

# Brammer Standard Company, Inc.

## Certificate of Analysis

### BS 291GF

Certified Reference Material for Chill Cast Iron

	Certified Value <sup>1</sup>	Estimate of Uncertainty <sup>2</sup>	Certified Values <sup>3</sup>	Certified Value <sup>1</sup>	Estimate of Uncertainty <sup>2</sup>
<b>Al</b>	<b>0.040</b>	0.004	<b>Mo</b>	<b>0.031</b>	0.003
<b>As</b>	<b>0.0052</b>	0.0008	<b>N</b>	<b>0.0053</b>	0.0007
<b>B</b>	<b>0.017</b>	0.001	<b>Nb</b>	<b>0.0036</b>	0.0009
<b>C</b>	<b>3.33</b>	0.05	<b>Ni</b>	<b>0.098</b>	0.007
<b>Ca</b>	<b>0.0010</b>	0.0004	<b>O</b>	<b>0.0009</b>	0.0003
<b>Co</b>	<b>0.0039</b>	0.0007	<b>P</b>	<b>0.034</b>	0.002
<b>Cr</b>	<b>0.070</b>	0.003	<b>S</b>	<b>0.014</b>	0.001
<b>Cu</b>	<b>0.231</b>	0.007	<b>Si</b>	<b>2.30</b>	0.08
<b>Fe</b>	<b>93.14</b>	0.09	<b>Sn</b>	<b>0.049</b>	0.004
<b>Mg</b>	<b>0.041</b>	0.001	<b>Ti</b>	<b>0.028</b>	0.002
<b>Mn</b>	<b>0.497</b>	0.009	<b>V</b>	<b>0.033</b>	0.001
	Reference Value <sup>1</sup>	Estimate of Uncertainty <sup>2</sup>	Reference Values <sup>3,4</sup>	Reference Value <sup>1</sup>	Estimate of Uncertainty <sup>2</sup>
<b>Pb</b>	<b>0.0002</b>	0.0001	<b>W</b>	<b>0.003</b>	0.002
<b>Sb</b>	<b>0.006</b>	0.002	<b>Zr</b>	<b>0.0018</b>	0.0009

### Informational Values<sup>3,5</sup>

H (0.0008)

<sup>1</sup> 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 5 for more information on its calculation.

<sup>2</sup> For each element, the uncertainty listed is based on a statistical evaluation of the contributions of homogeneity and the interlaboratory testing program. See page 5 for more information on its calculation.

<sup>3</sup> Values are given in weight percent. Values in brackets are reported by difference.

<sup>4,5</sup> Reference/Informational values 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.

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\* Code for method      Certified values listed as weight percent

