disc, approximately 44mm in diameter and 19mm thick by Brammer Standard Company, Inc.

<u>Use:</u> This CRM is intended for use in spark atomic emission, glow discharge, and x-ray spectrometric methods of analysis. Refer to ISO Guide 33 for information about the use of Certified Reference Materials.

Certified Area: The entire depth of the CRM may be used.

Caution: As with any bar material, avoid spark atomic emission spectrometric burns in the center of the CRM (5 mm radius), as some segregation may be present.

Sample Preparation: For best analytical results, use the same method for preparing the analytical surface on all reference materials as used for production specimens. Avoid overheating the sample during surface preparation.

Caution: CRM contains significant insoluble soft metal inclusions. Surface smearing may occur. Spark atomic emission spectrometers may require extended preburns to compensate.

<u>Certificate Number</u>: The unique identification number for this certificate of analysis is LF2C-040524. You may obtain information on revisions of certificates from the internet at <u>www.brammerstandard.com</u>.

Safety Notice: A Safety Data Sheet (SDS) is not required for this material. This material will not release or otherwise result in exposure to a hazardous chemical, under normal conditions of use. Inquiries concerning this Reference Material should be directed to:

Brammer Standard Co., Inc. 14603 Benfer Road	Phone: (281) 440-9396	Web: www.brammerstandard.com
Houston, Texas 77069-2895 USA	Fax: (281) 440-4432	Email: <u>contact@brammerstandard.com</u>

Brammer Standard Company, Inc., is accredited by the American Association for Laboratory Accreditation (A2LA) to ISO Standard 17034 as a Reference Material Producer for the production of Certified Reference Materials and Reference Materials (our current Certificate Number 656.02 expires 01/31/2025)

Brammer Standard Company's Chemical Laboratory is accredited by A2LA to ISO Standard 17025. (Our current Certificate Number 656.01 expires 01/31/2025)

By current Certificate Number 10539 expiring 01/01/2027, the Quality System of Brammer Standard Company, Inc., is registered to ISO 9001 by National Quality Assurance (NQA), U.S.A.

The scopes of accreditation are listed on the website: www.brammerstandard.com

References:

Versions used were those available at the time of testing and characterization

- E826 Standard Practice for Testing Homogeneity of a Metal Lot or Batch in Solid Form by Spark Atomic Emission Spectrometry
- E1019 Standard Test Methods for Determination of Carbon, Sulfur, Nitrogen, and Oxygen in Steel, Iron, Nickel, and Cobalt Alloys by Various Combustion and Fusion Techniques
- E1806 Standard Practice for Sampling Steel and Iron for Determination of Chemical Composition

ISO Standard 17025:2017 General requirements for the competence of testing and calibration laboratories

- ISO Standard 9001:2015 Quality Management Systems Requirements
- ISO Guide 30:2015 Terms and definitions used in connection with reference materials + 2008 amendment
- ISO Guide 31:2015 Reference materials Contents of certificates and labels
- ISO Guide 33:2015 Uses of certified reference materials
- ISO Standard 17034:2016 General requirements for the competence of reference material producers
- ISO Guide 35:2017 Reference Materials General and statistical principles for certification

ASTM documents available from ASTM, 100 Barr Harbor Dr., West Conshohocken, PA 19428.

ISO Guides and Standards available from Global Engineering - www.global.ihs.com

Other useful documents available from NIST, U.S. Department of Commerce, Gaithersburg, MD 20899.

NIST Special Publication 260-100, Handbook for SRM Users

NIST Special Publication 829, Use of NIST Standard Reference Materials for Decisions on Performance of Analytical Chemical Methods and Laboratories

Certified by: _____

_____ on April 5, 2024.

Beau R. Brammer

President