

**CERTIFICATE OF ANALYSIS**SPECTROSCOPIC STANDARD CERTIFIED REFERENCE MATERIAL  
(formerly known as Spectroscopic Standard)**SCRM No. 667/12**  
**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., a UKAS accredited reference material producer No. 4004.

**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	Mo	Ni	Cu	Ti	V	Ce	Mg
1	3.0344	2.9503	0.2295	0.2792	0.0069	1.2900	0.5563	0.0023	0.0929	0.0811	0.0370
2	3.0183	2.9994	0.2378	0.2971	0.0063	1.2750	0.5470	0.0026	0.0987	...	0.0401
3	3.0641	2.9554	0.2397	0.2986	0.0064	1.3078	0.5418	0.0032	0.0960	0.0777	0.0408
4	3.0711	2.9692	0.2357	0.3023	0.0063	1.2952	0.5451	0.0026	0.0938	0.0799	0.0395
5	3.0883	2.9535	0.2391	0.3112	0.0054	1.3218	0.5586	0.0039	0.0980	0.0855	0.0426
<b>M<sub>M</sub></b>	<b>3.0552</b>	<b>2.9656</b>	<b>0.2364</b>	<b>0.2977</b>	<b>0.0063</b>	<b>1.2980</b>	<b>0.5498</b>	<b>0.0029</b>	<b>0.0959</b>	<b>0.0811</b>	<b>0.0400</b>
<b>S<sub>M</sub></b>	0.0284	0.0203	0.0042	0.0117	0.0006	0.0178	0.0074	0.0007	0.0026	0.0033	0.0021
<b>S<sub>w</sub></b>	0.0091	0.0087	0.0024	0.0021	0.0004	0.0058	0.0046	0.0002	0.0008	0.0008	0.0005

M<sub>M</sub>: Mean of the intralaboratory means. S<sub>M</sub>: standard deviation of the intralaboratory means. S<sub>w</sub>: Intralaboratory standard deviation.

**CERTIFIED VALUES (C<sub>v</sub>)**

mass content in %

	C	Si	Mn	Cr	Mo	Ni	Cu	Ti	V	Ce	Mg
<b>C<sub>v</sub></b>	<b>3.06</b>	<b>2.966</b>	<b>0.236</b>	<b>0.298</b>	<b>0.0063</b>	<b>1.298</b>	<b>0.550</b>	<b>0.0029</b>	<b>0.096</b>	<b>0.081</b>	<b>0.0400</b>
C(95%)	0.04	0.026	0.006	0.015	0.0007	0.023	0.010	0.0008	0.004	0.005	0.0026

The half width confidence interval 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 35:2006 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 (ISO 9556:1989).

### 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 except No.2 determined manganese using ICP-OES. Analyst No. 2 used Flame Atomic Absorption Spectrometry (FAAS).

### CHROMIUM

All Analysts except No. 2 determined chromium using ICP-OES. No. 2 used FAAS.

### MOLYBDENUM

All Analysts except No. 2 determined molybdenum using ICP-OES. No. 2 used FAAS.

### NICKEL

All Analysts except No. 2 determined nickel using ICP-OES. No. 2 used FAAS.

### COPPER

All Analysts except No. 2 determined copper using ICP-OES. No. 2 used FAAS.

### TITANIUM

All Analysts except No. 2 determined titanium using ICP-OES. Analyst No.2 used FAAS.

### VANADIUM

All Analysts except No. 2 determined vanadium using ICP-OES. Analyst No.2 used FAAS.

### CERIUM

All Analysts determined cerium using ICP-OES.

### MAGNESIUM

All Analysts except No. 2 determined magnesium using ICP-OES whilst Analyst No.2 used FAAS.

### NOTE

The samples of this SCRM are in the form of chill cast rectangular blocks, each approximately 50mm 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. It has been established that there is no contribution to the uncertainty from the variation between the blocks.

### 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 34:2000 section 3.1 and is fully responsible for assigning the certified values and their uncertainties in accordance with ISO Guides 34:2000 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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