

Brammer Standard Company, Inc.

Certificate of Analysis

BS 2507

Certified Reference Material for Super Duplex 2507 - UNS Number S32750

	Certified Value ¹	Estimate of Uncertainty ²	Certified Values³	Certified Value ¹	Estimate of Uncertainty ²
As	0.0046	0.0006		Ni	0.07
B	0.0021	0.0004		O	0.0007
C	0.026	0.002		P	0.001
Co	0.040	0.003		Sb	0.0003
Cr	25.3	0.2		Si	0.01
Cu	0.222	0.009		Sn	0.0005
Fe	62.3	0.2		Ti	0.0007
Mn	0.79	0.01		V	0.003
Mo	3.75	0.03		W	0.004
N	0.273	0.009			
	Reference Value ¹	Estimate of Uncertainty ²	Reference Values^{3,4}	Reference Value ¹	Estimate of Uncertainty ²
Al	0.004	0.002		S	0.0003
Nb	0.011	0.003		Zr	<0.01

Informational Values^{3,5}

Ca (0.0003)

Mg (0.0002)

Pb (0.0002)

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.

⁵ Values in parentheses are not certified and are provided for information only.

Trace element information values for Ga, Ge, Ir, Os, Pt, Re, Y, and Zn 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.

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Analysis	*	As	*	B	*	C	*	Co	*	Cr	*	Cu	*	Fe	*	Mn	*	Mo	*	N
1	3	0.0036	12	0.0017	11	0.0227	12	0.0350	13	24.916667	3	0.210	16	62.1	3	0.776667	3	3.706667	2	0.257333
2	5	0.00443333	4	0.0018	1	0.023	4	0.03766667	4	25.105733	4	0.213	16	62.11403	8	0.78	4	3.720667	2	0.264
3	12	0.00463333	3	0.002	1	0.0243	14	0.03816667	4	25.113	4	0.21725	14	62.2	3	0.78	4	3.723867	2	0.265333
4	5	0.00463333	4	0.0020333	1	0.024375	5	0.03823333	17	25.13	3	0.22	4	62.21667	4	0.780333	4	3.737783	2	0.2703
5	10	0.00473333	3	0.0020333	1	0.025667	8	0.040	4	25.16	11	0.221	16	62.23	14	0.782333	4	3.74	2	0.27125
6	15	0.00483667	4	0.0020667	3	0.025667	4	0.0402	3	25.21	4	0.221	16	62.28	4	0.7878	10	3.741	2	0.275667
7	5	0.00506667	4	0.0021	1	0.026	3	0.0403	3	25.23	7	0.221333	16	62.37486	4	0.788333	8	3.75	2	0.276667
8	9	0.0051	5	0.0021	1	0.0263	4	0.04043333	10	25.24	4	0.2223	13	62.43033	4	0.788667	3	3.76	2	0.277
9	5	0.0060	5	0.00219	1	0.0268	11	0.0406	4	25.254667	14	0.222667	4	62.545	7	0.79	4	3.766	2	0.277333
10			7	0.0022333	1	0.027033	10	0.0407	3	25.29	4	0.223667	16	62.58	4	0.795767	11	3.77	2	0.279
11			14	0.0022667	1	0.027133	4	0.041	14	25.3	3	0.224			11	0.799	3	3.78	2	0.28
12			3	0.00246	1	0.027307	3	0.041	4	25.307333	8	0.224333	4	0.800867	14	3.78	2	0.281		
13			11	0.0025	1	0.027933	3	0.0414	17	25.312333	4	0.224383			4	0.801333	4	3.783867		
14			4	0.0025333	2	0.0281	5	0.04146667	13	25.380333	4	0.225333			4	0.80175				
15					3	0.0282	4	0.04253333	11	25.41	4	0.2255			10	0.804				
16					3	0.029	8	0.0426	3	25.456667	8	0.226								
17					1	0.03091	4	0.04615667	4	25.493333	10	0.228								
18									4	25.5055	3	0.23								
Average		0.00464		0.002144		0.02628		0.040439		25.267531		0.2225		62.325		0.790457		3.750758		0.2732
Std Dev		0.00019		0.000085		0.00095		0.000077		0.000075		0.0034		0.061		0.000082		0.000088		0.0039
H		0.00078		0.00057		0.0017		0.0020		0.077		0.0048		0.14		0.0095		0.023		0.0053
U ₁		0.00080		0.00058		0.0019		0.0020		0.077		0.0048		0.15		0.0095		0.023		0.0066
t-statistic		2.31		2.16		2.12		2.12		2.11		2.11		2.26		2.14		2.18		2.20
U ₂		0.0019		0.0012		0.0041		0.0043		0.16		0.012		0.35		0.020		0.051		0.014
U ₃		0.00062		0.00033		0.0010		0.0011		0.038		0.0029		0.11		0.0052		0.014		0.0042
Certified		0.0046		0.0021		0.026		0.040		25.3		0.222		62.3		0.79		3.75		0.273
Uncertainty		0.0006		0.0004		0.002		0.003		0.2		0.009		0.2		0.01		0.03		0.009
Tolerance		0.0019		0.0012		0.006		0.009		0.6		0.027		0.6		0.03		0.09		0.027