Analysis	*	Al	*	As	*	B	*	C	*	Ca	*	Co	*	Cr	*	Cu	*	Fe	*	Mg
1	11	0.039	4	0.0043667	4	0.0149562	1	3.28	4	0.000633333	11	0.0029	3	0.067	4	0.2246667	14	93.0	11	0.041
2	11	0.040	10	0.0044667	4	0.0158667	3	3.29	14	0.0008	11	0.003	4	0.0672935	3	0.2256667	16	93.07	11	0.041
3	11	0.040	5	0.0045	4	0.0159667	1	3.305	11	0.0009	5	0.0032	14	0.0688333	3	0.226	16	93.074	11	0.041
4	11	0.040	9	0.0045333	4	0.016	3	3.31	3	0.001	11	0.0032	8	0.069	3	0.226	16	93.1	11	0.041
5	11	0.040	5	0.0048333	11	0.0161	3	3.32	11	0.001	11	0.0032	4	0.069	3	0.226	16	93.11	11	0.041
6	11	0.041	4	0.0049333	11	0.0162	3	3.32	3	0.001	3	0.0034	4	0.0693333	3	0.226	16	93.12	11	0.041
7	11	0.041	4	0.0050312	11	0.0162	11	3.32	4	0.001063333	3	0.0035	11	0.0694	3	0.226	16	93.127	11	0.041
8	11	0.041	5	0.0051	11	0.0162	11	3.32	4	0.0011	3	0.0035	11	0.0694	4	0.2290557	4	93.1333	11	0.041
9	11	0.041	5	0.0052067	11	0.0162	11	3.32	3	0.0011	5	0.0035333	3	0.0696667	3	0.230	16	93.14	11	0.041
10	11	0.041	3	0.0056	3	0.0165	1	3.32	11	0.0011	3	0.0035333	11	0.0698	4	0.230	16	93.1433	11	0.041
11	11	0.041	3	0.0059	3	0.0166	1	3.3204	3	0.0012	4	0.0036	4	0.0698667	4	0.2301667	16	93.15	11	0.041
12	11	0.041	3	0.0059	3	0.0166	11	3.33	11	0.0012	5	0.0037	11	0.0699	5	0.2313333	16	93.15	11	0.041
13	11	0.041	10	0.006	3	0.0167	11	3.33	11	0.0012	11	0.0037	11	0.0699	4	0.2315667	16	93.16	11	0.041
14	11	0.041	3	0.0065	3	0.017	1	3.330667	4	0.001233333	4	0.0037667	3	0.0702	8	0.232	16	93.16	11	0.041
15	11	0.041			3	0.017	1	3.34	3	0.0014	14	0.0038	3	0.0702333	10	0.232	16	93.17	11	0.041
16	11	0.041			14	0.0180667	3	3.3433333	4	0.0014	4	0.004	3	0.0705	4	0.2323667	16	93.1739	11	0.041
17	11	0.042			4	0.0182667	1	3.3466667	4	0.001466667	10	0.004	3	0.0705	4	0.2324667	16	93.1793	11	0.041
18	11	0.043			5	0.0185667	1	3.347			4	0.0040667	4	0.0705667	14	0.233	16	93.19	11	0.041
19	11	0.043			4	0.0191	3	3.35			3	0.0042	3	0.071	4	0.2366667	16	93.228	11	0.041
20					3	0.0196667	4	3.3503763			4	0.0046	3	0.071	4	0.237	3	93.25		
21					4	0.0196667	4	3.3506667			3	0.0048	5	0.0710333	11	0.237				
22							1	3.3566667			3	0.005	4	0.0711	11	0.237				
23							3	3.37			4	0.005267	3	0.0717	11	0.237				
24							3	3.37			3	0.0055	10	0.072	11	0.238				
25							1	3.383					4	0.0720667	11	0.238				
26							1	3.3886					10	0.0726	3	0.24				
27													4	0.0726667						
28													4	0.0742333						
<b>Average</b>		0.04091		0.005205		0.01694		3.3314		0.000981		0.003874		0.0702		0.2313		93.141		0.04100
<b>Std Dev</b>		0.00094		0.000085		0.00043		0.0051		0.000052		0.000065		0.0013		0.0023		0.023		0.00094
<b>H</b>		0.002056		0.0008185		0.001367		0.021721		0.000423023		0.000724		0.002669		0.004882		0.18443		0.002059
<b>U<sub>1</sub></b>		0.0023		0.00082		0.0014		0.022		0.00043		0.00073		0.0030		0.0054		0.19		0.0023
<b>t-statistic</b>		2.10		2.1603687		2.09		2.06		2.119905297		2.07		2.05		2.06		2.09302		2.10
<b>U<sub>2</sub></b>		0.0047		0.0018		0.0030		0.046		0.00090		0.0015		0.0061		0.011		0.39		0.0048
<b>U<sub>3</sub></b>		0.0011		0.00048		0.00065		0.0090		0.00022		0.00031		0.0011		0.0022		0.087		0.0011
<b>Certified</b>		<b>0.040</b>		<b>0.0052</b>		<b>0.017</b>		<b>3.33</b>		<b>0.0010</b>		<b>0.0039</b>		<b>0.070</b>		<b>0.231</b>		<b>93.14</b>		<b>0.041</b>
<b>Uncertainty</b>		0.004		0.0008		0.001		0.05		0.0004		0.0007		0.003		0.007		0.09		0.001
<b>Tolerance</b>		0.012		0.0024		0.003		0.15		0.0009		0.0021		0.009		0.021		0.39		0.003

