

# CERTIFICATE OF ANALYSIS

**31X B3 (batch L)**

## Certified Reference Material Information

Type: BRASS (CHILL CAST)  
Form and Size: Disc ~40mm diameter  
Manufactured by: Polycast Ltd  
Certified and Supplied by: MBH Analytical Ltd

## Assigned Values

### Percentage element by weight

Element	Sn	Pb	Zn	Fe	Ni	Al	Si	Mn
Value <sup>1</sup>	0.0149	0.0194	34.95	0.0541	0.0431	0.287	0.0126	0.0072
Uncertainty <sup>2</sup>	0.0006	0.0004	0.12	0.0012	0.0006	0.004	0.0006	0.0004

Element	Cr	Co	As	Bi	Sb	Cd	B	Cu
Value <sup>1</sup>	0.0022	0.0212	0.0144	0.0098	0.0159	0.0108	0.0021	64.57
Uncertainty <sup>2</sup>	0.0002	0.0004	0.0004	0.0005	0.0010	0.0005	0.0002	0.12

## 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 8<sup>th</sup> January 2014

C Eveleigh



## **Method of Preparation**

This reference material was produced from commercial-grade brass, binaries and master alloys. The discs are the product of one melt poured into a sequence of multiple chill moulds with feeding systems designed to ensure sound discs. Approximately 2mm has been removed from the cast faces of the discs to minimise surface effects.

## **Sampling**

Samples for chemical analysis were taken from various positions throughout the casting process. 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, 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.

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	Si	Mn
1	0.0135	0.0183	34.80	0.0514	0.0417	0.278	0.0109	0.0061
2	0.0136	0.0186	34.82	0.0523	0.0419	0.280	0.0116	0.0064
3	0.0141	0.0190	34.86	0.0530	0.0423	0.282	0.0117	0.0066
4	0.0142	0.0192	34.88	0.0531	0.0424	0.283	0.0119	0.0067
5	0.0146	0.0192	34.95	0.0532	0.0429	0.284	0.0122	0.0070
6	0.0149	0.0193	34.95	0.0533	0.0429	0.287	0.0124	0.0071
7	0.0149	0.0195	34.96	0.0538	0.0430	0.289	0.0130	0.0072
8	0.0152	0.0195	35.00	0.0543	0.0432	0.293	0.0130	0.0072
9	0.0152	0.0195	35.01	0.0547	0.0437	0.295	0.0131	0.0073
10	0.0156	0.0196	35.10	0.0551	0.0440	0.295	0.0138	0.0073
11	0.0160	0.0200	35.13	0.0552	0.0441	0.295	0.0138	0.0076
12	0.0166	0.0203		0.0554	0.0443		0.0142	0.0078
13		0.0205		0.0557	0.0444			0.0079
14				0.0569				0.0085
<b>Mean</b>	<b>0.0149</b>	<b>0.0194</b>	<b>34.95</b>	<b>0.0541</b>	<b>0.0431</b>	<b>0.287</b>	<b>0.0126</b>	<b>0.0072</b>
<b>Std Dev</b>	0.0009	0.0006	0.11	0.0015	0.0009	0.006	0.0010	0.0006
<b>C<sub>(95%)</sub></b>	0.0006	0.0004	0.07	0.0009	0.0005	0.004	0.0006	0.0004

