



BUREAU OF ANALYSED SAMPLES LTD.



CERTIFICATE OF ANALYSIS

SPECTROSCOPIC CERTIFIED REFERENCE MATERIAL

SS-CRM 601/3 PLAIN CARBON CAST STEEL

Prepared under rigorous laboratory conditions and, AFTER CERTIFICATION ANALYSIS IN GREAT BRITAIN, issued by the Bureau of Analysed Samples Ltd., Newham Hall, Middlesbrough, England.

CO-OPERATING ANALYSTS

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AMG Analytical Services, Rotherham.
British Steel, Scunthorpe.
Element Teesside, Middlesbrough.
Pattinson & Stead (2005) Ltd., Middlesbrough.
Ridsdale & Co Ltd., Middlesbrough.

ANALYSES

Mean of 4 values – mass content in %.

Analyst No.	C	Si	Mn	P	S	Al
1	0.199	0.323	1.272	0.0297	0.0289	0.0620
2	0.195	0.317	1.258	0.0290	0.0288	0.0563
3	0.196	0.323	1.217	0.0294	0.0281	0.0594
4	0.200	0.327	1.244	0.0280	0.0256	0.0600
5	0.194	0.323	1.248	0.0298	0.0283	0.0622
M_M	0.197	0.323	1.248	0.0292	0.0279	0.0600
<i>s_M</i>	0.003	0.004	0.021	0.0008	0.0014	0.0024
<i>s_w</i>	0.002	0.002	0.004	0.0004	0.0009	0.0011

M_M: Mean of the laboratory mean values. *s_M*: standard deviation of the laboratory mean values. *s_w*: average within laboratory standard deviation.

CERTIFIED VALUES (C_v)

mass content in %

	C	Si	Mn	P	S	Al
C_v	0.197	0.323	1.248	0.0292	0.0279	0.0600
C(95%)	0.004	0.005	0.026	0.0010	0.0017	0.0030

The half width confidence interval, C(95%), is an expression of the uncertainty of the certified value.

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

where "t" is the appropriate two sided Student's t value at the 95% confidence level for "n" acceptable mean values.

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

NB: Although widely accepted within the industry "mass content in %" is neither an SI nor an IUPAC supported quantity. Multiplication of the certified value (C_v) by 10⁴ will yield the value in µg/g.

SS-CRM 601/3
PLAIN CARBON CAST STEEL
NOTES ON METHODS USED

CARBON

Analysts Nos. 1, 2 and 3 determined carbon using high frequency combustion and infrared absorption methods calibrated with carefully selected CRMs (see the traceability section for details). Analysts Nos. 4 and 5 used non-aqueous titration after combustion in a stream of oxygen.

SILICON

Analysts Nos. 1, 2 and 3 determined silicon using Inductively Coupled Plasma Optical Emission Spectrometry (ICP-OES) whilst Nos 4 and 5 used a gravimetric method, dehydrating the silica using perchloric acid, according to BS 6200: 3.26.1: 1995.

MANGANESE

Analysts Nos. 1, 2 and 3 determined manganese using ICP-OES. No. 4 used Flame Atomic Absorption Spectrometry (FAAS) and No. 5 a photometric method with potassium periodate.

PHOSPHORUS

Analysts Nos. 1, 2 and 3 determined phosphorus using ICP-OES. The others both used the phosphovanadomolybdate photometric method after solvent extraction.

SULPHUR

Analysts Nos. 1, 2 and 3 determined sulphur using high frequency combustion and infrared absorption methods calibrated with carefully selected CRMs (see the traceability section for details). Analyst No. 4 used an acid-base titration following combustion in a stream of oxygen whilst No. 5 determined sulphur gravimetrically as barium sulphate.

ALUMINIUM

All Analysts determined aluminium using ICP-OES.

DESCRIPTION OF SAMPLE

The material for this SS-CRM was prepared using a special method of casting known to provide material of uniform composition in a form suitable for use as a Certified Reference Material (CRM) for optical emission spectrometric analysis.

SS-CRM 601/3 is sold in the form of chill cast discs approximately 38mm in diameter and 19mm thick.

The preparation of representative samples for chemical analysis and the certification by co-operative analysis was undertaken by Bureau of Analysed Samples Ltd.

Bureau of Analysed Samples Ltd is a United Kingdom Accreditation Service (UKAS) Accredited Reference Material Producer, No. 4004, and, as the Producer of SS-CRM 601/3 as defined in BS EN ISO 17034, is fully responsible for assigning the certified values and their uncertainties in accordance with BS EN ISO 17034 and ISO Guide 35.

INTENDED USE

SS-CRM 601/3 is intended for establishing and checking the calibration of Optical Emission and X-Ray Spectrometers for the analysis of similar materials. The "as received" working surface of the disc should be cleaned before use to remove any protective coating. Users of optical emission spectrometry should also be aware that a minimum of three sparks, made on separate, clean locations across the face of the disc, should be obtained in order to establish a reliable mean value.

STABILITY

This SS-CRM will remain stable provided that the discs are stored in a dry atmosphere.

TRACEABILITY

The characterisation of this material has been achieved by chemical analysis involving inter-laboratory study, each laboratory using the method of their choice, details of which are given above. The analytical sample was prepared by taking turnings from several discs which were then mixed and subdivided. Each analyst received a representative sample of the bulk material, and the Certified Values accurately represent the chemical composition of the SS-CRM.

Most of the analytical methods used in the characterisation of this SS-CRM were either international or national standard methods or methods which are technically equivalent. All laboratories used either stoichiometric analytical techniques or methods which were calibrated predominantly against pure metals or stoichiometric compounds, ensuring traceability of the individual results to the SI.

For C and S results have been obtained using stoichiometric analytical techniques, methods which were calibrated against pure stoichiometric compounds or by calibration using 5 certified reference materials carefully selected to be similar in composition to SS-CRM 601/3 and all of which demonstrate full unbroken traceability to the SI. Different Analysts used different combinations of CRMs. The CRMs used were as follows: BCS-CRMs 111 and 238/2 and ECRMs 055-2, 056-2, 057-2, 084-1, 086-1 and 087-1.

MEASUREMENT UNCERTAINTY

The uncertainty of each of the certified values of SS-CRM 601/3 has been established by multiplying the standard error arising from the chemical analysis by the appropriate two-sided Student's t value at the 95% confidence level for the number of results. Homogeneity has been assessed in accordance with ASTM E826 and found to be acceptable. It has not, therefore, been included in the calculated measurement uncertainty. The stability of this SS-CRM and the transportation of the blocks also make negligible contributions to the overall uncertainty of the certified values.

COMMUTABILITY

When using optical emission spectrometers, it has been established that materials of similar composition from different sources may respond differently. The user should be aware that the metallurgical history of this SS-CRM may not accurately reflect the metallurgical history of the user's own materials.

Further information and advice on this or other Certified Reference Materials or Reference Materials produced by Bureau of Analysed Samples Ltd may be obtained from the address below.

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