

Brammer Standard Company, Inc.

Certificate of Analysis

B.S. 172A

Reference Material for Stellite 188 Cobalt Base Alloy

	Certified Value ¹	Estimate of of Uncertainty ²		Certified Value ¹	Estimate of Uncertainty ²
Carbon	0.098	0.003	Lanthanum	0.045	0.003
Manganese	0.77	0.02	Niobium	0.09	0.01
Silicon	0.37	0.02	Vanadium	0.007	0.001
Copper	0.027	0.002			
Nickel	23.7	0.2	Information values ³		
Chromium	21.85	0.07	Boron	(0.003)	
Molybdenum	0.30	0.01	Magnesium	(0.001)	
Tungsten	14.0	0.15	Phosphorus	(0.011)	
Aluminum	0.08	0.02	Sulfur	(<0.0005)	
Iron	1.76	0.02	Tantalum	(0.024)	

(analysis listed as percent by weight)

¹ The certified value listed is the present best estimate of the true value based on the results of an interlaboratory testing program.

² The uncertainties listed are based on value judgments of the material inhomogeneity and possible bias in the determined analytical values. No attempt is made to derive exact statistical measurements of imprecision because several methods were used in the determination of most constituents.

³ Values in parentheses are not certified and are provided for information only.

Some of the co-operating laboratories were:

AB Sandvik Steel, Sandviken, Sweden
Allegheny Ludlum Steel Corp., Brackenridge, Pennsylvania
Allegheny Ludlum Steel Corp., Lockport, New York
Brammer Standard Co., Inc., Houston, Texas
Crucible Research, Pittsburgh, Pennsylvania
J. Dirats and Co., Inc., Westfield, Massachusetts
Hoesch Stahl AG, Dortmund, Germany
Howmet Corporation, Dover, New Jersey
Charles C. Kawin Company, Broadview, Illinois
Ledoux & Company, Teaneck, New Jersey
PTL Testing Laboratory, Inc., Trenton, New Jersey
SKODA Concern Plzen, Central Research Institute, Plzen, Czechoslovakia
TCR Engineering Services, Bombay, India
VHG Laboratories, Inc., Manchester, New Hampshire

See the following pages for more information.

New Certificate Number REV2-172A-063010

New Certificate Number REV2-172A-063010 was Revised on June 30, 2010 to show estimates of uncertainty

Brammer Standard Company, Inc., 14603 Benfer Road, Houston, TX 77069
Telephone (281) 440-9396 Fax (281) 440-4432

BS 172A	Analysis listed as percent by weight										REV2-172A-063010
Analysis	C	Mn	Si	Cu	Ni	Cr	Mo	W	Al	Fe	
1	0.0952	0.74	0.35	0.024	23.53	21.75	0.28	13.91	0.06	1.73	
2	0.096	0.754	0.36	0.0245	23.54	21.76	0.29	13.97	0.062	1.73	
3	0.099	0.759	0.38	0.025	23.56	21.80	0.291	14.00	0.08	1.75	
4	0.099	0.76	0.38	0.026	23.58	21.83	0.293	14.108	0.08	1.75	
5	0.100	0.76		0.027	23.60	21.86	0.298	14.19	0.086	1.76	
6	0.101	0.77		0.028	23.70	21.87	0.304		0.097	1.77	
7		0.78		0.0285	23.72	21.92	0.31		0.104	1.78	
8		0.783		0.0308	23.84	21.93	0.32			1.78	
9		0.798			23.94	21.95				1.79	
10					23.95					1.80	
11					24.05						
Average	0.0984	0.767	0.367	0.0267	23.728	21.852	0.298	14.036	0.081	1.764	
Std Dev	0.0023	0.018	0.015	0.0023	0.188	0.073	0.013	0.112	0.016	0.024	
Certified	0.098	0.77	0.37	0.027	23.7	21.85	0.30	14.0	0.08	1.76	
t	2.57	2.31	3.18	2.36	2.23	2.31	2.36	2.78	2.45	2.26	
C(95%)	0.0024	0.013	0.024	0.0019	0.126	0.056	0.011	0.139	0.015	0.017	