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\* Code for method

Certified values listed as weight percent

Analysis	*	Mn	*	Mo	*	N	*	Nb	*	Ni	*	O	*	P	*	S	*	Si	*	Sn
1	8	0.486	3	0.0248	4	0.0045333	5	0.0018	3	0.091066667	2	0.000375	4	0.0308333	3	0.0103	10	2.2	4	0.044995
2	3	0.486	3	0.0275	2	0.0047767	14	0.0021333	4	0.0917	2	0.0006333	10	0.0312667	3	0.0121	3	2.22	4	0.0462667
3	3	0.487	4	0.028	2	0.0048	4	0.0026	4	0.0939	2	0.0007333	4	0.0318396	3	0.0126	3	2.25	11	0.0469
4	4	0.4892667	3	0.0288	2	0.0049	11	0.0028	3	0.095	2	0.0008	4	0.0323333	3	0.0127	6	2.276	3	0.0476667
5	3	0.491	3	0.029	2	0.005	11	0.003	4	0.096866667	2	0.0008667	4	0.0330333	1	0.0127667	4	2.28797	11	0.0477
6	3	0.494	3	0.0298	2	0.0050067	11	0.003	3	0.0969	2	0.001	3	0.0331	3	0.013	6	2.29	3	0.0478
7	3	0.494	3	0.0299	2	0.0050333	11	0.003	3	0.0969	2	0.0010	4	0.0335667	4	0.0133667	4	2.29004	3	0.0479
8	4	0.4941667	4	0.0299667	2	0.0054667	11	0.0031	8	0.097	2	0.0011033	3	0.0338	1	0.0135	3	2.3	3	0.048
9	3	0.495	8	0.03	2	0.00555	3	0.0034667	3	0.097	2	0.00115	4	0.0338333	1	0.0136	11	2.3	11	0.048
10	3	0.496	4	0.0305667	2	0.0059333	4	0.0040	3	0.0972	2	0.0012333	4	0.0339667	1	0.0136667	11	2.3	4	0.048
11	7	0.4963333	3	0.031	2	0.0060333	3	0.004	3	0.0974	4	0.0014433	10	0.034	3	0.0137	11	2.3	4	0.0482333
12	11	0.497	10	0.0317333	2	0.0066	3	0.0044	4	0.097766667	2	0.0021333	3	0.034	3	0.0138	4	2.30057	3	0.0483
13	11	0.498	10	0.032			3	0.0045	3	0.0978			4	0.0341	1	0.014	3	2.30333	11	0.0484
14	11	0.498	11	0.0321			3	0.0046	14	0.097833333			11	0.0341	1	0.0141667	4	2.304	9	0.0484667
15	14	0.4986667	11	0.0322			3	0.0046	11	0.0979			4	0.0341333	1	0.0143333	4	2.309	3	0.0485
16	11	0.499	4	0.0322			4	0.0058	11	0.0979			11	0.0345	1	0.0143967	4	2.30997	4	0.0485333
17	10	0.499	11	0.0322					10	0.098			3	0.0346	1	0.0146	11	2.31	3	0.0486
18	4	0.4993333	4	0.0322837					4	0.098033333			11	0.0346	1	0.0148333	3	2.31	10	0.049
19	11	0.5000	11	0.0323					5	0.098066667			11	0.0348	11	0.0149	11	2.31	4	0.0501
20	3	0.5	11	0.0324					11	0.0983			13	0.035	1	0.0149	3	2.31	11	0.0501
21	3	0.50	3	0.0326667					11	0.0986			4	0.0350	11	0.0149	4	2.3125	4	0.0515667
22	4	0.50	14	0.0329					11	0.0992			3	0.035	11	0.0152	4	2.31333	3	0.0524667
23	4	0.5000667	4	0.0331					4	0.099333333			11	0.0353	11	0.0152	3	2.32	10	0.0527333
24	4	0.5008638	4	0.0336333					7	0.099666667			3	0.0354	11	0.0155	4	2.32067	4	0.0535333
25	4	0.5053333	4	0.0341					3	0.10			3	0.036	4	0.0163184	3	2.33	4	0.0540333
26	10	0.5066667	4	0.0343					4	0.10033333			4	0.0360667	1	0.0163667	14	2.33667	4	0.0546667
27	4	0.508	5	0.0349					4	0.101			3	0.0371			3	2.34	5	0.0557667
28			4	0.0363333					4	0.10174540							4	2.37333		
29									4	0.10366667										
Average		0.496989		0.031453		0.005303		0.003550		0.0979		0.000949		0.034121		0.014028		2.3004		0.0491
Std Dev		0.000061		0.000060		0.000091		0.000079		0.0015		0.000093		0.000061		0.000062		0.0050		0.0011
H		0.007341		0.001817		0.0008249		0.0006988		0.003146		0.0004178		0.001887		0.001256		0.01745		0.002244
U <sub>1</sub>		0.0073		0.0018		0.00083		0.00070		0.0035		0.00043		0.0019		0.0013		0.018		0.0025
t-statistic		2.06		2.05		2.2009852		2.1314495		2.05		2.2009852		2.06		2.06		2.05		2.06
U <sub>2</sub>		0.015		0.0037		0.0018		0.0015		0.0072		0.00094		0.0039		0.0026		0.037		0.0051
U <sub>3</sub>		0.0029		0.00070		0.00053		0.00037		0.0013		0.00027		0.00075		0.00051		0.0070		0.00099
Certified		<b>0.497</b>		<b>0.031</b>		<b>0.0053</b>		<b>0.0036</b>		<b>0.098</b>		<b>0.0009</b>		<b>0.034</b>		<b>0.014</b>		<b>2.30</b>		<b>0.049</b>
Uncertainty		0.009		0.003		0.0007		0.0009		0.007		0.0003		0.002		0.001		0.08		0.004
Tolerance		0.027		0.009		0.0021		0.0027		0.021		0.0008		0.006		0.003		0.24		0.012

