Brammer Standard Company, Inc.

Certificate of Analysis

BS 291EE

Certified Reference Material for Chill Cast Iron

Certified Values[3]

	Certified Value[1]	Estimate of Uncertainty[2]		Certified Value[1]	Estimate of Uncertainty[2]
Al	**0.047**	0.001	**Nb**	**0.0034**	0.0007
As	**0.0003**	0.0001	**Ni**	**0.099**	0.001
B	**0.0055**	0.0002	**P**	**0.0190**	0.0004
C	**3.24**	0.04	**Pb**	**0.0004**	0.0002
Ca	**0.0009**	0.0001	**S**	**0.0119**	0.0009
Cr	**0.015**	0.001	**Si**	**2.08**	0.02
Cu	**0.234**	0.005	**Sn**	**0.0480**	0.0006
Fe	**93.6**	0.2	**Ti**	**0.0157**	0.0003
Mg	**0.043**	0.001	**V**	**0.0082**	0.0003
Mn	**0.480**	0.004	**Zr**	**0.0023**	0.0002
Mo	**0.0075**	0.0002			

Informational Values[3,4]

Co (0.0033) Sb (0.01) W (0.0030)

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 6 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 6 for more information on its calculation.

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

[4] Values in parentheses are not certified and are provided for information only.

