

CERTIFICATE OF ANALYSIS

32X PB20 (batch A)

Certified Reference Material Information

Type: PHOSPHOR BRONZE (CONCAST / WROUGHT)

Form and Size: Disc 38mm Diameter x 17mm Thickness

Produced by: Cerro Manganese Bronze Ltd

Certified and supplied by: MBH Analytical Limited

Certified Analysis

Percentage element by weight

Element	Sn	Pb	Zn	Fe	Ni	Al	Si
Value ¹	4.55	0.0045	0.007	0.0013	0.0090	(<0.001)	0.0046
Uncertainty ²	0.04	0.0006	0.001	0.0003	0.0005	-	0.0004

Element	As	Mn	Sb	P	C	S	Cu
Value ¹	0.0011	(0.0007)	0.0012	0.196	(0.0014)	0.0030	95.22
Uncertainty ²	0.0002	-	0.0003	0.008	-	0.0005	0.07

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:

MBH ANALYTICAL LIMITED _____

on 19th July 2004

C Eveleigh



Method of Preparation

This reference material was produced from a single length of continuous-cast bar, cold worked down to final dimension as supplied.

Sampling

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

Homogeneity

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

For each of the surfaces checked, the differences between the averaged result and the overall mean value were assessed to ensure that the overall homogeneity of the material comprising the batch satisfied the definition given in ISO guide 30 – 1992.

Some moderate segregation for Sn was evident for the central portion of the bar, of ~6mm diameter.

Using the individual data from each check (excluding results from the central portion) standard deviation values were derived for each element. These values were combined with the 95% half-width confidence intervals ($C_{(95\%)}$) obtained from the wet analysis programme, using the square-root of the summed squares, to derive the final uncertainty values.

Chemical Analysis

Analysis was carried out on millings taken from samples representative of the homogeneous 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.

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 four consistent replicate analyses is recommended to optimise precision and accuracy. 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	Si
1	4.48	0.0037	0.005	0.0010	0.0080	<0.0001	0.004
2	4.48	0.0037	0.0057	0.001	0.0083	0.0004	0.0041
3	4.504	0.0040	0.0060	0.0011	0.0085	<0.0005	0.0044
4	4.509	0.0041	0.0061	0.0012	0.0087	<0.0005	0.0047
5	4.53	0.0041	0.0064	0.0015	0.0089	0.0005	0.0047
6	4.550	0.0050	0.0075	0.0015	0.0090	0.0007	0.005
7	4.55	0.0054	0.0079	0.0016	0.0095	<0.001	0.0050
8	4.590	0.0056	0.0081	0.0016	0.010	0.001	0.0052
9	4.59				0.010		
10	4.603						
11	4.62						
Mean	4.546	0.0045	0.0066	0.0013	0.0090	(<0.001)	0.0046
Std Dev	0.050	0.0008	0.0011	0.0003	0.0007	-	0.0004
C_(95%)	0.033	0.0006	0.0009	0.0002	0.0005	-	0.0004

Sample	As	Mn	Sb	P	C	S	Cu
1	0.0009	0.0002	0.0008	0.186	0.00092	0.002	95.14
2	0.0009	0.0003	0.0010	0.192	0.0012	0.0022	95.20
3	0.001	0.0003	0.0011	0.192	0.0013	0.0024	95.2
4	0.001	0.0007	0.0012	0.192	0.0014	0.0028	95.24
5	0.0011	0.0009	0.0012	0.196	0.0014	0.0030	95.25
6	0.0012	0.0009	0.0016	0.198	0.0019	0.0031	95.30
7	0.0013	0.001	0.0017	0.199	<0.005	0.0031	
8	0.0013	0.0012		0.200		0.0032	
9	0.0015			0.201		0.004	
10				0.203		0.0040	
Mean	0.0011	0.0007	0.0012	0.196	(0.0014)	0.0030	95.22
Std Dev	0.0002	0.0004	0.0003	0.005	-	0.0007	0.05
C_(95%)	0.0002	0.0003	0.0003	0.004	-	0.0005	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

Zurich Certification Ltd	West Bromwich, England	UKAS accreditation 0854
Sheffield Assay Office	Sheffield, England	UKAS accreditation 0012
Bodycote Materials Testing	Middlesbrough, England	UKAS accreditation 0239
Laboratory Testing Inc	Hatfield, PA, USA	A2LA accreditation 0117
Universal Scientific Laboratory Pty Ltd	Milperra, NSW, Australia	NATA accreditation 492
Central Iron & Steel Research Inst	Beijing, China	CNAL accreditation 0435
Luo Yang Copper	Luo Yang, He Nan, China	CNAL accreditation 0173
Institute of Iron & Steel Technology	Shanghai, China	CNAL accreditation 0783
RWTUV Laboratory	Brno, Czech Republic	CIA accreditation 1060
Spectroscopic Solutions Ltd	Johannesburg, South Africa	
Genitest Inc	Montreal, Canada	
Coleshill Laboratories Ltd	Coleshill, England	

Note: to achieve National Accreditation (eg UKAS, NATA, A2LA, CNAL, CIA), test houses must demonstrate conformity to the general requirements of EN ISO/IEC 17025 and ISO9002.

Analytical Methods Used

ELEMENT	RESULT No. & METHOD		
	ICP-AES	FAAS	OTHER
Tin	1-6, 8-10	-	7, 11 volumetric (iodate)
Lead	1, 2, 5-8	3, 4	
Zinc	1-5, 7, 8	6	
Iron	2-4, 6, 8	1, 5, 7	
Nickel	2-6, 9	1, 7, 8	
Aluminium	1, 2, 4-8	3	
Silicon	2, 4-8	-	1, 3 photometric (molybdosilicic acid)
Arsenic	1-8	9	
Manganese	1, 3-8	2	
Antimony	1-3, 5-7	4	
Phosphorus	1, 3-5, 8-10	-	2, 6, 7 photometric (molybdenum yellow)
Carbon	-	-	all combustion with infra-red or volumetric detection
Sulfur	-	-	all combustion with infra-red or volumetric detection
Copper	3, 6	-	1, 4 electrogravimetric 2, 5 volumetric (thiosulphate)

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, ASTM E1831 and the ISO Guide to the Expression of Uncertainty in Measurement (GUM).

This certification is applicable to the whole of the disc although, in accordance with normal practice for OES analysis, it is appropriate to avoid use of the central area of ~6mm 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 July 2024, although we reserve the right to make changes as issue revisions, in the intervening period.

This sample 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.