continued from above

Analysis	La	Nb	V	B	Mg	P	S	Ta
1	0.041	0.079	0.006	0.0018	0.0005	0.008	<0.0002	0.021
2	0.044	0.080	0.0066	0.00197	0.0008	0.008	<0.0002	0.025
3	0.045	0.085	0.007	0.0020		0.0088	<0.0005	0.026
4	0.046	0.085	0.008	0.0020		0.010		
5	0.047	0.088		0.0021		0.013		
6	0.047	0.093		0.0023		0.013		
7	0.047	0.100		0.0028		0.013		
8		0.105		0.0038		0.014		
9				0.0039		0.015		
10				0.0042				
Average	0.0453	0.0894	0.0069	0.00269	0.0007	0.0114		0.0240
Std Dev	0.0022	0.0093	0.0008	0.00093	0.0002	0.0027		0.0026
Certified	0.045	0.09	0.007	(0.003)	(0.001)	(0.011)	(<0.0005)	(0.024)
t	2.45	2.36	3.18	2.26	12.71	2.31		4.30
C(95%)	0.0020	0.0078	0.0013	0.00066	0.0019	0.0021		0.0066

$C(95\%) = (t \times sd) / \sqrt{n}$ The half-width confidence interval, where t is the appropriate Student's t value, sd is the interlaboratory standard deviation, and n is the number of acceptable mean values. For further information regarding the confidence interval for the certified value see ISO Guide 35:2006 section 6.

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

Analysis: Chemical analyses were made on millings from cross-sections of the bars. Each individual value listed above is the average of each analyst's results.

Analytical Methods: Methods of analysis used were a combination of ASTM Standard Methods E 354, E 1019, plus additional ICP, and AA spectrometric methods. The following Certified Reference Material was used to validate the analytical data listed above: BAM 328-1

Homogeneity: This Reference Material was tested for homogeneity using ASTM Standard Method E 826 and found acceptable. It was also examined by spark atomic emission spectrometry and found to be compatible with the following NIST Certified Reference Materials: SRM 1199, SRM 1200

Form: This Reference Material is machined in the form of a disc, approximately 38 mm diameter and 10 mm thick by Brammer Standard Company. The bar stock used for this material was produced by hot-rolling billets and annealing.

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

Use: This Reference Material is intended for use in spark atomic emission and x-ray spectrometric methods of analysis. Refer to ISO Guide 33 for information about the use of Reference Materials.

Certified area: The entire depth of the disc may be used.

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

Certificate Number: The unique identification number for this certificate of analysis is REV2-172A-063010. This BS 172A Certificate of Analysis was revised to show the estimate of uncertainty for the certified values. After reviewing the analytical data, the sulfur value was changed to uncertified, and the uncertified values for magnesium and tantalum was shown for information.

The first Certificate of Analysis for BS 172A was certified on July 19, 1991(172A-071991). The first revision (Rev172A-092691) was produced after being retested for boron and phosphorus content and changing their values to uncertified.

Refer to the "Certificates" section of the Brammer Standard Company website for any revision to this or other Brammer Standard Company's Certificates of Analysis.

Safety Notice: A Material Safety Data Sheet (MSDS) 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 Fax: (281) 440-4432	website: brammerstandard.com email: contact@brammerstandard.com
--	--	--

Certified by: _____ on June 30, 2010.
Beau R. Brammer

Referenced Documents

ASTM documents available from ASTM, 1916 Race Street, Philadelphia, PA, 19103.

Versions used were those available at the time of interlaboratory testing

- E 354 Standard Test Methods for Chemical Analysis of High-Temperature, Electrical, Magnetic, and Other Similar Iron, Nickel, and Cobalt Alloys
- E 826 Standard Practice for Testing Homogeneity of Materials for the Development of Reference Materials
- E 1019 Standard Test Methods for Determination of Carbon, Sulfur, Nitrogen, and Oxygen in Steel, and in Iron, Nickel, and Cobalt Alloys

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

ISO Guide 33:2000 Uses of certified reference materials

ISO Guide 35:2006 Reference Materials - General and statistical principles for certification

Certificate Number REV2-172A-063010