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

BS 291EE * Code for method Certified values listed as weight percent

Analysis	*	Al	*	As	*	B	*	C	*	Ca	*	Cr	*	Cu	*	Fe	*	Mg	*	Mn
1	3	0.0443	3	0.0001	3	0.00532	3	3.12	3	0.00066	3	0.0127	10	0.2166667	10	93.25	3	0.04261	4	0.4673333
2	3	0.0445	3	0.0001	3	0.00532	3	3.14	3	0.00078	10	0.013	4	0.225	4	93.4	3	0.04266	3	0.4733333
3	3	0.0446	3	0.0001	14	0.0053333	3	3.17	3	0.0008	3	0.0134	3	0.226	14	93.4333333	3	0.04266	4	0.4742333
4	3	0.0456667	3	0.0001	4	0.0053667	3	3.17	3	0.0008	3	0.0134	3	0.228	4	93.4432333	3	0.04267	3	0.475
5	3	0.0459	3	0.0001	3	0.00537	3	3.18	3	0.00081	3	0.0136	3	0.2283333	16	[93.56]	3	0.04269	3	0.476
6	10	0.046	3	0.0001	3	0.00537	3	3.2	3	0.00082	3	0.0139	3	0.229	4	93.58	3	0.04275	3	0.476
7	3	0.0462	3	0.0002	3	0.00538	3	3.2	3	0.00083	3	0.0139	3	0.229	3	93.6	3	0.04277	3	0.476
8	3	0.0464	3	0.0002	3	0.00538	3	3.2	3	0.00083	3	0.0141	4	0.2296	16	[93.61]	3	0.04279	3	0.477
9	3	0.0466	3	0.0002	3	0.00538	3	3.2	4	0.00083333	3	0.0142	10	0.23	16	[93.64]	3	0.0428	3	0.477
10	14	0.0467	3	0.0002	3	0.0054	3	3.21	3	0.00084	3	0.0142	3	0.23	16	[93.64]	3	0.0428	3	0.477
11	3	0.0468	3	0.0002	3	0.0054	3	3.21	3	0.00085	3	0.0142	3	0.231	16	[93.65]	3	0.04283	3	0.478
12	3	0.0469	3	0.0002	3	0.00541	3	3.21	3	0.00086	3	0.0143	3	0.232	10	93.8833333	3	0.04284	3	0.479
13	3	0.047	3	0.0002	3	0.00542	3	3.21	3	0.00088	3	0.0143	3	0.232			3	0.04288	3	0.479
14	3	0.0471	3	0.0002	3	0.00542	3	3.21	3	0.00088	4	0.014367	3	0.232			3	0.04289	3	0.479
15	3	0.0471	3	0.0002	3	0.00542	3	3.21	3	0.00089	3	0.0144	3	0.232			3	0.0429	3	0.479
16	3	0.0471	3	0.0002	3	0.00543	3	3.21	3	0.00089	3	0.0144	3	0.233			3	0.04292	3	0.479
17	3	0.0472	3	0.0002	3	0.00544	3	3.21	3	0.00089	3	0.0144	3	0.233			3	0.04293	3	0.479
18	3	0.0473	3	0.0002	3	0.00544	3	3.22	14	0.0009	3	0.0147	3	0.233			3	0.04295	3	0.48
19	3	0.0474	3	0.0002	3	0.00545	3	3.22	3	0.0009	3	0.0147	3	0.233			3	0.04295	10	0.48
20	3	0.0475	3	0.0002	3	0.0054667	3	3.22	3	0.00091	3	0.0148	3	0.233			3	0.04304	3	0.48
21	3	0.0476	3	0.0003	3	0.00548	3	3.22	3	0.00094	3	0.0148	3	0.233			3	0.04304	3	0.48
22	3	0.0476	3	0.0003	3	0.00548	3	3.23	3	0.00094	3	0.0149	3	0.234			3	0.04305	3	0.48
23	3	0.0478	3	0.0003	3	0.0055	3	3.23	3	0.00094	3	0.0149	3	0.234			3	0.04305	3	0.48
24	3	0.0478	3	0.0003	3	0.0055	3	3.23	3	0.00094	3	0.0149	3	0.235			3	0.04309	3	0.48
25	3	0.0478	3	0.0003	3	0.0055	3	3.23	3	0.00094	3	0.0149	3	0.235			3	0.0431	3	0.481
26	3	0.0478	3	0.0003	3	0.00554	3	3.23	3	0.00095	3	0.015	3	0.235			3	0.04312	3	0.481
27	3	0.0479	3	0.0003	3	0.00555	3	3.24	3	0.00096	3	0.015	3	0.235			3	0.04315	3	0.481
28	3	0.0479	3	0.0003	3	0.00555	3	3.24	3	0.00096	3	0.015	3	0.235			3	0.04321	14	0.481667
