



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



## CERTIFICATE OF ANALYSIS

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

### SCRM No. 667/11 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 and XRF analysis. Blocks from this cast have been shown, by statistically designed procedures to provide reproducible results using optical 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. BOUSTEAD, I., <i>BSc</i> , & JUDGE, MISS C., <i>MChem</i> , | Bodycote Materials Testing Teesside, Middlesbrough. |
| 2. HEYWOOD, D.G., <i>AMet</i> ,                                | Pattinson & Stead, Middlesbrough.                   |
| 3. PAGE-GIBSON, J.E., <i>BSc</i> , <i>CChem</i> , <i>MRSC</i>  | Ridsdale & Co Ltd., Middlesbrough.                  |
| 4. WHITAKER, J. S.,  | Keighley Laboratories Ltd, Keighley.                |
| 5. SCRIMSHIRE, P.,   | 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.

It has been established that materials of similar composition from different sources may respond differently when using optical emission spectrometers. 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.

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## ANALYSES

Mean of 4 values – mass content in %.

Analyst No.	C	Si	Mn	Cr	Mo	Ni	Cu	Ti	V	Ce	Mg
1	2.7905	2.8740	0.1984	1.0152	0.0077	1.2888	0.4889	0.0050	0.1085	0.0630	0.0606
2	2.7838	2.8413	0.1965	1.0003	0.0069	1.2525	0.4855	0.0041	0.1143	0.0523	0.0617
3	2.7761	2.8414	0.2032	0.9786	0.0072	1.3013	0.4890	0.0041	0.1102	0.0584	0.0603
4	2.7703	2.8435	0.2029	1.0087	0.0068	1.2810	0.4880	0.0043	0.1077	0.0697	0.0617
5	2.7425	2.8445	0.2064	1.0110	0.0083	1.2948	0.4888	0.0051	0.1111	0.0679	0.0619
<b>M<sub>M</sub></b>	<b>2.7726</b>	<b>2.8489</b>	<b>0.2015</b>	<b>1.0028</b>	<b>0.0074</b>	<b>1.2837</b>	<b>0.4880</b>	<b>0.0045</b>	<b>0.1104</b>	<b>0.0623</b>	<b>0.0612</b>
<b>s<sub>M</sub></b>	0.0185	0.0141	0.0040	0.0146	0.0006	0.0190	0.0015	0.0005	0.0026	0.0071	0.0008
<b>s<sub>w</sub></b>	0.0078	0.0117	0.0020	0.0045	0.0004	0.0074	0.0021	0.0002	0.0013	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>2.773</b>	<b>2.849</b>	<b>0.202</b>	<b>1.003</b>	<b>0.0074</b>	<b>1.284</b>	<b>0.4880</b>	<b>0.0045</b>	<b>0.110</b>	<b>0.062</b>	<b>0.0612</b>
<b>C(95%)</b>	0.023	0.018	0.005	0.018	0.0008	0.024	0.0019	0.0006	0.003	0.009	0.0010

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 by high frequency combustion and infrared absorption, calibrated with pure chemicals. No. 2 determined carbon gravimetrically and No. 3 used a non-aqueous titration according to BS 6200: 3.8.2: 1991.

### SILICON

Analyst No. 1 determined silicon using Inductively Coupled Plasma Optical Emission Spectroscopy (ICP-OES). The other Analysts used gravimetric methods, dehydrating the silica using perchloric acid, according to BS 6200: 3.26.1: 1995.

### MANGANESE

Analysts Nos.1, 4 and 5 determined manganese using ICP-OES. No. 2 used flame atomic absorption spectrometry (FAAS) and Analyst No. 3 determined manganese photometrically according to BS 6200: 3.18.2: 1995.

### CHROMIUM

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

### MOLYBDENUM

Analysts Nos. 1, 4 and 5 determined molybdenum using ICP-OES. No. 2 used FAAS and No. 3 extracted molybdenum with thiocyanate into 4-methyl-pentan-2-one and completed photometrically.

### 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. No. 2 used FAAS.

### VANADIUM

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

### CERIUM

All Analysts except No. 2 determined nickel using ICP-OES. No. 2 used a spectrophotometric method with hydroxyquinoline.

### MAGNESIUM

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

## TRACEABILITY

The traceability of this CRM is ensured by the use of either stoichiometric analytical techniques or methods which are calibrated against pure metals or stoichiometric compounds.

This Certified Reference Material has been prepared in accordance with the recommendations specified in ISO Guides 30 to 35, available from the International Standards Organisation in Geneva.

For CASTINGS TECHNOLOGY INTERNATIONAL  
Dr. M.C. ASHTON,  
Chief Executive

For BUREAU OF ANALYSED SAMPLES LTD.  
P. D. RIDSDALE  
Chairman

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