MBH ANALYTICAL LTD

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CERTIFICATE OF ANALYSIS

36X 71500 (batch A)

Certified Reference Material Information

Type:	CUPRO-NICKEL (WROUGHT)
Form and Size:	Disc ~38mm diameter
Manufactured by:	Multimetals Ltd, Kota, India
Certified and Supplied by:	MBH Analytical Ltd

Assigned Values

Percentage element by weight

Element	Sn	Pb	Zn	Fe	Ni	Co	Mn
Value [1]	**0.0112**	**0.0114**	**0.150**	**0.888**	**31.24**	**0.0163**	**0.850**
Uncertainty [2]	0.0005	0.0008	0.003	0.005	0.10	0.0006	0.005

Element	Si	P	Al	C	S	B	Cu
Value [1]	**0.0096**	**0.0074**	**(0.001)**	**0.0240**	**0.0454**	**0.0049**	**66.74**
Uncertainty [2]	0.0006	0.0008	-	0.0007	0.0014	0.0003	0.10

Notes: values given in parentheses are not certified - they are provided for information only.

Definitions

[1] The certified values are the present best estimates of the true content for each element. Each value is a panel consensus, based on the averaged results of an interlaboratory testing programme, detailed on page 3.

[2] The uncertainty values are generated from the 95% confidence interval derived from the wet analysis results, in combination with a statistical assessment of the homogeneity data, as described on page 2.

Certified by:

MBH ANALYTICAL LIMITED _____ on 2nd August 2015

C Eveleigh

Method of Preparation

This reference material was produced from commercial wrought & annealed barstock to BS2874 CN107, UNS C71500. The detailed metallurgical history of this material is unknown.

Sampling

Samples for chemical analysis were taken from various positions throughout the bar. At least 15% of all discs were selected for non-destructive homogeneity testing.

Homogeneity

The discs were checked for sample and batch uniformity using an optical emission spectrometer.

Using the meaned data from each surface, standard deviation values were derived for each element as an indicator of any non-homogeneity (as determined for the specific sample size taken by the spectrometer).

Chemical Analysis

Analysis was carried out on millings taken from samples representative of the product. It was performed by a panel of laboratories mostly operating within the terms of EN ISO/IEC 17025 - 2005, using documented standard reference methods and validated by appropriate reference materials.

The individual values listed overpage are the average of each analyst's results.

Estimation of Uncertainties

Each element certified has been analysed by several laboratories, and 95% half-width confidence intervals ($C_{(95\%)}$) for the resultant mean values have been derived by the method shown on page 3.

As a separate exercise, the degree of non-homogeneity of the batch for each element has been quantified by a programme of non-destructive application testing, described above.

The final certified uncertainty for each element has been derived by combining these two factors, using the square-root of the summed squares.

Traceability

Much of the analytical work performed to assess this material has been carried out by laboratories with proven competence, as indicated by their accreditation to ISO 17025. It is an implicit requirement for this accreditation that analytical work should be performed with due traceability, via an unbroken chain of comparisons, each with stated uncertainty, to primary standards such as the mole, or to nationally- or internationally-recognised reference materials. In addition, some of the results derived as part of this testing programme have traceability to NIST standards, as part of the analytical calibration or process control.

Usage

Intended use:	With optical emission and X-ray fluorescence spectrometers.
Recommended method of use:	Copper alloys are generally prepared by machining on a mill or a lathe. However, users are recommended to follow the calibration and sample preparation procedures specified by the relevant instrument manufacturer. Preparation should be the same for reference materials and the samples for test. A minimum of five consistent replicate analyses is recommended to provide the necessary sample size. Users are advised to check against possible bias between reference materials and production samples due to differences in metallurgical history, and be aware of possible inter-element effects.

Analytical Data

Percentage element by weight

Sample	Sn	Pb	Zn	Fe	Ni	Co	Mn
1	0.0102	0.0097	0.145	0.880	31.06	0.0153	0.842
2	0.0102	0.0098	0.145	0.883	31.14	0.0154	0.846
3	0.0104	0.0100	0.145	0.885	31.17	0.0154	0.846
4	0.0107	0.0103	0.148	0.886	31.25	0.0155	0.848
5	0.0109	0.0104	0.149	0.887	31.25	0.0155	0.849
6	0.0111	0.0105	0.150	0.887	31.25	0.0155	0.849
7	0.0111	0.0105	0.150	0.888	31.28	0.0160	0.850
8	0.0113	0.0109	0.150	0.889	31.30	0.0167	0.851
9	0.0113	0.0120	0.150	0.890	31.42	0.0169	0.851
10	0.0116	0.0121	0.150	0.891		0.0172	0.854
11	0.0120	0.0123	0.151	0.892		0.0172	0.855
12	0.0124	0.0131	0.152	0.893		0.0177	0.858
13	0.0126	0.0133	0.153	0.897		0.0180	
14		0.0134	0.156				
15			0.157				
Mean	**0.0112**	**0.0114**	**0.150**	**0.888**	**31.24**	**0.0163**	**0.850**
Std Dev	0.0008	0.0014	0.004	0.004	0.10	0.0010	0.005
$C_{(95\%)}$	0.0005	0.0008	0.002	0.003	0.08	0.0006	0.003

