MBH ANALYTICAL LTD

HOLLAND HOUSE • QUEENS ROAD • BARNET • EN5 4DJ • ENGLAND • TEL: +44 (0)20 8441 2024 • FAX: +44 (0)20 8449 0810
email: info@mbh.co.uk web: www.mbh.co.uk

CERTIFICATE OF ANALYSIS

219X 08825 (batch A)

Certified Reference Material Information

Type:	NICKEL INCOLOY 825 (WROUGHT)
Form and Size:	Disc ~40mm diameter
Manufactured by:	Acciaierie Valbruna, Italy
Certified and Supplied by:	MBH Analytical Ltd

Assigned Values

Percentage element by weight

Element	C	Si	S	P	Mn	Cr	Co	Mo	Fe
Value [1]	**0.016**	**0.232**	**(0.0007)**	**0.0189**	**0.499**	**21.94**	**0.0646**	**3.01**	**31.82**
Uncertainty [2]	0.002	0.007	-	0.0007	0.005	0.08	0.0013	0.03	0.08

Element	Nb	Cu	Al	Ti	V	Mg	B	Zr	Ni
Value [1]	**(0.007)**	**1.87**	**0.149**	**1.192**	**0.038**	**(0.003)**	**0.0028**	**0.0021**	**39.12**
Uncertainty [2]	-	0.02	0.002	0.014	0.002	-	0.0003	0.0002	0.11

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

Definitions

[1] The above 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.

[2] 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:

on 6th August 2015

MBH ANALYTICAL LIMITED _____

C Eveleigh

Method of Preparation

This reference material was produced from commercial barstock to UNS N08825. The metal was arc-furnace melted and AOD refined. It was then continuous cast, hot-rolled, cold-finished and annealed.

Sampling

Samples for chemical analysis were taken from various positions within 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, 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:	Nickel-base alloys are generally prepared by linishing, 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. For OES, 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	C	Si	S	P	Mn	Cr	Co	Mo	Fe
1	0.0114	0.219	0.0001	0.0170	0.487	21.79	0.0621	2.941	31.70
2	0.0126	0.222	0.0003	0.0171	0.490	21.83	0.0623	2.959	31.75
3	0.0128	0.224	0.0003	0.0183	0.491	21.88	0.0625	2.991	31.77
4	0.0131	0.232	0.0005	0.0187	0.494	21.90	0.0631	2.995	31.78
5	0.0145	0.234	0.0006	0.0189	0.498	21.92	0.0638	3.000	31.78
6	0.0150	0.235	0.0007	0.0190	0.500	21.97	0.0649	3.000	31.85
7	0.0157	0.235	0.0008	0.0194	0.501	21.97	0.0652	3.001	31.85
8	0.0158	0.242	0.0010	0.0195	0.501	22.01	0.0653	3.031	31.91
9	0.0162	0.248	0.0013	0.0195	0.503	22.02	0.0659	3.038	31.97
10	0.0180		0.0016	0.0201	0.507	22.03	0.0659	3.060	
11	0.0201			0.0201	0.508	22.04	0.0662	3.062	
12	0.0203				0.510		0.0683		
Mean	**0.0155**	**0.232**	**(0.0007)**	**0.0189**	**0.499**	**21.94**	**0.0646**	**3.007**	**31.82**
Std Dev	0.0029	0.010	-	0.0011	0.007	0.09	0.0019	0.038	0.08
C (95%)	0.0018	0.007	-	0.0007	0.005	0.06	0.0012	0.026	0.06

