

# CERTIFICATE OF ANALYSIS

**32X 52100 (batch A)**

## Certified Reference Material Information

Type: PHOSPHOR BRONZE (WROUGHT)  
Form and Size: Disc ~38mm diameter  
Manufactured by: Bolton Aerospace Ltd, UK  
Certified and Supplied by: MBH Analytical Ltd

## Assigned Values

### Percentage element by weight

Element	Sn	Pb	Zn	Fe	Ni	P
Value <sup>1</sup>	7.72	0.0031	0.0028	(0.0007)	0.0110	0.147
Uncertainty <sup>2</sup>	0.03	0.0004	0.0003	-	0.0005	0.004

Element	Al	As	Bi	Ag	S	Cu
Value <sup>1</sup>	0.0008	0.0009	0.0019	0.0011	0.0007	92.08
Uncertainty <sup>2</sup>	0.0002	0.0001	0.0002	0.0001	0.0001	0.06

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

## Definitions

- <sup>1</sup> 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.
- <sup>2</sup> 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 12<sup>th</sup> May 2015

C Eveleigh

## **Method of Preparation**

This reference material was produced from commercial continuous-cast barstock to BS2784 PB104M, UNS C52100. 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	P
1	7.660	0.0022	0.0023	0.0003	0.0101	0.142
2	7.686	0.0022	0.0024	0.0004	0.0102	0.143
3	7.691	0.0024	0.0025	0.0004	0.0102	0.143
4	7.698	0.0029	0.0026	0.0004	0.0106	0.145
5	7.707	0.0030	0.0027	0.0005	0.0108	0.145
6	7.727	0.0030	0.0029	0.0007	0.0109	0.146
7	7.730	0.0031	0.0029	0.0008	0.0110	0.146
8	7.730	0.0031	0.0030	0.0008	0.0110	0.148
9	7.752	0.0031	0.0031	0.0008	0.0111	0.151
10	7.756	0.0031	0.0036	0.0009	0.0113	0.153
11	7.756	0.0033		0.0010	0.0114	0.155
12	7.760	0.0035		0.0010	0.0115	
13	7.771	0.0036			0.0117	
14		0.0038			0.0118	
15		0.0039			0.0118	
<b>Mean</b>	<b>7.724</b>	<b>0.0031</b>	<b>0.0028</b>	<b>(0.0007)</b>	<b>0.0110</b>	<b>0.147</b>
<b>Std Dev</b>	0.034	0.0005	0.0004	-	0.0006	0.004
<b>C<sub>(95%)</sub></b>	0.021	0.0003	0.0003	-	0.0003	0.003

Sample	Al	As	Bi	Ag	S	Cu
1	0.0005	0.0005	0.0013	0.0008	0.0005	91.95
2	0.0006	0.0006	0.0016	0.0009	0.0005	92.00
3	0.0006	0.0008	0.0017	0.0010	0.0005	92.07
4	0.0006	0.0008	0.0018	0.0010	0.0006	92.07
5	0.0006	0.0008	0.0019	0.0010	0.0007	92.10
6	0.0007	0.0009	0.0019	0.0010	0.0007	92.10
7	0.0009	0.0009	0.0020	0.0012	0.0009	92.13
8	0.0009	0.0010	0.0020	0.0012	0.0009	92.15
9	0.0010	0.0010	0.0021	0.0012	0.0009	92.15
10	0.0010	0.0010	0.0022	0.0013	0.0010	
11	0.0011	0.0011			0.0010	
12	0.0011	0.0011				
<b>Mean</b>	<b>0.0008</b>	<b>0.0009</b>	<b>0.0019</b>	<b>0.0011</b>	<b>0.0007</b>	<b>92.08</b>
<b>Std Dev</b>	0.0002	0.0002	0.0003	0.0002	0.0002	0.07
<b>C<sub>(95%)</sub></b>	0.0002	0.0001	0.0002	0.0001	0.0001	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	Milperra, NSW, Australia	NATA accreditation 0492
Genitest Inc	Montreal, Canada	PRI accreditation 123077
Shanghai Jinyi Test Technology Co	Shanghai, China	CNAL accreditation 0783
Luo Yang Copper Co	Luo Yang, He Nan, China	CNAL accreditation 0173
Bureau Veritas CPS Pvt Ltd	Chennai, India	NABL accreditation 0025
TCR Engineering Servs Pvt Ltd	Mumbai, India	NABL accreditation T367
Raghavendra SpectroMet Laboratory	Bangalore, India	NABL accreditation T371
Institute of Non-Ferrous Metals	Gliwice, Poland	PCA accreditation AB274
Tec-Eurolab	Campogalliano, Italy	ACCREDIA accreditation 52
London & Scandinavian Met. Co	Rotherham, England	
Colehill Laboratories Ltd	Birmingham, England	
Lithea sro	Brno, Czech Republic	

Note: to achieve the above accreditation (eg 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, 3, 5-7, 10, 11, 13	8	1, 9 4 12	volumetric (iodate) gravimetric photometric (phenyl fluorone)
Lead	1-5, 8-11, 13, 15	6, 7, 12, 14		
Zinc	1, 3-5, 7-9	2, 6, 10		
Iron	5-12	3, 4	1 2	photometric (orthophenanthroline) ICP-MS
Nickel	1, 3-6, 8, 9, 12-15	2, 7, 10, 11		
Phosphorus	3, 6-8, 10	-	1, 4, 11 2, 5, 9	photometric (molybdenum yellow) volumetric (alkalimetric)
Aluminium	1-3, 6-8, 11, 12	9, 10	4 5	ICP-MS photometric (chrome azurol-S)
Arsenic	2-4, 6-8, 10, 11	5, 9, 12	1	photometric (turbidity)
Bismuth	1-3, 5, 6, 8-10	4, 7		
Silver	1, 3-5, 9, 10	2, 6-8		
Sulfur	4, 5, 8, 9, 11	-	1-3, 6, 7, 10	combustion (infra-red detection)
Copper	1, 2, 6	-	3, 8, 9 4, 5, 7	electrogravimetric 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 May 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.