

Brammer Standard Company, Inc.

Certificate of Analysis SPL CZ 2015B-2024B

Certified Reference Material

Certified Values ³							
Sample	Element	Certified Value ¹	Estimate of Uncertainty ²	Sample	Element	Certified Value ¹	Estimate of Uncertainty ²
2015B	C	1.99	0.01	2020B	C	3.52	0.03
2015B	S	0.017	0.001	2020B	S	0.043	0.002
2016B	C	2.15	0.02	2021B	C	3.80	0.03
2016B	S	0.0047	0.0007	2021B	S	0.043	0.002
2017B	C	2.57	0.02	2022B	C	3.86	0.03
2017B	S	0.095	0.003	2022B	S	0.085	0.002
2018B	C	3.07	0.02	2023B	C	4.06	0.03
2018B	S	0.014	0.001	2023B	S	0.114	0.003
2019B	C	3.43	0.03	2024B	C	4.40	0.03
2019B	S	0.017	0.001	2024B	S	0.047	0.002

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 3 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 3 for more information on its calculation.

³ Values are given in weight percent.

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	* 2015B C	* 2015B S	* 2016B C	* 2016B S	* 2017B C	* 2017B S	* 2018B C	* 2018B S	* 2019B C	* 2019B S
1	1 1.97	1 0.0155	1 2.128	1 0.00362	1 2.546	1 0.09032	1 3.0052	1 0.01274	1 3.374	1 0.01496
2	1 1.9734	1 0.0157	1 2.1282	1 0.00402	1 2.556	1 0.09156	1 3.036	1 0.01292	1 3.398	1 0.01498
3	1 1.976	1 0.0157	1 2.1368	1 0.00406	1 2.5572	1 0.09168	1 3.0502	1 0.01326	1 3.402	1 0.01526
4	1 1.978	1 0.01614	1 2.137	1 0.00418	1 2.5636	1 0.09232	1 3.052	1 0.01334	1 3.4108	1 0.01576
5	1 1.9834	1 0.01636	1 2.1388	1 0.00432	1 2.5704	1 0.09286	1 3.0552	1 0.01344	1 3.4118	1 0.01586
6	1 1.9854	1 0.01638	1 2.1392	1 0.00456	1 2.5734	1 0.09396	1 3.06	1 0.01364	1 3.4188	1 0.016
7	1 1.9896	1 0.01656	1 2.1422	1 0.00462	1 2.574	1 0.09398	1 3.0604	1 0.01366	1 3.4236	1 0.01624
8	1 1.9904	1 0.01684	1 2.1444	1 0.00468	1 2.575	1 0.09402	1 3.0616	1 0.01366	1 3.4242	1 0.01672
9	1 1.9938	1 0.01692	1 2.148	1 0.00476	1 2.576	1 0.09448	1 3.0662	1 0.01366	1 3.4244	1 0.01672
10	1 1.994	1 0.0174	1 2.1502	1 0.00506	1 2.5762	1 0.09448	1 3.0678	1 0.01404	1 3.4298	1 0.01672
11	1 1.9948	1 0.01754	1 2.1526	1 0.00522	1 2.5766	1 0.0956	1 3.07	1 0.0143	1 3.4326	1 0.01678
12	1 1.998	1 0.01768	1 2.153	1 0.0053	1 2.5774	1 0.09588	1 3.072	1 0.0151	1 3.4336	1 0.01694
13	1 1.9992	1 0.01776	1 2.1624	1 0.0053	1 2.5798	1 0.09588	1 3.0816	1 0.01524	1 3.46	1 0.01736
14	1 2.001	1 0.01816	1 2.1662	1 0.0059	1 2.5818	1 0.09672	1 3.0848	1 0.01534	1 3.4614	1 0.01756
15	1 2.0058	1 0.01838	1 2.1772		1 2.5846	1 0.0982	1 3.091	1 0.01596	1 3.464	1 0.01862
16	1 2.0252		1 2.18		1 2.5854	1 0.10142	1 3.0922		1 3.469	1 0.01968
17	1 2.042		1 2.1824		1 2.616					
18										
Average	1.994	0.01685	2.151	0.004686	2.575	0.0946	3.068	0.01397	3.427	0.01657
Std Dev	0.024	0.00046	0.026	0.000085	0.031	0.0017	0.036	0.00038	0.043	0.00044
H	0.016052	0.001364	0.016778	0.000783	0.018646	0.003093	0.020682	0.001254	0.022091	0.001354
U ₁	0.029	0.0014	0.031	0.00079	0.036	0.0035	0.042	0.0013	0.048	0.0014
t-statistic	2.12	2.14	2.12	2.16	2.12	2.13	2.11	2.14	2.13	2.13
U ₂	0.062	0.0031	0.066	0.0017	0.077	0.0075	0.088	0.0028	0.010	0.0030
U ₃	0.015	0.0008	0.016	0.00045	0.019	0.0019	0.021	0.00073	0.026	0.00076
Certified	1.99	0.017	2.15	0.0047	2.57	0.095	3.07	0.014	3.43	0.017
Uncertainty	0.01	0.001	0.02	0.0007	0.02	0.003	0.02	0.001	0.03	0.001
Tolerance	0.06	0.003	0.07	0.0021	0.08	0.009	0.09	0.003	0.10	0.003

