

Brammer Standard Company, Inc.  
**Certificate of Analysis**

Certified Reference Material for Carbon, Sulfur, Oxygen, Nitrogen, and Hydrogen  
in Stainless Steel

**B.S. HON T**

	<b>Certified Value<sub>1</sub></b>	Estimate of Uncertainty <sub>2</sub>
<b>Carbon</b>	<b>0.050</b>	±0.002
<b>Sulfur</b>	<b>0.0040</b>	±0.0004
<b>Oxygen</b>	<b>0.0044</b>	±0.0004
<b>Nitrogen</b>	<b>0.0365</b>	±0.0008
<b>Hydrogen</b>	<b>0.00027</b>	±0.00005

*Values expressed as percent by weight*

Due to slight variations in pin weights, best precision and accuracy will be obtained by weighing each pin before analysis.

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

<sup>2</sup> The uncertainties listed are based on value judgments of the material inhomogeneity and the 95% confidence interval. The half-width confidence interval C(95%) is shown below:

$$C(95\%) = \frac{s_M \times t}{\sqrt{n}}$$

where:  $s_M$  = Standard Deviation of Laboratory Means  
 $t$  = Students t value  
 $n$  = number of laboratories

For further information regarding the confidence interval for the certified value, see ISO Guide 35.

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. Inquires concerning this Reference Material should be directed to:

Brammer Standard Co., Inc.  
14603 Benfer Road  
Houston, Texas 77069 USA

Phone: (281) 440-9396  
Fax: (281) 440-4432  
Web: [www.brammerstandard.com](http://www.brammerstandard.com)

**Use:** This Reference Material is intended for use in combustion instrument methods of analysis.

Certified by: Beau R. Brammer \_\_\_\_\_ on August 20, 2007.

**Certificate Number HON-T-082007p1**

**Description of the sample**

This sample is available only in the form of pins with an approximate diameter of 3.8 mm (0.15 in.) and a length of 11.2 mm (0.44 in.). This reference material is sold in units of 100 one gram pins. The material used for making BS CS 5 was AISI grade 304 stainless steel. The estimated composition in percent by weight is: Mn 1.7, P 0.03, Si 0.6, Ni 9.2, Cr 18.4, Mo 0.4

**Interlaboratory Testing Procedure**

Each participating laboratory received a set of test samples consisting of the new Brammer Reference Materials, plus three Certified Reference Materials (CRMs) as shown in the tables on the following pages. The participating laboratories were instructed to calibrate their instruments by their normal procedures and to analyze the samples in duplicate on two different runs. All instruments used were manufactured by the Leco Corporation.

**Certified Values for carbon and sulfur were established after interlaboratory testing in 1994.**

The original part number for the material certified for only carbon and sulfur was BS CS 5.

The laboratory means and standard deviations are listed on the following pages. The carbon and sulfur analyses were determined on calibrations that were validated with NIST CRMs and are therefore traceable to NIST. Regression calculations were used to produce the final certified carbon and sulfur values.

**Participating laboratories for carbon and sulfur analysis were:**

Allegheny Ludlum Steel Corp., Lockport, New York  
Brammer Standard Company, Houston, Texas  
Copperweld Steel Company, Warren, Ohio  
Crucible Specialty Metals, Syracuse, New York  
LTV Steel Company, Indiana Harbor Works, E. Chicago, Indiana  
Lukens Steel Company, Coatesville, Pennsylvania  
Republic Engineered Steels, Canton, Ohio  
The Timken Company, Harrison Plant, Canton, Ohio  
The Timken Company, Faircrest Steel Plant, Canton, Ohio  
Vac Air Alloys Corporation, Frewsburg, New York

**Certified Values for oxygen, nitrogen, and hydrogen were established after interlaboratory testing in 2007.**

The laboratory means and standard deviations are listed on the following pages. The analyses were determined on calibrations that were validated by testing Certified Reference Materials on each laboratory calibrated instrument along with the BS HON T material.

