



**CASTINGS TECHNOLOGY INTERNATIONAL**  
**and**  
**BUREAU OF ANALYSED SAMPLES LTD.**



## CERTIFICATE OF ANALYSIS

SPECTROSCOPIC STANDARD CERTIFIED REFERENCE MATERIAL  
(formerly known as Spectroscopic Standard)

### SCRM No. 670/13 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.

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**CO-OPERATING ANALYSTS AND FIRMS**

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|--|---|
| 1. MCKENNA, H.                           | Bodycote Materials Testing Teesside, Middlesbrough. |
| 2. CROCKER, F. H.                        | Pattinson & Stead (2005) Ltd, Middlesbrough.        |
| 3. JONES, S. J., <i>BSc, CChem, MRSC</i> | Ridsdale & Co Ltd., Middlesbrough.                  |
| 4. WHITAKER, J. S.                       | Keighley Laboratories Ltd, Keighley.                |
| 5. SCRIMSHIRE, P., <i>BSc</i>            | IncoTest, Hereford.                                 |

**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.

**SCRM 670/13**  
**DUCTILE (NODULAR) IRON**

**ANALYSES**

Mean of 4 values – mass content in %.

Analyst No.	C	Si	Mn	Cr	Mo	Ni	Cu	Ti	V	Ce	Mg
1	3.5053	2.1807	0.3110	0.4847	0.0138	0.9495	0.9372	0.1402	0.0112	0.0103	0.0487
2	3.4999	2.1926	0.3214	0.4898	0.0129	0.9634	0.9445	0.1414	0.0116	0.0108	0.0496
3	3.5063	2.2026	0.3145	0.4962	0.0144	0.9666	0.9317	0.1420	0.0118	0.0102	0.0492
4	3.5048	2.2055	0.3145	0.5043	0.0139	0.9681	0.9162	0.1418	0.0102	0.0096	0.0493
5	3.4800	2.1927	0.3128	0.5124	0.0141	0.9697	0.9199	0.1444	0.0112	0.0109	0.0493
<b>M<sub>M</sub></b>	<b>3.4993</b>	<b>2.1948</b>	<b>0.3148</b>	<b>0.4975</b>	<b>0.0138</b>	<b>0.9635</b>	<b>0.9299</b>	<b>0.1420</b>	<b>0.0112</b>	<b>0.0104</b>	<b>0.0492</b>
<b>s<sub>M</sub></b>	0.0111	0.0098	0.0040	0.0112	0.0006	0.0082	0.0119	0.0016	0.0007	0.0006	0.0004
<b>s<sub>w</sub></b>	0.0094	0.0088	0.0026	0.0028	0.0002	0.0058	0.0082	0.0014	0.0006	0.0003	0.0006

**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>3.499</b>	<b>2.195</b>	<b>0.315</b>	<b>0.498</b>	<b>0.0138</b>	<b>0.963</b>	<b>0.930</b>	<b>0.1420</b>	<b>0.0112</b>	<b>0.0104</b>	<b>0.0492</b>
<b>C(95%)</b>	0.014	0.013	0.005	0.014	0.0007	0.011	0.015	0.0019	0.0008	0.0007	0.0005

The half width confidence interval  $C(95\%) = \frac{t \times s_M}{\sqrt{n}}$  where "t" is the appropriate Student's t value and "n" is the number of acceptable mean values

For further information regarding the confidence interval for the certified value see ISO Guide 35:1989 section 4.

**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 Couple 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**

Analysts Nos. 1, 4 and 5 determined chromium using ICP-OES. No. 2 used FAAS and No 3 determined chromium titrimetrically after oxidation with ammonium persulphate according to the Standard Method BS EN 24937:1991 (ISO 4937:1986).

**MOLYBDENUM**

Analysts Nos. 1, 4 and 5 determined molybdenum using ICP-OES. Analyst Nos. 2 used FAAS and No. 3 determined molybdenum photometrically according to BS 6200:3.19.1:1985.

**NICKEL**

Analysts Nos. 1, 4 and 5 determined nickel using ICP-OES, Analyst No.2 used FAAS, and No. 3 titrated with potassium dichromate after separation with dimethylglyoxime.

**COPPER**

All Analysts except Nos. 2 and 3 determined copper using ICP-OES. Analysts Nos.2 and 3 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 except No. 2 determined cerium using ICP-OES. Analyst No.2 used a spectrophotometric method with hydroxyquinoline.

**MAGNESIUM**

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

For CASTINGS TECHNOLOGY INTERNATIONAL

Dr. M.C. ASHTON,  
Chief Executive

For BUREAU OF ANALYSED SAMPLES LTD.

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