29	4	0.0479	3	0.0003	3	0.00555	3	3.24	3	0.00096	3	0.015	3	0.235			3	4323	3	0.482
30	3	0.0479	3	0.0003	3	0.00556	3	3.24	3	0.00097	4	0.015067	3	0.236			3	0.04323	3	0.482
31	3	0.048	3	0.0003	3	0.00556	3	3.25	3	0.00097	14	0.0151	3	0.236			3	0.04324	3	0.482
32	3	0.0481	3	0.0003	3	0.00556	3	3.25	3	0.00098	3	0.0151	3	0.236			3	0.04325	3	0.482
33	3	0.0481	3	0.0004	3	0.00556	3	3.25	3	0.00098	3	0.0152	3	0.236			3	0.04327	3	0.482
34	3	0.0481	3	0.0004	3	0.00557	3	3.25	3	0.00099	4	0.015233	3	0.236			3	0.04329	3	0.483
35	3	0.0481	3	0.0004	3	0.00557	3	3.25	3	0.00099	3	0.015333	3	0.236			3	0.0433	3	0.483
36	3	0.0482	3	0.0004	3	0.00558	3	3.26	3	0.00099	3	0.0154	3	0.237			3	0.04334	3	0.483
37	3	0.0483	3	0.0004	3	0.00558	3	3.27	3	0.00099	3	0.0155	3	0.237			3	0.04334	3	0.483
38	3	0.0483	3	0.0005	3	0.00558	3	3.28	3	0.00099	3	0.0156	3	0.237			3	0.04338	3	0.483
39	3	0.0484			3	0.0056	3	3.28	3	0.00101	3	0.0156	3	0.237			3	0.04349	3	0.484
40	5	0.048433			3	0.00561	3	3.31	3	0.00105	3	0.0156	3	0.237			3	0.0435	3	0.484
41	3	0.0486			3	0.00561	3	3.32	3	0.00106	3	0.0157	3	0.238			3	0.0435	3	0.484
42	3	0.0486			3	0.00562	1	3.326667	3	0.00106	3	0.0158	3	0.239			3	0.04351	3	0.485
43	3	0.0487			3	0.00566	3	3.33	3	0.00107	3	0.0159	4	0.239167			3	0.04352	3	0.485
44	3	0.0488			3	0.00567	3	3.34	4	0.0011	3	0.0159	3	0.24					3	0.485
45	3	0.0489			3	0.00568	3	3.34	3	0.00111	5	0.0162	3	0.24					3	0.486
46	3	0.0492			3	0.00571	1	3.458567	3	0.00115	3	0.0164	3	0.24					3	0.487
47	3	0.0493			3	0.00574			3	0.00116	3	0.0177	3	0.241					3	0.488
48	3	0.0494			4	0.0058			4	0.0012	3	0.0179	3	0.243					3	0.488
49	3	0.0498			4	0.005967					3	0.0182	3	0.244					3	0.489
50					5	0.006267					3	0.0184	3	0.248					10	0.491667
51																			3	0.494
52																			4	0.499667
Average		0.04751		0.000165		0.00554		3.236		0.000949		0.01495		0.2343		93.574		0.04306		0.4798
Std Dev		0.00070		0.000015		0.00011		0.048		0.000056		0.00024		0.0032		0.031		0.00066		0.0054
H		0.0020		0.00022		0.00075		0.022		0.00038		0.0011		0.0045		0.24		0.0019		0.007
U_1		0.0021		0.00022		0.00076		0.053		0.00039		0.0012		0.0055		0.24		0.0020		0.0086
t-statistic		2.01		2.03		2.01		2.01		2.01		2.01		2.01		2.20		2.02		2.01
U_2		0.0042		0.00045		0.0015		0.11		0.00078		0.0023		0.011		0.52		0.0040		0.017
U_3		0.00060		0.000073		0.00021		0.016		0.00011		0.00033		0.0016		0.15		0.00061		0.0024
Certified		**0.047**		**0.0003**		**0.0055**		**3.24**		**0.0009**		**0.015**		**0.234**		**93.6**		**0.043**		**0.480**
Uncertainty		0.001		0.0001		0.0002		0.04		0.0001		0.001		0.005		0.2		0.001		0.004
Tolerance		0.003		0.0002		0.0008		0.12		0.0004		0.003		0.015		0.5		0.003		0.012