**Participating laboratories for oxygen, nitrogen and hydrogen analysis were:**

ATI Allvac, Monroe, South Carolina  
ATI Lockport, Lockport, New York  
Carpenter Technology, Reading, Pennsylvania  
Laboratory Testing Inc., Hatfield, Pennsylvania  
Mittal Steel, Indiana Harbor Works, East Chicago, Illinois  
The Timken Company, Canton, Ohio  
WCI Steel, Warren, Ohio

**Source:** The material for this reference material was melted and fabricated into wire by the Carpenter Technology Corporation in Reading, Pennsylvania. The wire was processed into pins by SKF Bearing Industries Company in Bremen, Indiana.

**Homogeneity:** This Reference Material was tested for homogeneity using ASTM Standard Practice E 826 and found acceptable.

**Traceability:** The final data for this reference material were calculated based on the values obtained from NIST SRMs 2166, 2167, and ECRM 292-1. This reference material is therefore directly traceable to NIST certified reference materials.

**Sample Preparation:** Prepare the test specimens by your normal methods.

**Certification Process:** The requirements of ISO Guide 31, ISO Guide 34, ISO Guide 35, and ASTM Standard Guides E 1724 and E 1831 were followed for the preparation of this reference material and certificate of analysis. This is a Certified Reference Material as defined by ISO Guide 30.

**Certificate Number:** The unique identification number for this certificate of analysis is HON-T082007-px, where x indicates the page number. Refer to future Brammer Standard Company catalogs for information on any revisions to this or other Brammer Standard reference materials. You may also obtain information on revisions of certificates from the internet at [www.brammerstandard.com](http://www.brammerstandard.com).

Lab Code	Day 1 Run 1	Run 2	Day 2 Run 1	Run 2	Lab Average	Within Lab 1s	Regression Results	Certified
1	0.0475	0.0489	0.0485	0.0501	0.04875	0.00108	0.04805	
2	0.0444	0.0461	0.0435	0.0434	0.04435	0.00125	0.04772	
3	0.0476	0.0504	0.0535	0.0539	0.05135	0.00295	0.04877	
4	0.049	0.048	0.048	0.051	0.0490	0.00141	0.04995	
5	0.0507	0.0506	0.0502	0.0490	0.05013	0.00078	0.05109	
6	0.0529	0.0524	0.0540	0.0508	0.05253	0.00133	0.05178	
7	0.04857	0.05074	0.04907	0.05287	0.05031	0.00194	0.05087	
8	0.04646	0.05227	0.05198	0.05545	0.05154	0.00373	0.05105	
9	0.0493	0.0494	0.0499	0.0499	0.04963	0.00032	0.05005	
10	0.052830	0.049519	0.053068	0.048916	0.05108	0.00217	0.04899	
				Average 1s	0.04987 0.00227	0.00170	0.04983 0.00139	<b>0.050</b>

NIST SRM 2166 Certified Carbon = 0.0150%, uncertainty = 0.001%

Lab Code	Day 1 Run 1	Run 2	Day 2 Run 1	Run 2	Lab Average	Within Lab 1s
1	0.0170	0.0217	0.0188	0.0196	0.01928	0.00195
2	0.0140	0.0144	0.0141	0.0141	0.01415	0.00017
3	0.0183	0.0192	0.0172	0.0212	0.01898	0.00169
4	0.015	0.014	0.012	0.013	0.0135	0.00129
5	0.0145	0.0143	0.0145	0.0150	0.01458	0.00030
6	0.0153	0.0151	0.0155	0.0150	0.01523	0.00022
7	0.01507	0.01495	0.01318	0.01302	0.01406	0.00111
8	0.01664	0.01643	0.01741	0.01754	0.01701	0.00055
9	0.0151	0.0152	0.0150	0.0150	0.01508	0.00010
10	0.014809	0.015281	0.014906	0.015282	0.01507	0.00025
				Average 1s	0.01569 0.00204	0.00076