Analysis	* 2020B C	* 2020B S	* 2021B C	* 2021B S	* 2022B C	* 2022B S	* 2023B C	* 2023B S	* 2024B C	* 2024B S
1	1 3.4656	1 0.04014	1 3.7456	1 0.03984	1 3.8032	1 0.0809	1 4.0328	1 0.10932	1 4.364	1 0.0435
2	1 3.498	1 0.0403	1 3.772	1 0.0408	1 3.826	1 0.0822	1 4.0334	1 0.1094	1 4.369	1 0.0449
3	1 3.498	1 0.04162	1 3.776	1 0.04158	1 3.8264	1 0.08298	1 4.0338	1 0.11152	1 4.3802	1 0.04554
4	1 3.5114	1 0.04214	1 3.7812	1 0.04186	1 3.8282	1 0.08388	1 4.0338	1 0.11184	1 4.3802	1 0.04652
5	1 3.5118	1 0.04226	1 3.789	1 0.04188	1 3.8354	1 0.08494	1 4.036	1 0.11302	1 4.3946	1 0.04694
6	1 3.5158	1 0.04296	1 3.79	1 0.04302	1 3.838	1 0.08512	1 4.039	1 0.11302	1 4.4024	1 0.04702
7	1 3.5186	1 0.04362	1 3.7964	1 0.04324	1 3.8422	1 0.0854	1 4.052	1 0.11398	1 4.4048	1 0.04704
8	1 3.5204	1 0.0441	1 3.797	1 0.04352	1 3.848	1 0.08546	1 4.0528	1 0.11398	1 4.4048	1 0.0478
9	1 3.525	1 0.04422	1 3.8044	1 0.04362	1 3.8596	1 0.08572	1 4.057	1 0.1148	1 4.4076	1 0.04784
10	1 3.5268	1 0.04424	1 3.806	1 0.04392	1 3.8598	1 0.08648	1 4.0624	1 0.1148	1 4.4092	1 0.04828
11	1 3.529	1 0.04436	1 3.8082	1 0.04392	1 3.8624	1 0.0868	1 4.0686	1 0.11482	1 4.414	1 0.0484
12	1 3.5304	1 0.04448	1 3.814	1 0.04414	1 3.8626	1 0.08714	1 4.0708	1 0.11488	1 4.416	1 0.04854
13	1 3.538	1 0.045	1 3.8158	1 0.04458	1 3.8634	1 0.08714	1 4.0794	1 0.11518	1 4.4224	1 0.04934
14	1 3.5412	1 0.04556	1 3.816	1 0.04508	1 3.8694	1 0.08734	1 4.0804	1 0.1152	1 4.4246	1 0.04948
15	1 3.5558	1 0.04556	1 3.8224	1 0.04534	1 3.8814		1 4.0836	1 0.1186	1 4.4268	1 0.04948
16	1 3.5602	1 0.04574	1 3.8224	1 0.0461	1 3.888		1 4.0864	1 0.1198	1 4.4306	1 0.05006
17	1 3.5804		1 3.83		1 3.9056		1 4.09		1 4.434	
18			1 3.8474		1 3.9056		1 4.091			
Average	3.525	0.0434	3.802	0.0432	3.855	0.0851	4.060	0.1140	4.405	0.0475
Std Dev	0.043	0.0011	0.045	0.0011	0.045	0.0017	0.048	0.0019	0.053	0.0012
H	0.022466	0.002115	0.023508	0.00211	0.023704	0.002934	0.024454	0.003395	0.025686	0.002208
U ₁	0.048	0.0024	0.051	0.0024	0.051	0.0034	0.054	0.0039	0.059	0.0025
t-statistic	2.12	2.13	2.11	2.13	2.11	2.16	2.11	2.13	2.12	2.13
U ₂	0.10	0.0051	0.101	0.0051	0.11	0.0074	0.11	0.0083	0.13	0.0053
U ₃	0.025	0.0013	0.025	0.0013	0.025	0.0020	0.027	0.0021	0.030	0.0013
Certified	3.52	0.043	3.80	0.043	3.86	0.085	4.06	0.114	4.40	0.047
Uncertainty	0.03	0.002	0.03	0.002	0.03	0.002	0.03	0.003	0.03	0.002
Tolerance	0.10	0.006	0.11	0.006	0.11	0.007	0.11	0.009	0.13	0.006