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\* Code for method

Certified values listed as weight percent

Analysis	*	Ti	*	V
1	4	0.0255333	4	0.0297
2	3	0.0264	3	0.0319667
3	3	0.0264	4	0.0320667
4	3	0.0264	11	0.0323
5	3	0.0264	4	0.0323211
6	4	0.0265	5	0.0323333
7	3	0.0267	11	0.0324
8	3	0.027	11	0.0324
9	3	0.027	11	0.0324
10	4	0.027	11	0.0325
11	4	0.0271072	3	0.0326
12	11	0.0275	4	0.0326667
13	4	0.0277333	4	0.0328333
14	5	0.0278	14	0.033
15	11	0.0278	3	0.033
16	3	0.028	3	0.033
17	10	0.028	4	0.0330667
18	11	0.0282	3	0.0332
19	11	0.0282	3	0.0334
20	11	0.0284	4	0.0334667
21	4	0.0287667	3	0.0336667
22	4	0.0287667	4	0.0336667
23	14	0.0288	3	0.0338
24	10	0.0298333	7	0.0339
25	4	0.0313	4	0.0339
26	4	0.0316	10	0.034
27	4	0.034	4	0.034
28			10	0.0369
Average		0.028042		0.0330
Std Dev		0.000061		0.00076
H		0.001722		0.001858
U <sub>1</sub>		0.0017		0.0020
t-statistic		2.06		2.05
U <sub>2</sub>		0.0035		0.0041
U <sub>3</sub>		0.00068		0.00078
Certified		<b>0.028</b>		<b>0.033</b>
Uncertainty		0.002		0.001
Tolerance		0.006		0.003

**BS 291GF**

\* Code for method

Reference values listed as weight percent

Analysis	*	Pb	*	Sb	*	W	*	Zr
1	5	0.00002	3	0.0011	5	0.0012333	5	0.00039
2	11	0.00009	3	0.0025	5	0.0013633	3	0.0011
3	11	0.0001	3	0.004	5	0.0018667	5	0.0011267
4	11	0.0001	4	0.0048333	11	0.002	3	0.0012
5	5	0.0001	4	0.005	14	0.0021667	3	0.0012
6	3	0.0001	4	0.006	11	0.0022	3	0.0013
7	5	0.0001	3	0.0063	11	0.0023	3	0.0013
8	11	0.0002	9	0.0071667	11	0.0023	4	0.0014
9	4	0.0003	5	0.0072	11	0.0027	4	0.0014667
10	9	0.0010	10	0.0074333	10	0.0034	4	0.0020333
11			5	0.0083333	4	0.0035667	10	0.0021
12			5	0.00894	3	0.0036667	4	0.0022
13					4	0.004	11	0.0022
14					4	0.0040333	11	0.0027
15					3	0.0046	11	0.003
16					3	0.0048	11	0.0031
17					3	0.0053	11	0.0031
18					3	0.0053		
19					3	0.0056		
20								
Average		0.00022		0.005734		0.003284		0.001819
Std Dev		0.00011		0.000091		0.000073		0.000077
H		0.00025		0.0008524		0.000677		0.0005352
U <sub>1</sub>		0.00027		0.00086		0.00068		0.00054
t-statistic		2.26		2.2009852		2.100922		2.1199053
U <sub>2</sub>		0.00061		0.0019		0.0014		0.0011
U <sub>3</sub>		0.00019		0.00054		0.00033		0.00028
Reference		<b>0.0002</b>		<b>0.006</b>		<b>0.003</b>		<b>0.0018</b>
Uncertainty		0.0001		0.002		0.002		0.0009
Tolerance		0.0001		0.005		0.002		0.0017