BS 291EE * Code for method Certified values listed as weight percent

Analysis	*	Mo	*	Nb	*	Ni	*	P	*	Pb	*	S	*	Si	*	Sn	*	Ti	*	V
1	3	0.0068	5	0.00038333	3	0.0948	4	0.01763333	5	0.0001	3	0.0097	3	2.0433333	3	0.044	3	0.0146	14	0.0077333
2	3	0.0070	10	0.001	3	0.0951	3	0.01766667	3	0.0001	3	0.0101	4	2.0496667	4	0.04623333	3	0.0146	4	0.0077333
3	3	0.0070	3	0.0022	4	0.0959667	3	0.0179	3	0.0001	3	0.0104	3	2.05	3	0.04643333	3	0.0146	3	0.0079
4	3	0.0071	3	0.0026	3	0.0969	3	0.0182	3	0.0001	3	0.0106	3	2.05	3	0.0471	3	0.0147	3	0.008
5	3	0.0071	4	0.00266667	10	0.097	3	0.0183	3	0.0001	3	0.0106	3	2.05	3	0.0473	3	0.0148	3	0.0081
6	3	0.0071	3	0.0027	3	0.0972	3	0.0184	3	0.0001	3	0.0107	3	2.06	3	0.0475	3	0.0149	3	0.0081
7	4	0.0071	3	0.0029	3	0.0973	3	0.0184	3	0.0001	3	0.011	3	2.06	3	0.0476	3	0.0153	3	0.0081
8	3	0.0072	3	0.003	3	0.0973	4	0.01846667	5	0.00012333	3	0.011	3	2.06	3	0.0476	3	0.0154	3	0.0081
9	3	0.0072	3	0.003	3	0.0977	10	0.0185	4	0.00013333	3	0.011	3	2.06	3	0.0476	3	0.0154	3	0.0081
10	3	0.0072	3	0.003	3	0.0978	3	0.0185	3	0.0002	3	0.0111	3	2.06	3	0.0477	3	0.0155	3	0.0081
11	3	0.0073	3	0.0031	3	0.0978	3	0.0186	5	0.0002	3	0.0111	3	2.06	3	0.0477	3	0.0155	3	0.0081
12	3	0.0073	3	0.0031	4	0.0978333	3	0.0186	3	0.0002	3	0.0112	3	2.06	3	0.0477	3	0.0155	3	0.0081
13	3	0.0073	3	0.0032	3	0.0979	3	0.0186	3	0.0002	3	0.0113	3	2.0633333	3	0.0477	3	0.0156	3	0.0081
14	3	0.0073	3	0.0033	3	0.098	5	0.01866667	9	0.0002	3	0.0114	3	2.07	3	0.0478	3	0.0156	3	0.0081
15	3	0.0074	3	0.0033	3	0.098	3	0.0187	3	0.0002	3	0.0114	3	2.07	3	0.0478	3	0.0156	3	0.0082
16	3	0.0074	3	0.0033	3	0.098	3	0.0188	3	0.0002	3	0.0116	14	2.07	3	0.0478	3	0.0156	3	0.0082
17	3	0.0074	3	0.0033	3	0.098	3	0.0188	3	0.0003	1	0.011667	3	2.07	3	0.0478	3	0.0156	3	0.0082
18	3	0.0074	3	0.0033	3	0.098	14	0.01883333	3	0.0003	3	0.0117	3	2.07	9	0.0479	3	0.0156	3	0.0082
19	3	0.0074	3	0.0033	3	0.0982	3	0.0189	3	0.0003	3	0.0117	3	2.07	3	0.0479	3	0.0156	3	0.0082
20	3	0.0074	3	0.0033	3	0.0982	3	0.0189	3	0.0003	3	0.0117	3	2.07	3	0.0479	3	0.0157	3	0.0082
21	3	0.0074	3	0.0034	3	0.0983	3	0.0189	3	0.0004	3	0.0118	3	2.07	3	0.0479	3	0.0157	3	0.0082
22	3	0.0074	3	0.0034	4	0.098333	3	0.0189	3	0.0004	3	0.0118	3	2.07	3	0.0479	3	0.0157	3	0.0082
23	3	0.0075	3	0.0034	3	0.0984	3	0.0189	3	0.0004	3	0.0119	17	2.070267	3	0.0479	3	0.0157	3	0.0082
24	3	0.0075	3	0.0035	3	0.0984	3	0.0189	3	0.0004	3	0.012	3	2.08	3	0.0479	3	0.0157	3	0.0082
25	3	0.0075	3	0.0035	3	0.0984	3	0.019	3	0.0004	3	0.0122	3	2.08	3	0.048	3	0.0157	3	0.0082
26	3	0.0075	3	0.0035	3	0.0985	3	0.019	3	0.0004	3	0.0122	3	2.08	3	0.048	3	0.0158	3	0.0082
27	3	0.0075	3	0.0035	3	0.0985	3	0.019	3	0.0004	3	0.0122	3	2.09	3	0.0481	3	0.0158	3	0.0083
28	3	0.0075	3	0.0035	3	0.0986	3	0.019	3	0.0004	3	0.0122	3	2.09	3	0.0481	3	0.0158	3	0.0083
29	3	0.0075	3	0.0035	3	0.0987	3	0.019	3	0.0005	3	0.0123	3	2.09	3	0.0481	3	0.0158	3	0.0083
