

**CERTIFICATE OF ANALYSIS**SPECTROSCOPIC STANDARD CERTIFIED REFERENCE MATERIAL
(formerly known as Spectroscopic Standard)**SCRM No. 670/15**
DUCTILE (NODULAR) IRON

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

The material for this SCRM was prepared at the Castings Technology International Laboratories at Sheffield, U.K. (formerly BCIRA) using a special method of casting known to provide material of uniform composition in a form suitable for use as a calibration standard in optical emission spectroscopic analysis. Blocks from this cast have been shown, by statistically designed procedures, to provide reproducible results using vacuum direct reading emission spectroscopy.

The preparation of representative samples for chemical analysis and the certification by cooperative analysis was undertaken by Bureau of Analysed Samples Ltd. Bureau of Analysed Samples Ltd. has been accredited by The United Kingdom Accreditation Service (UKAS) in accordance with ISO Guide 34 and ISO/IEC 17025 as a Reference Material Producer.

CO-OPERATING ANALYSTS AND FIRMS

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Pattinson & Stead (2005) Ltd, Middlesbrough.
Ridsdale & Co Ltd., Middlesbrough.
Keighley Laboratories Ltd, Keighley.
IncoTest, Hereford.

ANALYSES

Mean of 4 values – mass content in %.

Analyst No.	C	Si	Mn	Cr	Ni	Cu	Ti	V	Ce	Mg	Mo
1	3.7183	2.1605	0.3482	0.4821	0.8897	0.9431	0.1078	0.0259	0.0096	0.0391	0.0044
2	3.7155	2.1689	0.3494	0.5158	0.8833	0.9141	0.1075	0.0237	0.0072	0.0427	0.0015
3	3.6917	2.1401	0.3563	0.4718	0.9042	0.9158	0.1117	0.0257	0.0076	0.0417	0.0021
4	3.7228	2.1641	0.3596	0.5091	0.8891	0.9297	0.1112	0.0251	0.0089	0.0408	0.0007
5	3.7083	2.1421	0.3576	0.5076	0.8800	0.9105	0.1097	0.0243	0.0090	0.0431	0.0017
M_M	3.7113	2.1551	0.3542	0.4973	0.8893	0.9226	0.1096	0.0249	0.0085	0.0415	
S_M	0.0122	0.0132	0.0052	0.0192	0.0093	0.0136	0.0020	0.0010	0.0011	0.0017	
S_w	0.0098	0.0075	0.0020	0.0040	0.0045	0.0050	0.0008	0.0003	0.0003	0.0004	

Additional Information: Analyst No. 5 determined S by a combustion/infra red absorption technique and found 0.010%.

M_M: Mean of the intralaboratory means. **S_M**: standard deviation of the intralaboratory means. **S_w**: Intralaboratory standard deviation.**CERTIFIED VALUES (C_v)**

mass content in %

	C	Si	Mn	Cr	Ni	Cu	Ti	V	Ce	Mg
C_v	3.711	2.155	0.354	0.497	0.889	0.923	0.1096	0.0249	0.0085	0.041
C(95%)	0.016	0.017	0.007	0.024	0.015	0.017	0.0024	0.0012	0.0014	0.006

The half width confidence interval $C(95\%) = t \times \sqrt{\left(\frac{S_M}{\sqrt{n}}\right)^2 + u_{hom}^2}$ where t is the appropriate two sided Student's t value at the 95% confidence level for n acceptable mean values and u_{hom} is the uncertainty contribution due to the between blocks homogeneity.

For further information regarding the confidence interval for the certified value see ISO Guide 35:2006 sections 6.1 and 10.5.2.

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NOTES ON METHODS USED

CARBON

Analysts Nos. 1, 4 and 5 determined carbon using high frequency combustion and infrared absorption, Nos. 2 and 3 used gravimetric methods, Analyst No. 3 using the standard method BS 6200.3.8.3:1990.

SILICON

Analysts Nos. 1 and 5 determined silicon using Inductively Coupled Plasma Optical Emission Spectroscopy (ICP-OES). The remaining Analysts used gravimetric methods, dehydrating the silica using perchloric acid, according to BS 6200: 3.26.1: 1995.

MANGANESE

All Analysts determined manganese using ICP-OES.

CHROMIUM

All Analysts determined chromium using ICP-OES.

NICKEL

All Analysts except No.3 determined nickel using ICP-OES. Analyst No. 3 separated nickel with dimethylglyoxime, dissolved the precipitate in dilute sulphuric acid, boiled with excess ferric ammonium sulphate and titrated with potassium dichromate.

COPPER

All Analysts determined copper using ICP-OES.

TITANIUM

All Analysts determined titanium using ICP-OES.

VANADIUM

All Analysts determined vanadium using ICP-OES.

CERIUM

All Analysts determined cerium using ICP-OES.

MAGNESIUM

All Analysts determined magnesium using ICP-OES.

MOLYBDENUM

All Analysts except No.3 determined molybdenum using ICP-OES. Analyst No. 3 followed the standard method BS 6200 3.19.1:1985 and determined molybdenum photometrically with thiocyanate in the presence of Sn (II) and extracted the complex with 4-methyl-pentan-2-one.

NOTE

The samples of this SCRM are in the form of chill cast rectangular blocks, each approximately 48mm x 42mm x 12mm thick with a single chilled working face. Spectroscopic reproducibility has been shown to be reliable to a depth of 5mm below the original surface of this block. Sparking must be made on the fully ground surface only and the sample should be discarded when this face has been ground back as far as the small shoulder around the edge of the sample.

Using vacuum direct reading optical emission spectrometers it has been established that materials of similar composition from different sources may respond differently. This SCRM is primarily intended for the construction of basic response curves which should be related to the response curves obtained from an identical examination of the user's own material. It will remain stable provided that the blocks are stored in a dry atmosphere. Provided that the material is suitably stored there will be no contribution to the uncertainty from the long term stability of this SCRM.

Any contribution to the uncertainty arising from the variation between the blocks has been included in the C(95%) value given on the first page and has been calculated according to the equation given underneath that table.

TRACEABILITY

The traceability of this SCRM has been established in accordance with principles of ISO Guides 30 – 35 and the International Vocabulary of Basic and General Terms in Metrology.

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. Most methods used 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. Four of the participating laboratories were accredited to ISO/IEC 17025 at the time of the analysis, although not necessarily for all of the constituents determined.

Bureau of Analysed Samples Ltd is the reference material producer as defined in ISO Guide 34:2009 section 3.1 and is fully responsible for assigning the certified values and their uncertainties in accordance with ISO Guides 34:2009 and 35:2006. Castings Technology International was responsible for the casting of the SCRM.

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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