

# CERTIFICATE OF ANALYSIS

**36X CN13 (batch A)**

## Certified Reference Material Information

Type: CUPRO-NICKEL (WROUGHT)  
Form and Size: Disc ~38mm diameter  
Manufactured by: Langley Alloys Ltd, UK  
Certified and Supplied by: MBH Analytical Ltd

## Assigned Values

### Percentage element by weight

Element	Zn	Fe	Ni	Al	Si	Mn	Mg	P
Value <sup>1</sup>	0.0017	0.870	14.52	2.65	0.012	0.442	0.0039	0.0011
Uncertainty <sup>2</sup>	0.0003	0.009	0.07	0.02	0.002	0.005	0.0005	0.0003

Element	Sn	Pb	Co	Cr	S	C	B	Cu
Value <sup>1</sup>	(0.0011)	(0.0013)	(0.0010)	(0.0004)	(0.0018)	(0.0033)	(0.0017)	81.46
Uncertainty <sup>2</sup>	-	-	-	-	-	-	-	0.10

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 28th January 2014

C Eveleigh

## **Method of Preparation**

This reference material was produced by cutting slices from a single batch of commercial bar, type Hiduron 130. The metal was induction melted and continuous cast. The cast material was hot-worked to final size.

## **Sampling**

Samples for chemical analysis were taken from various positions within the bar. At least 8% of all discs were randomly selected for non-destructive homogeneity testing.

## **Homogeneity**

The discs were checked for sample and batch uniformity using an optical emission spectrometer.

Using the combined data for 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	Zn	Fe	Ni	Al	Si	Mn	Mg	P
1	0.0010	0.851	14.35	2.583	0.0084	0.429	0.0027	0.0006
2	0.0013	0.855	14.36	2.587	0.0096	0.430	0.0028	0.0009
3	0.0014	0.855	14.39	2.602	0.0104	0.433	0.0031	0.0010
4	0.0017	0.858	14.46	2.624	0.0106	0.435	0.0039	0.0010
5	0.0017	0.862	14.50	2.626	0.0124	0.435	0.0039	0.0011
6	0.0017	0.868	14.51	2.634	0.0133	0.435	0.0041	0.0015
7	0.0021	0.869	14.51	2.658	0.0138	0.443	0.0042	0.0016
8	0.0021	0.875	14.52	2.661	0.0145	0.445	0.0042	
9	0.0022	0.875	14.54	2.666	0.0147	0.445	0.0044	
10		0.880	14.56	2.678	0.0155	0.448	0.0049	
11		0.882	14.56	2.678		0.450	0.0050	
12		0.889	14.57	2.679		0.450		
13		0.891	14.66	2.692		0.454		
14			14.66	2.694		0.454		
15			14.70					
<b>Mean</b>	<b>0.0017</b>	<b>0.870</b>	<b>14.52</b>	<b>2.647</b>	<b>0.0123</b>	<b>0.442</b>	<b>0.0039</b>	<b>0.0011</b>
<b>Std Dev</b>	0.0004	0.013	0.10	0.038	0.0024	0.009	0.0008	0.0003
<b>C<sub>(95%)</sub></b>	0.0003	0.008	0.06	0.022	0.0017	0.005	0.0005	0.0003

Sample	Sn	Pb	Co	Cr	S	C	B	Cu
1	0.0005	0.0005	0.0003	0.0002	0.0003	0.0017	0.0008	81.27
2	0.0007	0.0006	0.0005	0.0002	0.0005	0.0026	0.0013	81.34
3	0.0007	0.0006	0.0007	0.0003	0.0006	0.0028	0.0014	81.38
4	0.0011	0.0010	0.0009	0.0003	0.0010	0.0037	0.0015	81.47
5	0.0012	0.0014	0.0009	0.0006	0.0013	0.0039	0.0016	81.48
6	0.0012	0.0018	0.0010	0.0008	0.0015	0.0040	0.0017	81.50
7	0.0015	0.0018	0.0012		0.0020	0.0046	0.0019	81.50
8	0.0017	0.0018	0.0014		0.0022		0.0020	81.59
9		0.0018	0.0014		0.0024		0.0020	81.61
10		0.0020	0.0014		0.0026		0.0022	
11			0.0015		0.0030		0.0024	
12					0.0031			
13					0.0033			
<b>Mean</b>	<b>(0.0011)</b>	<b>(0.0013)</b>	<b>(0.0010)</b>	<b>(0.0004)</b>	<b>(0.0018)</b>	<b>(0.0033)</b>	<b>(0.0017)</b>	<b>81.46</b>
<b>Std Dev</b>	-	-	-	-	-	-	-	0.11
<b>C<sub>(95%)</sub></b>	-	-	-	-	-	-	-	0.09

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	Middlesbrough, England	UKAS accreditation 0239
Sheffield Assay Office	Sheffield, England	UKAS accreditation 0012
Metals Technology (Testing) Ltd	Sheffield, England	UKAS accreditation 0963
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
Bureau Veritas 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
Tec-Eurolab	Campogalliano, Italy	ACCREDIA accreditation 52
Mineral & Metallurgical Laboratories	Bangalore, India	
Colonial Metals Co	Columbia, PA, USA	
London & Scandinavian Met. Co	Rotherham, England	
Coleshill Laboratories Ltd	Birmingham, England	
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	XRF	FAAS	OTHER	
Zinc	1-4, 8, 9	-	5-7		
Iron	1, 3, 4, 6-9	10	12, 13	2, 5 11	photometric (orthophenanthroline) volumetric (redox)
Nickel	2-4, 6, 7, 9-11	15	-	1, 8, 12-14 5	gravimetric (dimethyl glyoxime) volumetric (dimethyl glyoxime)
Aluminium	1, 5-8, 11, 12, 14	2	4, 9, 13	3 10	volumetric (EDTA) photometric (chrome azurol-S)
Silicon	1-4, 7, 9	-	-	5, 6, 8, 10	photometric (molybdenum yellow)
Manganese	1, 3, 6-10, 13	11	4, 5, 12, 14	2	volumetric (arsenate)
Magnesium	1-5, 8-11	-	6, 7		
Phosphorus	1, 6, 7	-	-	2-4 5	photometric (molybdenum yellow) volumetric (alkalimetric)
Tin	3-5, 7, 8	-	2, 6	1	photometric (phenyl fluorone)
Lead	1, 3, 4, 6-9	-	2, 5, 10		
Cobalt	1, 2, 5-9, 11	-	3, 4, 10		
Chromium	2-4	-	1, 5, 6		
Sulfur	3, 5	-	-	1, 2, 4, 6-13	combustion (infra red detection)
Carbon	-	-	-	all	combustion (infra red detection)
Boron	1-3, 5-9	-	4, 10		
Copper	2, 9	-	-	1, 3, 4, 8 5-7	volumetric (thiosulfate) electrogravimetric

## 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).

This certification is applicable to the whole of the disc. However, in accordance with normal practice for OES, it is appropriate to avoid usage of the central portion of approx 8mm 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 January 2034, 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 sourcing, 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.