REPLICAST LTD.
and
BUREAU OF ANALYSED SAMPLES LTD.

CERTIFICATE OF ANALYSIS

SPECTROSCOPIC CERTIFIED REFERENCE MATERIAL

SCRM No. 667/13
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.

CO-OPERATING ANALYSTS

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ANALYSES

Mean of 4 values – mass content in %.

Analyst No.	C	Si	Mn	Cr	Ni	Cu	V	Ce	Mg	*Mo*	*Ti*
1	3.0533	2.8533	0.2140	0.2871	1.2943	0.4979	0.1002	0.1124	0.0667	*0.0048*	*0.0043*
2	3.0155	2.8723	0.2257	0.2924	1.2908	0.4926	0.1051	0.1045	0.0705	*0.0067*	*0.0079*
3	2.9956	2.8865	0.2265	0.2933	1.3001	0.5001	0.1058	0.1054	0.0715	*0.0064*	*0.0090*
4	3.0624	2.8500	0.2208	0.2933	1.3117	0.4933	0.1003	0.1081	0.0668	*0.0032*	*0.0063*
5	3.0559	…	0.2250	0.3016	1.3189	0.5022	0.1039	0.1183	0.0733	*0.0064*	*0.0072*
M_M	**3.0365**	**2.8655**	**0.2224**	**0.2935**	**1.3032**	**0.4972**	**0.1031**	**0.1097**	**0.0698**		
s_M	0.0294	0.0171	0.0052	0.0052	0.0119	0.0042	0.0027	0.0057	0.0030		
s_W	0.0071	0.0127	0.0018	0.0035	0.0057	0.0028	0.0015	0.0010	0.0007		

Values given in italics are for information only

M_M: Mean of the intralaboratory means. s_M: standard deviation of the intralaboratory means. s_W: Intralaboratory standard deviation.

CERTIFIED VALUES (Cv)

mass content in %

	C	Si	Mn	Cr	Ni	Cu	V	Ce	Mg
Cv	**3.04**	**2.866**	**0.222**	**0.294**	**1.303**	**0.497**	**0.103**	**0.110**	**0.070**
C(95%)	0.04	0.028	0.007	0.007	0.015	0.006	0.004	0.008	0.004

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.

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

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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 after combustion in a stream of oxygen, Analyst No. 3 using the standard method BS 6200.3.8.3:1990.

SILICON

Analyst No. 1 determined silicon using Inductively Coupled Plasma Optical Emission Spectrometry (ICP-OES). The remaining Analysts determined silicon gravimetrically, 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 for No. 3, determined nickel using ICP-OES. No. 3 precipitated nickel with dimethylglyoxime, dissolved the precipitate with sulphuric acid, added Fe(III) and titrated the reduced Fe(II) with dichromate.

COPPER

All Analysts, except for No. 2, determined copper using ICP-OES. No. 2 used Flame Atomic Absorption Spectrometry.

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

Analyst No. 3 determined molybdenum photometrically, extracting the yellow thiocyanate complex with 4-methyl-pentan-2-one. The remaining Analysts determined molybdenum using ICP-OES.

TITANIUM

All Analysts determined titanium using ICP-OES

DESCRIPTION OF SAMPLE

The material for this SCRM was prepared by Replicast at Sheffield, U.K 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. Blocks from this cast have been shown, by statistically designed procedures, to provide reproducible results using optical emission spectrometry.

SCRM 667/13 is sold 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.

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 SCRM 667/13 as defined in ISO Guide 34:2009 section 3.1, is fully responsible for assigning the certified values and their uncertainties in accordance with ISO Guides 34:2009 and 35:2006.

INTENDED USE

SCRM 667/13 is primarily intended for the construction of calibration curves or for Quality Control purposes. It is one of a series of such SCRMs (SCRMs 666 – 670) which may be used together.

STABILITY

This SCRM will remain stable provided that the blocks 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 blocks 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 SCRM.

Most of the analytical methods used in the characterisation of this SCRM 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.

MEASUREMENT UNCERTAINTY

The uncertainty of each of the certified values of SCRM 667/13 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 – 85 and found to be acceptable. It has not, therefore, been included in the calculated measurement uncertainty. The stability of this SCRM and the transportation of the blocks also make negligible contributions to the overall uncertainty of the certified values.

COMMUTABILTY

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, although similar, the metallurgical history of this SCRM may not be identical to that of other SCRMs in this series and 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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