NIST SRM 2167 Certified Carbon = 0.051%, uncertainty = 0.002%

Lab Code	Day 1 Run 1	Run 2	Day 2 Run 1	Run 2	Lab Average	Within Lab 1s
1	0.0548	0.0521	0.0502	0.0498	0.05173	0.00228
2	0.0475	0.0482	0.0474	0.0471	0.04755	0.00047
3	0.0520	0.0499	0.0542	0.0518	0.05198	0.00176
4	0.046	0.050	0.053	0.045	0.0485	0.00370
5	0.0497	0.0499	0.0503	0.0501	0.05000	0.00026
6	0.0516	0.0523	0.0520	0.0510	0.05173	0.00056
7	0.05038	0.05059	0.04941	0.04875	0.04978	0.00086
8	0.04908	0.04957	0.05256	0.05255	0.05094	0.00188
9	0.0505	0.0506	0.0506	0.0509	0.05065	0.00017
10	0.052006	0.052886	0.052572	0.052403	0.05247	0.00037
				Average 1s	0.05053 0.00159	0.00123

ECRM 292-1 Certified Carbon = 0.0367%, uncertainty = 0.0008%

Lab Code	Day 1 Run 1	Run 2	Day 2 Run 1	Run 2	Lab Average	Within Lab 1s
1	0.0375	0.0385	0.0393	0.0366	0.03798	0.00118
2	0.0338	0.0342	0.0337	0.0338	0.03388	0.00022
3	0.0390	0.0399	0.0413	0.0482	0.04210	0.00418
4	0.038	0.039	0.037	0.038	0.0380	0.00082
5	0.0356	0.0360	0.0363	0.0362	0.03603	0.00031
6	0.0374	0.0371	0.0375	0.0370	0.03725	0.00024
7	0.03646	0.03739	0.03580	0.03896	0.03715	0.00137
8	0.03712	0.03775	0.03999	0.04026	0.03878	0.00158
9	0.0364	0.0364	0.0362	0.0362	0.03630	0.00012
10	0.038015	0.038381	0.042774	0.03815	0.03933	0.00230
				Average 1s	0.03768 0.00219	0.00123

1s = one standard deviation

Lab Code	Day 1 Run 1	Run 2	Day 2 Run 1	Run 2	Lab Average	Within Lab 1s	Regression Results	Certified
1	0.0049	0.0052	0.0052	0.0065	0.00545	0.00071	0.00474	
2	0.0040	0.0039	0.0037	0.0037	0.00383	0.00015	0.00389	
3	0.0046	0.0044	0.0047	0.0040	0.00443	0.00031	0.00411	
4	0.0039	0.0039	0.0036	0.0039	0.00383	0.00015	0.00368	
5	0.0036	0.0037	0.0040	0.0042	0.00388	0.00028	0.00385	
6	0.0040	0.0039	0.0039	0.0040	0.00395	0.00006	0.00400	
7	0.00420	0.00422	0.00445	0.00440	0.00432	0.00013	0.00362	
8	0.00493	0.00496	0.00486	0.00452	0.00482	0.00020	0.00417	
9	0.0041	0.0040	0.0036	0.0036	0.00383	0.00026	0.00385	
10	0.004880	0.004896	0.003998	0.004095	0.00447	0.00049	0.00368	
				Average 1s	0.00428 0.00054	0.00027	0.00396 0.00033	<b>0.0040</b>

NIST SRM 2166 Certified Sulfur = 0.0023%, uncertainty = 0.0002%

Lab Code	Day 1 Run 1	Run 2	Day 2 Run 1	Run 2	Lab Average	Within Lab 1s
1	0.0023	0.0029	0.0034	0.0026	0.00280	0.00047
2	0.0024	0.0022	0.0022	0.0023	0.00228	0.00010
3	0.0027	0.0026	0.0024	0.0024	0.00253	0.00015
4	0.0026	0.0029	0.0017	0.0021	0.00233	0.00053
5	0.0021	0.0022	0.0023	0.0023	0.00223	0.00010
6	0.0022	0.0023	0.0024	0.0020	0.00223	0.00017
7	0.00259	0.00273	0.00268	0.00263	0.00266	0.00006
8	0.00246	0.00268	0.00184	0.00207	0.00226	0.00038
9	0.0023	0.0023	0.0023	0.0022	0.00228	0.00005
10	0.002568	0.002253	0.001996	0.002218	0.00226	0.00024
				Average 1s	0.00238 0.00020	0.00022