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:

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

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) | 7 Photometric | 13 Titrimetric |
| 2 Fusion (ASTM E1019) | 8 Flame Atomic Absorption | 14 DCP Atomic Emission |
| 3 Spark Atomic Emission | 9 GF Atomic Absorption | 15 HG Atomic Fluorescence |
| 4 ICP Atomic Emission | 10 X-Ray Fluorescence | 16 Difference |
| 5 ICP Mass Spectrometry | 11 GD Atomic Emission | 17 Wet |
| 6 Gravimetric | 12 GD Mass Spectrometry | |

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

Lab Name	Location	Registrar	Accreditation
Brammer Standard Company, Inc.	Houston, Texas	American Association for Laboratory Accreditation	17025, 17034
British Steel Ltd.	North Lincolnshire, United Kingdom	United Kingdom Accreditation Service	17025
Bundesanstalt für Materialforschung und -prüfung (BAM)	Berlin, Germany	Duetsche Akkreditierungsstelle GmbH	17025
Dunaferr Labor Nonprofit	Vasmüter, Hungary	The National Accreditation Authority	17025
Enviform a.s.	Trinec, Czech Republic	Czech Accreditation Institute	17025
ICRM	Yekaterinburg, Russia	Federalnaja Sluzba po Akreditacii	17025
MS Utilities & Services a.s.	Bohumín, Czech Republic	Czech Accreditation Institute	17025
SES Inspekt, s.r.o.	Timace, Slovak Republic	Slovenska Narodna Akreditacna Sluzba	17025
Tata Steel IJmuiden B.V.	Velsen-Noord, Netherlands	Raad Voor Accreditatie	17025
U.S. Steel Kosice - Labortest, s.r.o.	Kosice, Slovak Republic	Slovenska Narodna Akreditacna Sluzba	17025
Vitkovice Testing Center	Ostrava, Czech Republic	Czech Accreditation Institute	17025
Voestalpine Stahl GmbH	Linz, Austria	Akkreditierung Austria	17025
Welding Research Institute	Bratislava, Slovak Republic	Slovenska Narodna Akreditacna Sluzba	17025
Liberty	Ostrava, Czech Republic	Czech Accreditation Institute	17025
ZDAS	Zdar nad Sazavou, Czech Republic	Czech Accreditation Institute	17025

Analysis: Chemical analyses were made on 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: AR 301, 315; BAM RE2/250; BAS 481-1; BS LE 204; CKS 211, 218, 228, 229; CTIF FB 10-1, FB 12; ECRM 035-2, 090-1, 288-1, 428-1, 428-2, 476-1, 478-1, 478-2, 480-1, 485-3, 486-1, 487-1, 488-1, 491-1, 492-1; JK 20A; JSS 113-2; LECO 501-024, 501-105, 501-961, 502-052, 502-103; SPL CZ 2015A, 2016A, 2017A, 2018A, 2019A, 2020A, 2021A, 2022A, 2023A, 2024A; NCS 56006, NS16028; SRM 82B, 122G, 338, 342A; VS Ch2/7, Ch5/7, Ch9/6, Ch12-1, Ch13/1, Ch20 UNL15/4.

Homogeneity: This Certified Reference Material (CRM) was tested for homogeneity by MS Utilities and Services in Czech Republic 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: SPL CZ 2015A, 2016A, 2017A, 2018A, 2019A, 2020A, 2021A, 2022A, 2023A, 2024A.

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 CZ 2015B-2024B 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 raw material for this CRM was produced by Enviform a.s.; Trinec, Czech Republic and the final production of the candidate material was completed by SPL-LABMAT s.r.o.

Form: This graphite free candidate material was nitrogen-sprayed, crushed, sieved, and homogenized. More than 95% of the material consist of the fraction between 0.2mm - 0.8mm grain size. The supply unit is 200g of CRM in a glass bottle with a plastic screw lid, sealed in a plastic container.

Use: This CRM is intended for calibration and validation including combustion methods with a minimum test portion of 0.2g. This set covers the most frequent concentration ranges of the certified elements. Refer to ISO Guide 33 for information about the use of Certified Reference Materials.

Certificate Number: The unique identification number for this certificate of analysis is CZ 2015B-2024B-032221. You may obtain information on revisions of certificates from the internet at 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

Fax: (281) 440-4432 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

Inquiries, complaints, or claims regarding this CRM should be directed to:

SPL-LABMAT s.r.o, 1. maje 432, CZ-735 31 Bohumin, Czech Republic
te./fax: 596 014 627, email: info@spl-labmat.cz

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 March 22, 2021.

Beau R. Brammer
President