30	3	0.0075	3	0.0035	3	0.0987	3	0.0191	3	0.0005	3	0.0123	3	2.09	3	0.0481	3	0.0158	3	0.0083
31	3	0.0076	3	0.0036	3	0.0989	3	0.0191	3	0.0005	3	0.0123	3	2.09	3	0.0482	3	0.0158	3	0.0083
32	3	0.0076	3	0.0036	14	0.098967	3	0.0191	3	0.0005	3	0.0123	3	2.09	3	0.0482	4	0.0158	3	0.0083
33	3	0.0076	3	0.0037	3	0.099	3	0.0191	3	0.0005	3	0.0123	3	2.09	3	0.0482	14	0.015833	3	0.0083
34	3	0.0076	3	0.0037	3	0.0992	3	0.0191	3	0.0005	3	0.012333	3	2.09	3	0.0482	3	0.0159	3	0.0083
35	3	0.0076	3	0.0037	3	0.0993	3	0.0192	3	0.0005	3	0.0125	3	2.09	3	0.0482	3	0.0159	3	0.0083
36	3	0.0077	3	0.0038	3	0.0995	3	0.0192	3	0.0005	3	0.0125	3	2.09	3	0.0483	3	0.0159	3	0.0083
37	3	0.0077	3	0.0038	3	0.0996	3	0.0192	3	0.0005	3	0.0126	3	2.1	3	0.0483	3	0.0159	3	0.0084
38	3	0.0077	3	0.0038	3	0.0996	3	0.0193	3	0.0005	3	0.0126	3	2.1	3	0.0483	3	0.0159	3	0.0084
39	3	0.0077	3	0.0038	3	0.0996	3	0.0193	3	0.0005	3	0.0127	4	2.10	3	0.0483	3	0.0159	3	0.0084
40	3	0.0077	3	0.0038	3	0.0996	3	0.0193	3	0.0005	3	0.0127	3	2.1	3	0.0485	3	0.016	3	0.0084
41	3	0.0077	3	0.004	3	0.0996	3	0.0194	10	0.0006	1	0.012767	3	2.1	3	0.0485	10	0.016	3	0.0084
42	5	0.007733	3	0.004	3	0.0996	3	0.0194	3	0.0006	3	0.0128	3	2.1	3	0.0485	3	0.016	3	0.0084
43	3	0.0078	3	0.0041	3	0.0999	3	0.0195	3	0.0006	3	0.0128	3	2.11	3	0.0486	4	0.0161	3	0.0085
44	3	0.0078	3	0.0043	3	0.0999	3	0.0195	3	0.0006	3	0.0128	3	2.11	3	0.0486	3	0.0161	4	0.0085
45	3	0.008	3	0.0043	3	0.1	3	0.0196	3	0.0006	10	0.013	3	2.11	3	0.0488	3	0.0162	3	0.0085
46	3	0.008333	3	0.0045	3	0.1003	3	0.0196	3	0.0006	3	0.0134	3	2.11	10	0.049	3	0.0162	3	0.0085
47	14	0.008367	3	0.0045	3	0.1004	3	0.0197	3	0.0007	3	0.0138	3	2.12	3	0.049	3	0.0162	5	0.008533
48	4	0.0088			3	0.1009	3	0.0198	3	0.0007	3	0.0147	3	2.12	3	0.049	4	0.016233	5	0.008567
49	10	0.009			3	0.101	3	0.0198	3	0.0007	1	0.014733	3	2.12	3	0.0492	3	0.0163	3	0.0086
50					3	0.103333	4	0.0198					3	2.12	4	0.0503	3	0.0164	10	0.0087
51							10	0.020							4	0.050467	3	0.0164		
52							3	0.0202							10	0.052433	5	0.017367		
Average		0.00747		0.00341		0.0987		0.01903		0.000136		0.01187		2.071		0.04804		0.01569		0.00823
Std Dev		0.00016		0.00012		0.0014		0.00029		0.000011		0.00018		0.015		0.00070		0.00024		0.00017
H		0.00085		0.000615		0.0028		0.001275		0.00021		0.0010		0.016		0.0020		0.001168		0.00088
U_1		0.00086		0.00063		0.0032		0.0013		0.00021		0.0010		0.022		0.0021		0.0012		0.00090
t-statistic		2.01		2.01		2.01		2.01		2.01		2.01		2.01		2.01		2.01		2.01
U_2		0.0017		0.0013		0.0064		0.0026		0.00043		0.0021		0.045		0.0042		0.0024		0.0018
U_3		0.00025		0.00018		0.00090		0.00036		0.000061		0.00030		0.0063		0.00058		0.00033		0.00026
Certified		**0.0075**		**0.0034**		**0.099**		**0.0190**		**0.0004**		**0.0119**		**2.08**		**0.0480**		**0.0157**		**0.0082**
Uncertainty		0.0002		0.0007		0.001		0.0004		0.0002		0.0009		0.02		0.0006		0.0003		0.0003
Tolerance		0.0008		0.0021		0.003		0.0016		0.0003		0.0027		0.06		0.0018		0.0012		0.0012