NIST SRM 2167 Certified Sulfur = 0.0091%, uncertainty = 0.0002%

Lab Code	Day 1 Run 1	Run 2	Day 2 Run 1	Run 2	Lab Average	Within Lab 1s
1	0.0096	0.0096	0.0098	0.0099	0.00973	0.00015
2	0.0089	0.0089	0.0088	0.0088	0.00885	0.00006
3	0.0092	0.0093	0.0094	0.0090	0.00923	0.00017
4	0.0090	0.0092	0.0095	0.0086	0.00908	0.00038
5	0.0088	0.0087	0.0090	0.0093	0.00895	0.00026
6	0.0088	0.0088	0.0090	0.0085	0.00878	0.00021
7	0.0114	0.0115	0.0102	0.0102	0.01083	0.00072
8	0.01120	0.01157	0.01087	0.01068	0.01108	0.00039
9	0.0086	0.0083	0.0085	0.0087	0.00853	0.00017
10	0.012495	0.013083	0.010739	0.010467	0.01170	0.00129
				Average 1s	0.00967 0.00112	0.00038

ECRM 292-1 Certified Sulfur = 0.0055%, uncertainty = 0.0002%

Lab Code	Day 1 Run 1	Run 2	Day 2 Run 1	Run 2	Lab Average	Within Lab 1s
1	0.0066	0.0064	0.0066	0.0066	0.00655	0.00010
2	0.0054	0.0054	0.0054	0.0054	0.00540	0.00000
3	0.0060	0.0061	0.0061	0.0060	0.00605	0.00006
4	0.0057	0.0061	0.0057	0.0061	0.00590	0.00023
5	0.0056	0.0057	0.0059	0.0058	0.00575	0.00013
6	0.0055	0.0057	0.0058	0.0053	0.00558	0.00022
7	0.00699	0.00640	0.00654	0.00694	0.00672	0.00029
8	0.00696	0.00687	0.00670	0.00675	0.00682	0.00012
9	0.0058	0.0057	0.0055	0.0054	0.00560	0.00018
10	0.007954	0.007860	0.008379	0.006388	0.00765	0.00087
				Average 1s	0.00620 0.00071	0.00022

1s = one standard deviation

**BS HON-T TEST RESULTS**

data listed as ppm by weight (µg/g)

**Oxygen**

SKF200S-1 JSS GS-1c 502-416 BS HON T

Lab 1	82.6	50.6	62.7	46.5
	93.4	53.3	74.7	47.5
	103.5	43.4	75.9	42.7
	93.2	56	74.6	49.3
Lab 2	90	49	70	41
	86	51	68	45
	92	49	70	47
	87	53	72	49
Lab 3	92	46	66	44
	87	52	66	44
	90	49	65	42
	88	46	65	47
Lab 4	98		75	43
	92	76	73	46
	93	57	73	46
	94	63	73	53
Lab 5	73.0	42.7	63.7	37.7
	87.7	51	68.5	39
	85.8	46.7	64.6	38.7
	81.5	53.2	60.8	35.7
Lab 6	84	46	68	48
	83	45	68	48
	82	46	66	45
	81	46	67	43
Average	88.3	50.9	68.8	44.5
Std Dev	6.3	7.1	4.2	4.0
# Labs	24	23	24	24
t	2.0687	2.0739	2.0687	2.0687
95%	2.6	3.1	1.8	1.7
Certified Uncertainty	89.8	46	68	44