Analysis	*	Ni	*	O	*	P	*	Sb	*	Si	*	Sn	*	Ti	*	V	*	W
1	3	6.85	2	0.0028	12	0.021333	11	0.0002	4	0.3056667	12	0.0042	4	0.00113	4	0.057867	4	0.066893
2	3	6.85333333	2	0.0031133	4	0.0218	4	0.00053	3	0.31	11	0.0043	4	0.001147	11	0.0604	3	0.067
3	3	6.87	2	0.0032	11	0.0223	9	0.0006	3	0.31	4	0.004567	14	0.002633	4	0.060933	12	0.0680
4	8	6.88	2	0.00334	3	0.022333	12	0.00077667	4	0.313	3	0.0049	4	0.00278	5	0.061833	3	0.0702
5	4	6.90356667	2	0.0038	4	0.022533	5	0.0008	10	0.317	5	0.004933	4	0.003067	3	0.063	3	0.073
6	14	6.91	2	0.003865	3	0.023	5	0.00081667	3	0.318	4	0.0050	3	0.0032	4	0.0631	4	0.073133
7	3	6.93	2	0.0039333	10	0.023	9	0.0017	17	0.32	5	0.005027	11	0.0033	14	0.063667	3	0.074333
8	4	6.934	2	0.0039533	7	0.023133	10	0.0022	4	0.3208333	4	0.005033	3	0.0034	4	0.064067	4	0.074867
9	11	6.94	2	0.0043	4	0.023567			14	0.3213333	3	0.005033	3	0.0035	10	0.0641	14	0.0758
10	4	6.94686667	2	0.0046667	4	0.0236			4	0.3217	4	0.005067	4	0.003633	4	0.064667	4	0.076
11	4	6.96168667	2	0.0048167	4	0.023967			3	0.322	4	0.005233			4	0.06493	10	0.0764
12	4	6.96533333			4	0.0241			11	0.325	5	0.005267	4	0.065667	5	0.076633		
13	10	6.98			4	0.025333			17	0.3333	9	0.005267	3	0.066	4	0.077433		
14	6	6.982			3	0.0255			4	0.3403333	3	0.0057	3	0.0673	4	0.077667		
15	4	6.99246667							4	0.35712			3	0.0737	4	0.077767		
16	17	7.01																
17	4	7.01563333																
18	4	7.03333333																
Average		6.942122		0.00377		0.023250		0.000845		0.322352		0.00496		0.00278		0.064082		0.0738
Std Dev		0.000075		0.00012		0.000085		0.000053		0.000082		0.00017		0.00010		0.000082		0.0020
H		0.034		0.00072		0.0016		0.00040		0.0058		0.00080		0.000633		0.0026		0.0027
U ₁		0.034		0.00073		0.0016		0.00040		0.0058		0.00082		0.00064		0.0026		0.0034
t-statistic		2.11		2.23		2.16		2.36		2.14		2.16		2.26		2.14		2.14
U ₂		0.072		0.0016		0.0034		0.0010		0.012		0.0018		0.0014		0.0055		0.0073
U ₃		0.017		0.00049		0.00091		0.00034		0.0032		0.00047		0.00046		0.0014		0.0019
Certified		6.94		0.0038		0.023		0.0008		0.32		0.0050		0.0028		0.064		0.074
Uncertainty		0.07		0.0007		0.001		0.0003		0.01		0.0005		0.0007		0.003		0.004
Tolerance		0.21		0.0021		0.003		0.0007		0.03		0.0018		0.0021		0.009		0.012

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* Code for method

Reference values listed as weight percent

Analysis	*	Al	*	Nb	*	S	*	Zr
1	5	0.002	11	0.0075	1	0.000167	5	0.0000047
2	5	0.00217	3	0.0075667	12	0.00018	12	0.00016333
3	5	0.0026	10	0.0076	1	0.0002	4	0.0008
4	3	0.0034	4	0.0089667	1	0.000233	4	0.00306333
5	4	0.0047	4	0.0099367	11	0.0003	10	0.00493333
6	14	0.00473333	12	0.0106667	1	0.000333	3	0.0052
7	4	0.0050	3	0.0107	1	0.000347		
8	4	0.0057	4	0.0115667	1	0.0005		
9	11	0.0068	4	0.0127	1	0.0005		
10			5	0.0130667	1	0.000567		
11			14	0.0137	3	0.0006		
12			4	0.0140333	1	0.0007		
13			5	0.0143333	3	0.0009		
14			5	0.0148	1	0.000943		
15					1	0.000967		
16								
17								
18								
19								
20								
Average		0.00412		0.011224		0.000496		0.00239
Std Dev		0.00011		0.000085		0.000082		0.00011
H		0.00074		0.0011		0.00033		0.00060
U₁		0.00075		0.0011		0.00034		0.00061
t-statistic		2.31		2.16		2.14		2.57
U₂		0.0017		0.0025		0.00073		0.0016
U₃		0.00058		0.00066		0.00019		0.00064
Reference		0.004		0.011		0.0005		<0.01
Uncertainty		0.002		0.003		0.0003		
Tolerance		0.003		0.009		0.0004		

