MBH ANALYTICAL LTD

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CERTIFICATE OF ANALYSIS

31X HT38 (batch A)

Certified Reference Material Information

Type:	HIGH-TENSILE BRASS (WROUGHT)
Form and Size:	Disc 50mm Diameter x 18mm Thickness
Manufactured by:	Cerro Manganese Bronze Limited
Certified and Supplied by:	MBH Analytical Limited

Certified Analysis

Percentage element by weight

Element	Sn	Pb	Zn	Fe	Ni	Al	Mn
Value [1]	**0.039**	**0.051**	**36.66**	**0.0530**	**0.0242**	**0.960**	**2.60**
Uncertainty [2]	0.002	0.003	0.14	0.0013	0.0009	0.013	0.04

Element	Si	As	S	Sb	P	C	Cu
Value [1]	**0.86**	**0.0008**	**(0.001)**	**(0.0006)**	**0.0024**	**0.003**	**58.77**
Uncertainty [2]	0.02	0.0002	-	-	0.0005	0.001	0.09

Note: 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:

on 24th February 2004

MBH ANALYTICAL LIMITED _____

C Eveleigh

Method of Preparation

This reference material was produced from commercial bar, continuous cast, hot extruded, cold drawn and stress-relieved. The discs are derived from a single piece of bar, from one batch.

Sampling

Samples for chemical analysis, and discs for homogeneity checks, were taken at regular intervals from the bar. At least 10% of all discs were incorporated into the schedule for homogeneity checking.

Homogeneity

The discs were checked for lateral and batch uniformity using an optical emission spectrometer. Multiple measurements were taken from each surface under test.

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 certified portion of the product. It was performed by a panel of laboratories mostly operating within the terms of EN ISO/IEC 17025 - 2000, 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, discussed 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

Most of the analytical work performed to assess this material has been carried out by laboratories with proven competence, as indicated by their accreditation to a national authority. It is part of the 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 primary reference materials.

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	Al	Mn
1	0.0340	0.0476	36.53	0.0518	0.0212	0.940	2.516
2	0.0355	0.048	36.58	0.0521	0.0233	0.942	2.554
3	0.0356	0.0481	36.65	0.0521	0.0235	0.946	2.555
4	0.037	0.0492	36.70	0.0527	0.0242	0.955	2.59
5	0.0393	0.0495	36.72	0.0530	0.0244	0.962	2.592
6	0.0394	0.0515	36.75	0.0531	0.0245	0.965	2.617
7	0.0395	0.0520		0.0535	0.0248	0.965	2.62
8	0.0395	0.0526		0.0540	0.0250	0.970	2.65
9	0.0406	0.0556		0.0548	0.0250	0.975	2.66
10	0.0416	0.0568			0.0256	0.977	2.694
11	0.0420						
Mean	**0.0385**	**0.0511**	**36.66**	**0.0530**	**0.0242**	**0.960**	**2.604**
Std Dev	0.0026	0.0032	0.09	0.0010	0.0012	0.013	0.055
$C_{(95\%)}$	0.0018	0.0023	0.09	0.0008	0.0009	0.010	0.039

Sample	Si	As	S	Sb	P	C	Cu
1	0.83	0.0004	0.0004	0.0004	0.0019	0.0022	58.69
2	0.850	0.0007	0.0004	0.0005	0.0020	0.0025	58.70
3	0.857	0.0007	0.0005	0.0007	0.0021	0.0028	58.75
4	0.859	0.0007	0.0017	0.0008	0.0023	0.0029	58.78
5	0.874	0.0008	0.0018	0.0008	0.0026	0.0037	58.80
6	0.879	0.0010	<0.005		0.0028	0.0039	58.80
7	0.893	0.0010			0.0033		58.86
Mean	**0.863**	**0.0008**	**(0.001)**	**0.0006**	**0.0024**	**0.0030**	**58.77**
Std Dev	0.021	0.0002	-	0.0002	0.0005	0.0007	0.06
$C_{(95\%)}$	0.019	0.0002	-	0.0002	0.0005	0.0007	0.06

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

Sheffield Assay Office	Sheffield, England	UKAS accreditation 0012
Bodycote Materials Testing Ltd	Middlesbrough, England	UKAS accreditation 0639
Universal Scientific Laboratory Pty Ltd	Milperra, NSW, Australia	NATA accreditation 0492
Institute of Iron & Steel Technology	Shanghai, China	CNAL accreditation 0783
Luo Yang Copper	Luo Yang, He Nan, China	CNAL accreditation 0173
Sargam Metals Pvt Ltd	Chennai, India	NABL accreditation 0025
TCR Engineering Services Pvt Ltd	Mumbai, India	NABL accreditation 0367
Genitest Inc	Montreal, Canada	
Coleshill Laboratories Ltd	Coleshill, England	
Outokumpu Copper MKM UK	Aldridge, England	
SiPi Metals Inc	Chicago, IL, USA	

Note: to achieve National Accreditation (eg UKAS, NATA, CNAL, NABL), 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, 6-8, 10, 11	3, 9	1	ICP-MS
			5	photometric (phenyl fluorone)
Lead	2, 3, 5, 6, 8, 10	4, 7, 9	1	volumetric (EDTA)
Zinc	1, 4, 6	-	2, 3, 5	volumetric (EDTA)
Iron	2-5, 7, 8	1, 6	9	photometric (orthophenanthroline)
Nickel	2, 4, 6-8, 10	3, 5	1, 9	photometric (dimethyl glyoxime)
Aluminium	2, 5-10	1	3	photometric (chrome azurol-S)
			4	volumetric (EDTA)
Manganese	2-4, 6, 8, 9	7, 10	1	volumetric (ferrous ammonium sulfate)
			5	photometric (periodate)
Silicon	5, 6, 7	-	1, 2, 3, 4	gravimetric (perchloric acid)
Arsenic	3, 4, 6, 7	2	1	ICP-MS
			5	photometric (turbidity)
Sulfur	-	-	all	combustion (infra-red detection)
Antimony	1, 3	4, 5	2	ICP-MS
Phosphorus	2, 4-7	-	1	volumetric (alkalimetric)
			3	photometric (molybdenum yellow)
Carbon	-	-	all	combustion (infra-red detection)
Copper	2, 7	-	1, 3, 4, 5	electrogravimetric
			6	volumetric (thiosulfate)

Notes

This Certified Reference Material has been produced and certified in accordance with the requirements of ISO Guide 34-2000, ISO Guide 31-2000 and ISO Guide 35-1989, taking into account the requirements of ASTM E1724 and the ISO Guide to the Expression of Uncertainty in Measurement (GUM).

This product has been found to be of satisfactory homogeneity across the main portion of the diameter. However, in accordance with normal practice for OES use, it is appropriate to avoid using the central portion of ~15mm diameter.

This material will remain stable 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. This certification will therefore expire in February 2026, 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.