

CERTIFICATE OF ANALYSIS

111X 12673 (batch A)

Certified Reference Material Information

Type: COBALT / CHROMIUM / TUNGSTEN (CAST)
Form and Size: Disc 40mm Diameter x 15mm Thickness
Manufactured by: Willan Metals Limited
Certified and Supplied by: MBH Analytical Limited

Certified Analysis

Percentage element by weight

Element	Si	Mn	Ni	Cr	W	Nb	Ta	Fe	Cu
Value ¹	0.82	0.52	1.69	19.0	9.75	2.35	0.06	1.70	0.104
Uncertainty ²	0.03	0.02	0.02	0.2	0.06	0.06	0.01	0.03	0.004

Element	Pb	Sn	Mo	Al	P	C	S	N
Value ¹	(0.003)	0.074	0.086	<0.005	0.010	(0.005)	0.022	0.031
Uncertainty ²	-	0.008	0.004	-	0.002	-	0.002	0.004

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

Definitions

- ¹ The certified values are derived from the 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 (page 3). When appropriate, these values have been modified to account for additional information from the material homogeneity checks.

Certified by:

MBH ANALYTICAL LIMITED _____

on 26th April 2001



Method of Preparation

This reference material was produced from commercial alloy, with additions of pure metals and master alloys. The discs are the product of one melt poured into a single mould with a feeding system designed to ensure sound discs. Metal has been removed from the cast faces of the discs to minimise surface effects.

Sampling

Milled samples for chemical analysis, and discs for homogeneity checks, were taken from various positions within the mould.

Homogeneity

Samples representative of the batch were checked for uniformity using an optical emission spectrometer.

Multiple measurements were taken from each surface under test.

The mean value of the material was then calculated from the multiple measurement averages.

For each of the surfaces checked, the differences between the averaged result and the overall mean value were evaluated to ensure that the homogeneity of the material satisfied the acceptance criteria defined in ISO guide 30 - 1992, and fell within 95% probability limits.

Chemical Analysis

Analysis was carried out on millings taken from samples representative of the product. It was performed by participating laboratories mostly operating within the terms of EN ISO/IEC 17025 - 2000, using documented standard methods of analysis.

The individual values listed overpage are the average of each analyst's results.

Usage

Intended use: With optical emission and X-ray fluorescence spectrometers.

Recommended method of use: Cobalt alloys are generally prepared by finishing, milling, turning or polishing. 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	Si	Mn	Ni	Cr	W	Nb	Ta	Fe	Cu
1	0.76	0.50	1.65	18.80	9.66	2.25	0.05	1.64	0.10
2	0.78	0.50	1.67	18.84	9.69	2.32	0.05	1.66	0.10
3	0.79	0.501	1.68	18.97	9.70	2.35	0.058	1.68	0.10
4	0.80	0.51	1.68	19.04	9.76	2.35	0.06	1.68	0.100
5	0.81	0.51	1.70	19.15	9.78	2.36	0.07	1.69	0.104
6	0.81	0.52	1.70	19.2	9.79	2.40		1.70	0.105
7	0.82	0.548	1.71	19.2	9.80	2.45		1.71	0.11
8	0.852	0.55	1.72		9.85			1.74	0.11
9	0.86		1.73					1.74	
10	0.87							1.74	
Mean	0.815	0.517	1.693	19.03	9.754	2.354	0.058	1.698	0.104
Std Dev	0.036	0.021	0.025	0.17	0.065	0.062	0.008	0.035	0.004
C_(95%)	0.026	0.017	0.020	0.15	0.054	0.058	0.010	0.025	0.004

Sample	Pb	Sn	Mo	Al	P	C	S	N
1	0.002	0.065	0.08	0.002	0.006	0.001	0.019	0.027
2	0.002	0.07	0.08	0.004	0.009	0.005	0.021	0.027
3	0.0024	0.070	0.082	0.004	0.009	0.005	0.021	0.030
4	0.004	0.075	0.086	<0.005	0.010	0.007	0.022	0.030
5	0.006	0.08	0.0864	<0.01	0.011	0.007	0.022	0.035
6		0.086	0.09	<0.05	0.013		0.023	0.035
7			0.09				0.027	
8			0.091					
Mean	0.003	0.074	0.086	<0.005	0.010	0.005	0.022	0.031
Std Dev	0.002	0.008	0.005	-	0.002	0.002	0.002	0.004
C_(95%)	0.002	0.008	0.004	-	0.002	0.003	0.002	0.004

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

Willan Metals Ltd	Rotherham, England	UKAS approval 0014
LGC-NW Ltd	Runcorn, England	UKAS approval 1214
IncoTest Ltd	Hereford, England	UKAS approval 0281
Metals Technology Testing Ltd	Sheffield, England	UKAS approval 0963
AllVac SMP Ltd	Sheffield, England	UKAS approval 1385
London & Scandinavian Met Co	Rotherham, England	UKAS approval 1091
Rotech Laboratories Ltd	Wednesbury, England	UKAS approval 0366
Bodycote Materials Testing Ltd	Middlesbrough, England	UKAS approval 0239
Universal Scientific Laboratory Pty, Ltd	Milperra, NSW, Australia	NATA accreditation 492
Central Iron & Steel Res Inst	Beijing, China	National reg. E0584
Shiva Analyticals Ltd	Bangalore, India	

Analytical Methods Used

Silicon:	FAAS	ICP	XRF	gravimetric (perchloric acid)	photometric (molybdate)
Manganese:	FAAS	ICP	XRF	photometric (periodate)	
Nickel:	FAAS	ICP	XRF	photometric (dimethyl glyoxime)	
Chromium:	FAAS	ICP	XRF	volumetric/potentiometric (ferrous ammonium sulfate)	
Tungsten:	FAAS	ICP	XRF	photometric (thiocyanate)	gravimetric (cinchonine)
Niobium:	FAAS	ICP	XRF	photometric (4-p.a.resorcinol)	
Tantalum:	FAAS	ICP	XRF	photometric (phenyl fluorone)	
Iron:	FAAS	ICP	XRF	volumetric (potassium dichromate)	
Copper:	FAAS	ICP	XRF	photometric (neocuprone)	
Lead:	FAAS		XRF	ICP-MS	
Tin:	FAAS	ICP	XRF	ICP-MS	photometric (catechol violet)
Molybdenum:	FAAS	ICP	XRF	photometric (thiocyanate)	
Aluminium:	FAAS	ICP	XRF		
Phosphorus:	ionex.AAS	ICP	XRF	photometric (molybdenum blue)	
Carbon:				combustion (infra-red and gravimetric detection)	
Sulfur:				combustion (infra-red and volumetric-iodate detection)	
Nitrogen:				inert gas fusion (thermal conductivity)	

Notes

This Certified Reference Material has been produced in accordance with the requirements of ISO Guide 34-2000, ISO Guide 31-2000, ISO Guide 35-1989, and ASTM Guides E1724 and E1831.

To achieve UKAS (UK Accreditation Scheme) approval, test houses must demonstrate conformity to the general requirements of EN ISO/IEC 17025 and ISO9002.

The above certification is applicable to the whole of the disc.

This material will remain stable provided adequate precautions are taken to protect it from cross-contamination, extremes of temperature and atmospheric moisture.

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