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CERTIFICATE OF ANALYSIS

31X CZ121 (batch A)

Certified Reference Material Information

Type:	LEADED BRASS (WROUGHT)
Form and Size:	Disc ~41mm diameter
Manufactured by:	Boliden Brass, UK
Certified and Supplied by:	MBH Analytical Ltd

Assigned Values

Percentage element by weight

Element	Sn	Pb	Zn	Fe	Mn	Ni	Cr	As
Value [1]	**0.1940**	**3.01**	**38.57**	**0.167**	**0.0052**	**0.1028**	**(0.0002)**	**0.0299**
Uncertainty [2]	0.0019	0.03	0.12	0.005	0.0003	0.0010	-	0.0007

Element	Al	P	Si	Sb	Bi	Ag	Cu
Value [1]	**0.0034**	**0.0028**	**(0.0030)**	**0.0050**	**0.0046**	**0.0060**	**57.84**
Uncertainty [2]	0.0004	0.0003	-	0.0003	0.0005	0.0005	0.10

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 5th November 2015

MBH ANALYTICAL LIMITED _____

C Eveleigh

Method of Preparation

This reference material was produced from commercial wrought barstock to BS2874 CZ121, with nominal composition to UNS C38500. The detailed metallurgical history of this material is unknown.

Sampling

Samples for chemical analysis were taken from various positions throughout the bar. Approximately 10% 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, 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

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. Note this sample is liable to the effects of Pb smearing, and care needs to be taken during the preparation of the surface, to minimise this effect. 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	Mn	Ni	Cr	As
1	0.1875	2.953	38.42	0.1595	0.0048	0.1001	0.00010	0.0270
2	0.1900	2.981	38.44	0.1597	0.0050	0.1007	0.00010	0.0281
3	0.1920	2.987	38.53	0.1618	0.0050	0.1008	0.00011	0.0291
4	0.1922	2.994	38.56	0.1638	0.0050	0.1025	0.00017	0.0292
5	0.1925	2.998	38.57	0.1646	0.0051	0.1027	0.00025	0.0294
6	0.1932	3.000	38.57	0.1652	0.0051	0.1028	0.00033	0.0294
7	0.1940	3.012	38.65	0.1655	0.0051	0.1030	<0.0005	0.0297
8	0.1950	3.013	38.66	0.1671	0.0052	0.1030	<0.001	0.0299
9	0.1953	3.016	38.71	0.1720	0.0052	0.1033		0.0301
10	0.1958	3.058		0.1720	0.0053	0.1040		0.0303
11	0.1961	3.070		0.1726	0.0053	0.1041		0.0305
12	0.1965			0.1750	0.0055	0.1044		0.0305
13	0.1970				0.0055	0.1056		0.0313
14	0.1995				0.0055			0.0317
15					0.0056			0.0320
Mean	**0.1940**	**3.007**	**38.57**	**0.1666**	**0.0052**	**0.1028**	**(0.0002)**	**0.0299**
Std Dev	0.0031	0.033	0.10	0.0052	0.0002	0.0016	-	0.0013
$C_{(95\%)}$	0.0018	0.022	0.07	0.0033	0.0001	0.0009	-	0.0007

Sample	Al	P	Si	Sb	Bi	Ag	Cu
1	0.0026	0.0020	0.0018	0.0043	0.0036	0.0049	57.75
2	0.0027	0.0021	0.0021	0.0043	0.0036	0.0052	57.76
3	0.0028	0.0022	0.0022	0.0044	0.0038	0.0053	57.76
4	0.0030	0.0023	0.0028	0.0047	0.0040	0.0057	57.82
5	0.0031	0.0025	0.0035	0.0049	0.0040	0.0058	57.83
6	0.0035	0.0026	0.0037	0.0051	0.0044	0.0058	57.86
7	0.0036	0.0028	0.0037	0.0051	0.0047	0.0059	57.86
8	0.0041	0.0030	0.0040	0.0051	0.0051	0.0066	57.88
9	0.0041	0.0031		0.0052	0.0051	0.0066	57.93
10	0.0041	0.0032		0.0053	0.0052	0.0067	57.96
11		0.0034		0.0054	0.0057	0.0069	
12		0.0034		0.0055	0.0059	0.0071	
13		0.0035		0.0056			
14				0.0056			
Mean	**0.0034**	**0.0028**	**(0.0030)**	**0.0050**	**0.0046**	**0.0060**	**57.84**
Std Dev	0.0006	0.0005	-	0.0005	0.0008	0.0007	0.07
$C_{(95\%)}$	0.0004	0.0003	-	0.0003	0.0005	0.0005	0.05

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
Institute of Non-Ferrous Metals	Gliwice, Poland	PCA accreditation AB274
Mineral & Metallurgical Laboratories	Bangalore, India	
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	1, 3-7, 9, 12, 14	2, 10, 11	8	photometric (phenyl fluorone)
			13	volumetric (iodate)
Lead	1-3, 5, 6, 8-11	7	4	gravimetric (as sulfate)
Zinc	1, 6, 7	-	2-5, 8, 9	volumetric (EDTA)
Iron	1, 3, 5, 7, 8, 10, 11	4, 6, 9	2	photometric (orthophenanthroline)
			12	volumetric (redox)
Manganese	2-4, 6-8, 10, 12-15	1, 5, 11	9	volumetric (arsenite)
Nickel	2-6, 9-11	1, 7	8	gravimetric (dimethyl glyoxime)
			12, 13	photometric (dimethyl glyoxime)
Chromium	3-8	1, 2		
Arsenic	1-3, 6-12, 14	5, 13, 15	4	photometric (turbidity)
Aluminium	2, 3, 5, 6, 8-10	1, 4, 7		
Phosphorus	3, 4, 6, 8-10, 13	-	1, 5, 11	photometric (molybdenum yellow)
			2, 7, 12	volumetric (alkalimetric)
Silicon	1, 4, 7, 8	-	2, 3, 5, 6	photometric (molybdenum blue)
Antimony	2, 3, 5, 7-10, 12-14	1, 4, 11	6	photometric (crystal violet)
Bismuth	1, 2, 5-11	4, 12	3	photometric (iodide)
Silver	1-7, 9, 12	8, 10, 11		
Copper	5, 10	-	1-3, 9	volumetric (thiosulfate)
			4, 6-8	electrogravimetric

Notes

This Certified Reference Material has been produced and certified, wherever possible, in accordance with the requirements of ISO Guide 34-2009, ISO Guide 31-2015 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 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 November 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.