

# CERTIFICATE OF ANALYSIS

**59X G77J1 (batch G)**

## Certified Reference Material Information

Type: ALUMINIUM / MAGNESIUM / COPPER (HIP)

Form and Size: Disc ~65mm diameter

Produced by: RSP Technologies, Holland

Certified and Supplied by: MBH Analytical Ltd

## Assigned Values

### Percentage element by weight

Element	Cu	Mg	Si	Fe	Mn	Ni	Zn	Pb	Sn
Value <sup>1</sup>	<b>2.810</b>	<b>4.52</b>	<b>0.1015</b>	<b>0.209</b>	<b>0.810</b>	<b>0.205</b>	<b>2.289</b>	<b>0.158</b>	<b>0.148</b>
Uncertainty <sup>2</sup>	0.013	0.02	0.0014	0.004	0.009	0.004	0.015	0.003	0.001

Element	Ti	Cr	V	Co	Zr	Cd	Ga	Bi
Value <sup>1</sup>	<b>0.251</b>	<b>0.297</b>	<b>0.0064</b>	<b>0.0104</b>	<b>0.0484</b>	<b>0.0351</b>	<b>0.010</b>	<b>0.0578</b>
Uncertainty <sup>2</sup>	0.001	0.005	0.0006	0.0003	0.0014	0.0011	0.001	0.0009

## 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 5th December 2016

C. Eveleigh

## **Method of Preparation**

This reference material was produced using commercial-grade aluminium and master alloys. The melt was rapid-quenched, and the resultant ribbon was milled into powder. The bulk powder was sieved, homogenised, then pressed into a billet which was extruded to bar of the final diameter.

## **Sampling**

Samples for chemical analysis were taken from various positions throughout the batch. Approximately 5% of all discs were selected for non-destructive homogeneity testing.

## **Homogeneity**

Samples representative of the batch were checked for uniformity using an optical emission spectrometer. The testing procedure was in accordance with ASTM E826 and the material found acceptable.

From this test data, through-batch variation values were derived for each element as an indicator of any minor compositional variation (as determined for the specific sample size and other limitations of 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.

Of the individual results herein, some have traceability (to the mole) via primary analytical methods. Some are traceable to substances of known stoichiometry. Most have traceability via commercial solutions. Furthermore, some results have additional 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: Aluminium 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	Cu	Mg	Si	Fe	Mn	Ni	Zn	Pb	Sn
1	2.774	4.485	0.0983	0.2008	0.7825	0.1910	2.262	0.1500	0.1440
2	2.783	4.490	0.0992	0.2010	0.7842	0.1935	2.269	0.1503	0.1450
3	2.783	4.496	0.0995	0.2026	0.7990	0.2000	2.271	0.1510	0.1458
4	2.789	4.500	0.1008	0.2034	0.8007	0.2000	2.272	0.1554	0.1471
5	2.792	4.502	0.1010	0.2036	0.8027	0.2003	2.275	0.1571	0.1481
6	2.801	4.502	0.1010	0.2060	0.8059	0.2009	2.280	0.1571	0.1486
7	2.804	4.504	0.1020	0.2069	0.8082	0.2012	2.285	0.1590	0.1490
8	2.811	4.507	0.1026	0.2090	0.8090	0.2044	2.289	0.1601	0.1492
9	2.814	4.510	0.1030	0.2103	0.8199	0.2049	2.295	0.1602	0.1500
10	2.817	4.510	0.1035	0.2105	0.8210	0.2060	2.301	0.1603	0.1500
11	2.820	4.528	0.1050	0.2115	0.8217	0.2090	2.306	0.1606	0.1500
12	2.822	4.570		0.2132	0.8240	0.2098	2.310	0.1629	0.1502
13	2.838	4.570		0.2140	0.8274	0.2113	2.311	0.1650	0.1510
14	2.845	4.585		0.2180	0.8300	0.2122	2.327	0.1687	
15	2.858	4.585		0.2198		0.2180			
16				0.2200		0.2180			
<b>Mean</b>	<b>2.810</b>	<b>4.523</b>	<b>0.1014</b>	<b>0.2094</b>	<b>0.8097</b>	<b>0.2050</b>	<b>2.289</b>	<b>0.1584</b>	<b>0.1483</b>
<b>Std Dev</b>	0.024	0.036	0.0020	0.0064	0.0151	0.0078	0.019	0.0055	0.0022
<b>C<sub>(95%)</sub></b>	0.013	0.020	0.0014	0.0034	0.0087	0.0041	0.011	0.0032	0.0013