Lab Name	Location	Registrar	Accreditation
Brammer Standard Company, Inc.	Houston, TX	A2LA	17025, 17034
Jey Swen Enterprises, Co.	Koahsiung, Taiwan		
NSL Analytical	Cleveland, OH	ANAB	17025
Elemental Analysis, Inc.	Lexington, KY	A2LA	17025
Vitkovice Testing Center	Hulvaky, Ostrava	Czech Accreditation Institute	17025
Dirats Laboratories	Westfield, MA	ANAB	17025
Element Materials Technology	Glendale Heights, IL	A2LA	17025
TUV Rheinland Pvt Ltd	Bangalore, India	NABL	17025
Anderson Laboratories, Inc.	Greendale, WI	A2LA	17025
Instytut Metalurgii Zelaza	Gliwice, Poland	PCA	17025
Laboratory Testing, Inc.	Hatfield, PA	PRI	17025
Luvak Inc.	Boylston, MA	PRI	17025
National Analysis Center For Iron And Steel	Beijing, China	CNAS	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

**Analysis:** 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: 12X3490, 12X43400A, 12X61500A; AR 115C, 307, 614A, 631, 644, 645, 647, 655, 659, 662, 668, 673, 870, 882, 892, 960, 1648, 1651, 1652; BAS 236, 434, 451, 464/1; BS LE 204, 6A, 54J, 55G, 56H, 61G, 65H, 73B, 75C, 286CA, 286CB, 291CB, 291DG, 291FF, 291FH, 300, 1009, 1020, 1026, 1045, 1762, 4340A, 8620E, 8740; CKD 181A, 227, 228, 230, 234, 244C, 249C; CZ 2015A; DSZU CA01A, CA012, CA013, CA021; ECRM 85-1, 86-1, 87-1, 195-1, 479-1, 480-1; IARM 28K, 30C, 38A, 156A; IMZ 90/1, 112, 112A, 114A; IPT 12A, 17A, 31, 97; JSS 171-5; LECO 501-024, 501-503, 501-504, 501-505, 501-529, 501-646, 501-919, 502-712, 502-856, 502-870, 502-889, 502-903, 502-913, 502-947; NCS NS 11019; SPL 1B, 3A, 6A, 8A, 14A, 36A; SRM C2425A, 5L, 7G, 16F, 41, 82B, 125A, 153, 160B, 342A, 361, 363, 365, 892, 1269.

**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 6A, 291CB, 291DG, 291FF; SPL 36A; SRM C2425A.

**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 291GF 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 JeySwen; Tianjin, China.

**Form:** This CRM is machined in the form of a disc approximately 33-35mm in diameter and 28-32 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 several mm inward from each surface.

Note: Shrinkage cavities may appear in the top portion of some discs. These cavities are normal and will not affect the certified portion of the disc.]

**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 291GF-110722. You may obtain information on revisions of certificates from the internet at [www.brammerstandard.com](http://www.brammerstandard.com).

**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  
Houston, Texas 77069-2895 USA

**Phone: (281) 440-9396**

**Web: [www.brammerstandard.com](http://www.brammerstandard.com)**

**Fax: (281) 440-4432**

**Email: [contact@brammerstandard.com](mailto: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](http://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](http://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 November 7, 2022.

Beau R. Brammer  
President