Sample	Si	P	Al	C	S	B	Cu
1	0.0084	0.0052	0.0003	0.0224	0.0432	0.0038	66.56
2	0.0086	0.0056	0.0004	0.0230	0.0442	0.0046	66.63
3	0.0087	0.0059	0.0005	0.0230	0.0443	0.0048	66.64
4	0.0094	0.0074	0.0005	0.0234	0.0446	0.0048	66.69
5	0.0098	0.0075	0.0006	0.0241	0.0449	0.0048	66.71
6	0.0099	0.0076	0.0006	0.0241	0.0449	0.0048	66.75
7	0.0100	0.0079	0.0009	0.0241	0.0452	0.0051	66.81
8	0.0101	0.0079	0.0014	0.0244	0.0452	0.0051	66.81
9	0.0104	0.0080	0.0022	0.0246	0.0453	0.0052	66.89
10	0.0105	0.0081	0.0025	0.0254	0.0454	0.0052	66.90
11		0.0085	0.0029	0.0256	0.0487	0.0053	
12		0.0088	0.0031		0.0488		
Mean	**0.0096**	**0.0074**	**(0.0013)**	**0.0240**	**0.0454**	**0.0049**	**66.74**
Std Dev	0.0008	0.0012	-	0.0010	0.0017	0.0004	0.11
$C_{(95\%)}$	0.0006	0.0008	-	0.0007	0.0011	0.0003	0.08

Note: $C_{(95\%)}$ is the 95% half-width confidence interval derived from the equation:

$$C_{(95\%)} = (t \times SD)/\sqrt{n}$$

where n is the number of available values, t is the Student's t value for n-1 degrees of freedom, and SD is the standard deviation of the test results.

Participating Laboratories

Exova Ltd	Middlesbrough, England	UKAS accreditation 0239
Sheffield Assay Office	Sheffield, England	UKAS accreditation 0012
Birmingham Assay Office	Birmingham, England	UKAS accreditation 0667
Universal Scientific Laboratory Pty Ltd	Milperra, NSW, Australia	NATA accreditation 0492
Shanghai Jinyi Test Technology Co	Shanghai, China	CNAL accreditation 0783
Luo Yang Copper	Luo Yang, He Nan, China	CNAL accreditation 0173
Shandong Metallurgical & Science Research	Jinan, Shandong, China	CNAS accreditation 1461
Genitest, Inc	Montreal, Canada	PRI accreditation 123077
Bureau Veritas CPS Pvt Ltd	Chennai, India	NABL accreditation 0025
Raghavendra Spectromet Laboratory	Bangalore, India	NABL accreditation 0371
TCR Engineering Services Ltd	Mumbai, India	NABL accreditation 0367
Tec-Eurolab	Campogalliano, Italy	ACCREDIA accreditation 52
Institute of Non-Ferrous Metals	Gliwice, Poland	PCA accreditation AB274
AMG Superalloys UK Ltd	Rotherham, England	
Coleshill Laboratories Ltd	Birmingham, England	
Analyticka Laborator Lithea sro	Brno, Czech Republic	

Note: to achieve the above accreditation (UKAS, NATA, etc), test houses must demonstrate conformity to the general requirements of EN ISO/IEC 17025.

Analytical Methods Used

ELEMENT	RESULT No. & METHOD			
	ICP-AES	FAAS	OTHER	
Tin	2-4, 6-13	1	5	photometric (phenyl fluorone)
Lead	1, 2, 4, 6, 9-14	3, 5, 7, 8		
Zinc	2, 3, 5, 7-11, 13, 14	1, 4, 6, 12		
Iron	2, 4, 6-8, 10-13	1, 9	3, 5	photometric (orthophenanthroline)
Nickel	1, 3, 7	-	4, 5, 8, 9	volumetric (dimethyl glyoxime/EDTA)
			2, 6	gravimetric (dimethyl glyoxime)
Cobalt	1, 2, 5-8, 10-12	3, 4, 9		
Manganese	2-4, 8, 9, 11, 12	1, 6, 7, 10	5	photometric (periodate)
Silicon	2-6, 8, 9	-	1, 7, 10	photometric (molybdenum blue)
Phosphorus	2, 3, 5-7, 10-12	-	1	volumetric (alkalimetric)
			4, 8, 9	photometric (molybdenum yellow)
Aluminium	1, 3, 6-10, 12	2, 5, 11	4	photometric (chrome azurol-S)
Carbon	-	-	all	combustion (IR or volumetric detection)
Sulfur	4, 5, 9	-	1-3, 6-8, 10-12	combustion (IR or volumetric detection)
Boron	1-9	10, 11		
Copper	6-8	-	1, 2, 10	electrogravimetric
			3-5, 9	volumetric (thiosulfate)

Notes

This Certified Reference Material has been produced and certified, wherever possible, in accordance with the requirements of ISO Guide 34-2009, ISO Guide 31-2000 and ISO Guide 35-2006, taking into account the requirements of the ISO Guide to the Expression of Uncertainty in Measurement (GUM).

This certification is applicable to the whole of the disc. However, in accordance with normal practice for emission spectrometry, it is appropriate to avoid usage of the centre of the disc, ~8 mm diameter.

This material will remain stable indefinitely, provided adequate precautions are taken to protect it from cross-contamination, extremes of temperature and atmospheric moisture. All production records will be retained for a period of 20 years from the date of this certificate. Technical support for this certification will therefore expire in August 2035, although we reserve the right to make changes as issue revisions, in the intervening period.

This material is also available in the form of chippings.

The manufacture, analysis and certification of this product were supervised by C Eveleigh, PhD, Technical Director, MBH Analytical Ltd.

The material to which this certificate of analysis refers is supplied subject to our general conditions of sale.