Sample	Cr	Co	As	Bi	Sb	Cd	B	Cu
1	0.0018	0.0204	0.0132	0.0086	0.0136	0.0101	0.0015	64.41
2	0.0018	0.0204	0.0133	0.0088	0.0140	0.0104	0.0018	64.50
3	0.0018	0.0204	0.0136	0.0090	0.0141	0.0107	0.0018	64.50
4	0.0019	0.0205	0.0140	0.0091	0.0144	0.0108	0.0020	64.53
5	0.0020	0.0206	0.0140	0.0094	0.0144	0.0108	0.0020	64.56
6	0.0021	0.0208	0.0141	0.0094	0.0145	0.0108	0.0020	64.56
7	0.0022	0.0209	0.0141	0.0097	0.0156	0.0109	0.0021	64.57
8	0.0022	0.0210	0.0142	0.0097	0.0161	0.0109	0.0021	64.62
9	0.0022	0.0210	0.0145	0.0098	0.0162	0.0109	0.0023	64.64
10	0.0023	0.0215	0.0145	0.0101	0.0165	0.0112	0.0025	64.68
11	0.0023	0.0218	0.0149	0.0103	0.0171		0.0025	64.71
12	0.0023	0.0219	0.0150	0.0107	0.0176			
13	0.0024	0.0220	0.0152	0.0112	0.0177			
14	0.0025	0.0224	0.0155	0.0115	0.0181			
15	0.0027	0.0225	0.0160		0.0182			
<b>Mean</b>	<b>0.0022</b>	<b>0.0212</b>	<b>0.0144</b>	<b>0.0098</b>	<b>0.0159</b>	<b>0.0108</b>	<b>0.0021</b>	<b>64.57</b>
<b>Std Dev</b>	0.0003	0.0007	0.0008	0.0009	0.0016	0.0003	0.0003	0.09
<b>C<sub>(95%)</sub></b>	0.0001	0.0004	0.0004	0.0005	0.0009	0.0002	0.0002	0.06

Note: C<sub>(95%)</sub> 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  
Sheffield Assay Office  
Universal Scientific Laboratory Pty Ltd  
Institute of Iron & Steel Technology  
Luo Yang Copper  
Bureau Veritas Pvt Ltd  
Raghavendra Spectromet Laboratory  
TCR Engineering Services Ltd  
Institute of Non-Ferrous Metals  
Tec-Eurolab  
Colonial Metals Co  
London & Scandinavian Met. Co  
Coleshill Laboratories Ltd  
Lithea sro

Middlesbrough, England  
Sheffield, England  
Milperra, NSW, Australia  
Shanghai, China  
Luo Yang, He Nan, China  
Chennai, India  
Bangalore, India  
Mumbai, India  
Gliwice, Poland  
Campogalliano, Italy  
Columbia, PA, USA  
Rotherham, England  
Birmingham, England  
Brno, Czech Republic

UKAS accreditation 0239  
UKAS accreditation 0012  
NATA accreditation 0492  
CNAL accreditation 0783  
CNAL accreditation 0173  
NABL accreditation 0025  
NABL accreditation 0371  
NABL accreditation 0367  
PCA accreditation AB274  
ACCREDIA accreditation 52

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	XRF	FAAS	OTHER
Tin	1, 5-12	-	3, 4	2 photometric (phenyl fluorone)
Lead	1-3, 5-7, 9, 10, 13	-	4, 8, 11, 12	
Zinc	2, 4-8, 11	9	-	1, 3-5, 10 volumetric (EDTA)
Iron	1, 2, 4-6, 9, 11-13	3	7, 10, 14	8 photometric (orthophenanthroline)
Nickel	1-6, 11-13	7	8-10	
Aluminium	2, 3, 5, 6, 9-11	7	1, 4	8 photometric (chrome azurol S)
Silicon	6-10	-	-	1-5, 11, 12 photometric (molybdenum blue)
Manganese	1-6, 8-10, 12-14	-	7, 11	
Chromium	2-5, 7-9, 11-13, 15	-	1, 6, 10, 14	
Cobalt	1, 2, 5-8, 11-14	-	3, 4, 9, 10, 15	
Arsenic	1, 3-8, 10-15	-	9, 11	2 photometric (turbidity)
Bismuth	1-3, 5, 8, 10-14	-	4, 6, 7, 9	
Antimony	4-8, 10-14	2	1, 9, 15	3 photometric (crystal violet)
Cadmium	1-3, 5-8	-	4, 9, 10	
Boron	1, 3-6, 8-11	-	2, 7	
Copper	2, 7, 11	-	-	1, 3, 4, 9 electrogravimetric 5, 6, 8, 10 volumetric (thiosulfate)

## Notes

This Certified Reference Material has been produced and certified 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).

The unidirectional solidification effects associated with semi-chill casting have led to the formation of inhomogeneous segregates in the rear portion of the disc. The above certification is therefore only applicable from the front face of the disc to a depth of 12mm. Material to the rear of the disc, to a depth of ~3mm, is not certified.

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 January 2034, 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.