Sample	Ti	Cr	V	Co	Zr	Cd	Ga	Bi
1	0.2478	0.2833	0.0051	0.0095	0.0446	0.0327	0.0094	0.0552
2	0.2482	0.2855	0.0051	0.0098	0.0461	0.0333	0.0097	0.0559
3	0.2500	0.2880	0.0052	0.0099	0.0463	0.0335	0.0102	0.0566
4	0.2500	0.2880	0.0058	0.0100	0.0465	0.0345	0.0104	0.0566
5	0.2500	0.2903	0.0059	0.0101	0.0470	0.0345	0.0108	0.0571
6	0.2502	0.2921	0.0061	0.0101	0.0470	0.0353	0.0110	0.0578
7	0.2505	0.2952	0.0065	0.0102	0.0471	0.0353		0.0579
8	0.2510	0.2964	0.0068	0.0103	0.0480	0.0354		0.0580
9	0.2512	0.2967	0.0070	0.0103	0.0492	0.0362		0.0581
10	0.2515	0.2983	0.0070	0.0104	0.0497	0.0366		0.0583
11	0.2535	0.3001	0.0075	0.0107	0.0498	0.0384		0.0598
12	0.2540	0.3010	0.0076	0.0107	0.0515			0.0598
13	0.2548	0.3030	0.0077	0.0111	0.0523			0.0602
14		0.3080		0.0111	0.0524			
15		0.3090		0.0112				
16		0.3105						
<b>Mean</b>	<b>0.2510</b>	<b>0.2966</b>	<b>0.0064</b>	<b>0.0104</b>	<b>0.0484</b>	<b>0.0351</b>	<b>0.0103</b>	<b>0.0578</b>
<b>Std Dev</b>	0.0021	0.0084	0.0009	0.0005	0.0025	0.0016	0.0006	0.0015
<b>C<sub>(95%)</sub></b>	0.0013	0.0045	0.0006	0.0003	0.0014	0.0011	0.0006	0.0009

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, UK	UKAS accreditation	0239
Sheffield Analytical Services	Sheffield, UK	UKAS accreditation	0012
Universal Scientific Laboratory Pty Ltd	Milperra, NSW, Australia	NATA accreditation	0492
Genitest Inc.	Montreal, QC, Canada	PRI accreditation	123077
Luo Yang Copper	Luo Yang, He Nan, China	CNAL accreditation	0173
Shandong Metallurgical & Science Research	Jinan, Shandong, China	CNAS accreditation	1461
Bureau Veritas CPS Ltd	Chennai, India	NABL accreditation	0025
TCR Engineering Services PVT. Ltd	Mumbai, India	NABL accreditation	0367
Raghavendra Spectro Metallurgical Laboratory	Bangalore, India	NABL accreditation	0371
Institute of Non-ferrous Metals	Gliwice, Poland	PCA accreditation	AB274
TEC Eurolab SRL	Modena, Italy	ACCREDIA accreditation	52
Mineral and Metallurgical Laboratories	Bangalore, India		
AMG Superalloys UK Ltd	Rotherham, UK		
Analyticka Laborator Lithea sro	Brno, Czech Republic		
PT Geoservices Ltd.	Cikarang, Indonesia		
Coleshill Laboratories Limited	Coleshill, UK		

Note: to achieve the above accreditation (UKAS, 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
Copper	1, 3-7, 10, 12, 13, 15	2, 11, 14	8 volumetric (thiosulfate) 9 photometric (BCO)
Magnesium	2-5, 7, 8, 10-12, 14, 15	1, 9, 13	6 gravimetric (oxine)
Silicon	1-4, 8, 9	-	5, 6, 10 gravimetric (perchloric acid) 7, 11 photometric (molybdenum blue)
Iron	1, 3-7, 9, 10, 12, 15, 16	8, 11, 14	2 volumetric (redox) 13 photometric (orthophenanthroline)
Manganese	1, 2, 4-7, 9, 14	11-13	3 volumetric (bismuthate) 8, 10 photometric (periodate)
Nickel	1, 2, 5, 7-9, 11-15	4, 6, 10, 16	3 gravimetric (dimethyl glyoxime)
Zinc	1-3, 5, 7, 9-11, 14	4, 6, 8, 12	13 gravimetric
Lead	1, 2, 4-6, 9, 10, 12-14	7, 8, 11	3 photometric (sulfide)
Tin	1-6, 8, 10, 12, 13	7, 11	9 volumetric (iodine)
Titanium	1, 2, 6, 7, 9-13	8	3 photometric (hydrogen peroxide) 4, 5 photometric (diantipyryl methane)
Chromium	1, 3, 5, 7-11, 14-16	2, 4, 6, 12	13 volumetric (ferrous ammonium sulfate)
Vanadium	1, 2, 4, 5, 7, 8, 10-13	6, 9	3 volumetric (ferrous ammonium sulfate)
Cobalt	1, 3, 5-10, 12, 14, 15	2, 4, 11, 13	
Zirconium	1-3, 5, 7-14	4	6 photometric (xylenol orange)
Cadmium	2-7, 9-11	1, 8	
Galium	1, 3-6	-	2 photometric (butyl rhodamine B)
Bismuth	1-3, 5-9, 11-13	4, 10	

## Notes

This Certified Reference Material has been produced and certified 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 OES, it is appropriate to avoid usage of the central portion of ~ 10mm 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 December 2036, 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, Technical Director, MBH Analytical Ltd.

The material to which this certificate of analysis refers is supplied subject to our general conditions of sale.