BS 2507

* Code for method

Informational values listed as weight percent

Analysis	*	Ca	*	Mg	*	Pb
1	12	0.0000207	12	0.000033	12	0.00001
2	4	0.0002	4	0.0001	5	0.00001
3	3	0.0003	4	0.0002	9	0.0001
4	11	0.0003	3	0.0003	9	0.00015
5	14	0.0006			11	0.0002
6					3	0.0007
Average		0.00028		0.000158		0.00020
Std Dev		0.00027		0.000083		0.00011
H		0.00027		0.00022		0.00024
U₁		0.00038		0.00024		0.00027
t-statistic		2.78		3.18		2.57
U₂		0.0011		0.00076		0.00068
U₃		0.00048		0.00038		0.00028
Informational		(0.0003)		(0.0002)		(0.0002)

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. U₁ is the combined uncertainty from homogeneity and labs. U₂ is U₁ multiplied by the coverage factor (95 % t-statistic). U₃ is U₂ 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 U₃ 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.

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* Code for analytical method

Trace analysis listed as mg/kg (ppm)

Analysis	*	Ga	*	Ge	*	Ir	*	Os	*	Pt	*	Re	*	Y	*	Zn				
1	12	24	12	4	12	0.12	12	0.11	12	0.12	12	3.1	12	0.01	12	0.55				
2	12	25	12	4	12	0.12	12	0.12	12	0.12	12	3.1	12	0.01	12	0.59				
3	12	25	12	4	12	0.13	12	0.12	12	0.12	12	3.2	12	0.01	12	0.59				

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, TX	A2LA	17025, 17034
Eurofins EAG Materials Science, LLC	Liverpool, NY	A2LA	17025
NSL Analytical	Cleveland, OH	ANAB	17025
Luvak Inc.	Boylston, MA	PRI	17025
Dirats Laboratories	Westfield, MA	ANAB	17025
LECO Corporation	St. Joseph, MI	A2LA	17025
Laboratory Testing, Inc.	Hatfield, PA	PRI	17025
National Analysis Center For Iron And Steel	Beijing, China	CNAS	17025
Analytical Process Laboratories	Milwaukee, WI	A2LA	17025
Vitkovice Testing Center	Ostrava, Czech	ILAC	17025
Element Materials Technology	Glendale Heights, IL	A2LA	17025
Element Materials Technology	Huntington beach, CA	A2LA	17025
TUV Rheinland Pvt Ltd	Bangalore, India	NABL	17025
Instytut Metalurgii Zelaza	Gliwice, Poland	PCA	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, 12X6A90, 13X12536, 13X125370, 13X14934, 13X14935, 23X80030; AR 512, 644, 646, 654, 657, 659, 662, 663, 668, 673, 675, 676, 870, 881, 882, 891, 892, 1650; BAS 72, 261, 342, 346A, 406/2, 461, 464/1, 466/1, 466/2; BS CD4MCU, HONU, 17-4PHA, 80F, 81G, 82B, 85D, 179, 179C, 189A, 302A, 316D, 318, 2205A; DSZU CA013; ECRM 085-1, 184-1, 195-1, 299-1; IARM 4A, 5E, 21A, 301B, 318B; IMZ 83A, 123, 158; IPT 12A, 17A; JK 37; JSS 652-5, 654-5; LECO 501-501, 501-644, 501-646, 501-675, 501-676, 502-414, 502-449, 502-712, 502-855, 502-856, 502-868, 502-870, 502-887, 502-903, 502-904, 502-913, 502-928; SPL 3A; SRM 101G, 126C, 160B, 344, 349A, 361, 363, 897, 898, 899, 1155.

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 466/1, 466/2; BS CD4MCU, HON U, 179, 179C, 318, 2205A; DSZU CA013; ECRM 299-1; IARM 5E, 318B; LECO 502-870, 502-887; SRM 126C.

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 2507 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 BGH Edelstahl Freital GmbH; Freital, Germany.

Form: This CRM is machined in the form of a disc, approximately 38mm in diameter and 19mm 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 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.

Certificate Number: The unique identification number for this certificate of analysis is 2507-031521. 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

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 15, 2021.

Beau R. Brammer

President