+/- 4.0

**Nitrogen**

SKF200S-1 JSS GS-1c 502-416 BS HON T

Lab 1	311.8	254.1	580.3	379.5
	310.8	251.5	577.7	366.7
	308.6	245.6	552.2	365.7
	296.6	229.3	564.8	348.9
Lab 2	296	255	586	374
	301	249	584	370
	293	254	576	361
	292	251	573	360
Lab 3	287	233	561	368
	284	230	571	361
	283	235	576	363
	286	230	583	368
Lab 4	295	256	559	363
	297	250	578	366
	288	254	571	365
	305	255	564	348
Lab 5	298.1	247.7	566	369
	306.3	242.5	565	357.2
	303	241.6	566.6	362.2
	303.8	244.3	564.1	366.4
Lab 6	301	250	568	373
	297	252	553	375
	303	253	552	371
	304	247	570	368
Average	298.0	246.3	569.2	365.4
Std Dev	8.1	8.6	9.6	7.2
# Labs	24	24	24	24
t	2.0687	2.0687	2.0687	2.0687
95%	3.4	3.6	4.0	3.0
Certified Uncertainty	312.3	254	566	365

+ / - 8.0

**Hydrogen**

762-747 JSS GS-1c 502-416 BS HON T

Lab 7	1.61	2.09	6.57	2.72
	2.00	2.19	6.9	2.73
	1.82	1.63	6.35	2.45
	1.60	1.71	6.19	2.48
Lab 8	1.71	1.85	6.27	2.54
	1.80	1.82	6.43	2.57
	1.68	1.71	6.27	2.27
	1.93	1.77	6.19	2.37
Lab 1	1.55	1.46	6.52	2.53
	1.83	1.45	6.48	2.85
	1.71	1.6	6.45	2.66
	1.52	1.45	6.55	2.65
Lab 4	1.64	1.87	6.51	3.23
	1.64	1.77	6.41	2.83
	1.81	2.35	6.64	3.11
	1.77	2.11	6.59	3.19
Average	1.73	1.80	6.46	2.70
Std Dev	0.13	0.26	0.18	0.27
# Labs	16	16	16	16
t	2.1315	2.1315	2.1315	2.1315
95%	0.07	0.14	0.09	0.15
Certified Uncertainty	1.7	1.7	6.5	2.7

+ / - 0.5

Certificate Number HON-T-082007p5

**Brammer Standard Company, Inc., is accredited to ISO Guide 34 as a Reference Material Producer for the production of Certified Reference Materials and Reference Materials by A2LA (Certificate Number 656.02)  
The scope of accreditation is listed on the website: [www.brammerstandard.com](http://www.brammerstandard.com)**

**By Certificate Number 10539, the Quality System of Brammer Standard Company, Inc., is registered to ISO 9001:2000 by National Quality Assurance, U.S.A.**

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

## **References:**

*ASTM documents available from ASTM, 100 Barr Harbor Drive, West Conshohocken, PA 19428-2959,  
Telephone: 610-832-9500 Fax: 610-832-9555 e-mail: [service@astm.org](mailto:service@astm.org) Website: [www.astm.org](http://www.astm.org)*

E 826 - 85 (Withdrawn 2005) Standard Practice for Testing Homogeneity of Materials for the Development of Reference Materials

E 1019 - 2003 Standard Test Methods for Determination of Carbon, Sulfur, Nitrogen, and Oxygen in Steel and in Iron, Nickel, and Cobalt Alloys

E 1724 - 95 (Reapproved 2001) Standard Guide for Testing and Certification of Metal and Metal-Related Reference Materials

E 1806 - 96 (Reapproved 2006) Standard Practice for Sampling Steel and Iron for Determination of Chemical Composition

E 1831 - 96 Standard Guide for Preparing Certificates for Reference Materials Relating to Chemical Composition of Metals, Ores, and Related Materials.

*ISO Guides and Standards available from Global Engineering - [www.global.ihs.com](http://www.global.ihs.com)*

ISO Standard 17025 (First edition, 2005), General requirements for the competence of calibration and testing laboratories.

ISO Guide 30 (Second edition, 1992), Terms and definitions used in connection with reference materials.

ISO Guide 31 (Second edition, 2000), Reference materials -Contents of certificates and labels.

ISO Guide 33 (Second edition, 2000), Uses of certified reference materials.

ISO Guide 34 (Second edition, 2000), General requirements for the competence of reference material producers.

ISO Guide 35 (Second edition, 2006), Certification of reference materials - General and statistical principles.

*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

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