BS 291EE * Code for method Certified values listed as weight percent

Analysis	*	Zr
1	10	0.001
2	5	0.0010467
3	4	0.0018
4	3	0.0019
5	3	0.0019
6	3	0.002
7	3	0.002
8	3	0.002
9	3	0.0021
10	3	0.0021
11	3	0.0021
12	3	0.0021
13	3	0.0021
14	3	0.0022
15	3	0.0022
16	3	0.0022
17	3	0.0022
18	3	0.0022
19	3	0.0022
20	3	0.0022
21	3	0.0022
22	3	0.0022
23	3	0.0023
24	3	0.0023
25	3	0.0023
26	3	0.0023
27	3	0.0023
28	3	0.0024
29	3	0.0024
30	3	0.0024
31	3	0.0024
32	3	0.0024
33	3	0.0024
34	3	0.0024
35	3	0.0025
36	3	0.0025
37	3	0.0025
38	3	0.0025
39	3	0.0025
40	3	0.0025
41	3	0.0025
42	3	0.0025
43	3	0.0026
44	3	0.0027
45	3	0.0027
46	3	0.0028
47	3	0.0028
Average		0.00230
Std Dev		0.00010
H		0.00053
U_1		0.00054
t-statistic		2.01
U_2		0.0011
U_3		0.00016
Certified		**0.0023**
Uncertainty		0.0002
Tolerance		0.0008

BS 291EE * Code for method Informational values listed as weight percent

Analysis	*	Co	*	Sb	*	W
1	3	0.001	10	0.012	3	0.0011
2	3	0.001			3	0.0014
3	3	0.0011			3	0.0015
4	3	0.0011			3	0.0017
5	3	0.0013			3	0.0019
6	3	0.0017			4	0.0019333
7	3	0.0017			3	0.002
8	3	0.0017			3	0.0022
9	3	0.002			3	0.0023
10	3	0.0021			3	0.0023
11	3	0.0024			4	0.0024333
12	3	0.0025			3	0.0025
13	3	0.0026			10	0.0025
14	3	0.0026			3	0.0026
15	3	0.0028			3	0.0026
16	14	0.0029667			3	0.0026
17	3	0.0029667			3	0.0027
18	3	0.003			3	0.0027
19	4	0.003			3	0.0027
20	3	0.0031			3	0.0028
21	3	0.0032			3	0.0029
22	3	0.0032			3	0.003
23	3	0.0033			3	0.003
24	10	0.0033			3	0.003
25	3	0.0035			3	0.003
26	3	0.0036			3	0.001
27	5	0.003667			3	0.0032
28	3	0.0037			3	0.0032
29	3	0.0038			3	0.0032
30	3	0.004			3	0.0032
31	4	0.004133			3	0.0033
32	5	0.004233			3	0.0034
33	3	0.0043			3	0.0035
34	3	0.0045			3	0.0035
35	3	0.0045			3	0.0035
36	3	0.0046			3	0.0037
37	3	0.0047			3	0.0038
38	3	0.0048			3	0.0038
39	3	0.0048			3	0.0038
40	3	0.0051			3	0.0038
41	3	0.0051			3	0.0039
42	3	0.0059			3	0.0041
43	3	0.0059			3	0.0042
44					3	0.0044
45					3	0.0044
46					3	0.0047
47					3	0.0048
Average		0.0033		0.01		0.0030
Std Dev		0.0078		0.28		0.0066
H		0.0006		0.00		0.0006
U_1		0.0078		0.28		0.0067
t-statistic		2.02		12.71		2.01
U_2		0.016		3.53		0.013
U_3		0.0024		3.53		0.0020
Informaitona		(0.0033)		(0.01)		(0.0030)

For each element, in accordance with the requirements of ISO Guides 34 and 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 it's 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:

$$C_L = \sqrt{S_L^2 + U_L^2} \qquad W_L = \frac{1}{C_L^2} \qquad A = \frac{\sum_{i=1}^{n} W_L M_L}{\sum_{i=1}^{n} W_L} \qquad S = \frac{1}{\sqrt{\sum_{i=1}^{n} W_L}} \qquad U_1 = \sqrt{H^2 + S^2} \qquad U_2 = t \times U_1 \qquad U_3 = \frac{U_2}{\sqrt{n}}$$

*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.

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
17 Wet

ICP = Inductively Coupled Plasma GF = Graphite Furnace GD = Glow Discharge
DCP = Direct Current Plasma HG = Hydride Generation

Lab Name	Location	Registrar	Accreditation
NSL Analytical	Cleveland, OH	ANAB	17025
Exova	Santa Fe Spring, CA	A2LA	17025
Laboratory Testing, Inc.	Hatfield, PA	PRI	17025
Dirats Laboratories	Westfield,MA	ANAB	17025
Luvak Inc.	Boylston, MA	PRI	17025
Instytut Metalurgii Zelaza	Gliwice, Poland	PCA	17025
Brammer Standard Company, Inc.	Houston, TX	A2LA	17025, 17034

A2LA = American Association for Laboratory Accreditation
ANAB = ANSI-ASQ National Accreditation Board
PCA = Polish Center For Accreditation
PRI =Performance Review Institute

Analysis: Chemical analyses were made on solid pieces and chips 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: 11XC1N, 11XC4Q, 11XC6U, 11XSG1A; AR 306, 323, 673; BAS 464/1; BS CI4, LF2B, 8, 29, 291, 291BB, 291DJ, 1026; CKD 234, 238, 239; CZ 20034 14A; LECO 501-024;SPL 2a, 3a, 8a, 15a; SRM 7G, 9F, 16F, 33D, 160B, 342A, 361, 362, 363, 365, 1140, 3109A, 3113, 8620C.

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 — BS CI4, 8, 29, 291, 291BB, 291DJ; CZ 20034 14A; SRM 1140.

Validity statement: 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 291EE 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 cast stock for this CRM was produced by Shijiazhuang Trump Scientific Co, LTD.; Shijiazhuang, China.

Form: This CRM is machined in the form of a disc, approximately 35 mm in diameter and ~ 30 mm thick by Brammer Standard Company, Inc.

Use: 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 certified area of each disc is the portion extending upward 25 mm from the analytical surface.

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.

Certificate Number: The unique identification number for this certificate of analysis is 291EE-022818. You may obtain information on revisions of certificates from the internet at.

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:

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14603 Benfer Road
Houston, Texas 77069-2895 USA
Phone: (281) 440-9396Web: www.brammerstandard.com
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Email: contact@brammerstandard.com

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 (Certificate Number 656.02)

Brammer Standard Company's Chemical Laboratory is accredited by A2LA to ISO Standard 17025. (Certificate Number 656.01)

By Certificate Number 10539, 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 17025:2005 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 35:2006 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 February 28, 2018.

Beau R. Brammer

President