Sample	Nb	Cu	Al	Ti	V	Mg	B	Zr	Ni
1	0.0044	1.818	0.146	1.169	0.0360	0.0016	0.0025	0.0019	38.94
2	0.0047	1.820	0.146	1.176	0.0363	0.0021	0.0025	0.0019	38.98
3	0.0048	1.822	0.146	1.185	0.0365	0.0022	0.0026	0.0020	39.02
4	0.0051	1.840	0.147	1.186	0.0365	0.0022	0.0026	0.0021	39.03
5	0.0059	1.862	0.147	1.186	0.0385	0.0025	0.0028	0.0022	39.03
6	0.0069	1.863	0.147	1.187	0.0389	0.0030	0.0029	0.0023	39.09
7	0.0074	1.864	0.149	1.189	0.0391	0.0031	0.0029	0.0025	39.18
8	0.0074	1.868	0.150	1.190	0.0393	0.0037	0.0033		39.18
9	0.0079	1.875	0.150	1.200	0.0395	0.0040	0.0035		39.28
10	0.0084	1.879	0.150	1.201	0.0403				39.29
11	0.0086	1.887	0.150	1.215	0.0416				39.30
12	0.0091	1.898	0.151	1.222					
13		1.914	0.154						
14		1.919							
Mean	**0.0067**	**1.866**	**0.149**	**1.192**	**0.0384**	**0.0027**	**0.0028**	**0.0021**	**39.12**
Std Dev	0.0017	0.033	0.003	0.015	0.0018	0.0008	0.0004	0.0002	0.13
C (95%)	0.0011	0.019	0.002	0.010	0.0012	0.0006	0.0003	0.0002	0.09

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
Metals Technology (Testing) Ltd	Sheffield, England	UKAS accreditation 0963
Universal Scientific Laboratory Pty Ltd	Revesby, Australia	NATA accreditation 492
Shanghai Jinyi Test Tech Co	Shanghai, China	CNAS accreditation L0041
Shandong Metallurgical & Science Research	Jinan, Shandong, China	CNAS accreditation 1461
Bureau Veritas CPS Pvt	Chennai, India	NABL accreditation 0025
Raghavendra SpectroMet Laboratory	Bangalore, India	NABL accreditation T371
Genitest Inc	Montreal, Canada	PRI accreditation 123077
Tec-Eurolab	Campogalliano, Italy	ACCREDIA accreditation 52
Instytut Metalurgii Zelaza	Gliwice, Poland	PCA accreditation AB554
AMG Superalloys UK Ltd	Rotherham, England	
Coleshill Laboratories Ltd	Birmingham, England	
Analyticka Laborator Lithea sro	Brno, Czech Republic	

Note: to achieve the above accreditation (UKAS, NATA, etc), test houses are required to demonstrate conformity to the general requirements of EN ISO/IEC 17025.

Analytical Methods Used

ELEMENT	RESULT No. & METHOD			
	ICP-AES	FAAS	OTHER	
Carbon	-	-	all	combustion (IR or volumetric detection)
Silicon	2, 4, 5, 7	-	1, 6	photometric (molybdenum blue)
			3, 8, 9	gravimetric (perchloric acid)
Sulfur	4	-	1-3, 5-10	combustion (IR or volumetric detection)
Phosphorus	2-7	-	8, 9, 11	volumetric (alkalimetric)
			10	photometric (molybdenum blue)
			1	XRF
Manganese	1, 2, 4, 5, 8-11	6	3	volumetric (arsenite)
			7, 12	photometric (periodate)
Chromium	1, 7-10	-	2-6, 11	volumetric (ferrous ammonium sulfate)
Cobalt	1, 2, 4, 5, 7, 8, 10-12	3, 6	9	photometric (iodine)
Molybdenum	1, 2, 5-7, 9-11	4	3, 8	photometric (thiocyanate)
Iron	1, 2, 5, 6, 9	-	3, 4, 7, 8	volumetric (dichromate)
Niobium	2-7, 9-12	-	1	photometric (chlorosulfophenol)
			8	ICP-MS
Copper	1, 3-5, 7, 8, 10, 12-14	6, 9	2, 11	photometric (BCO)
Aluminium	1-3, 6, 7, 9-13	5, 8	4	photometric (chrome azurol S)
Titanium	1-3, 5-7, 11, 12	4, 10	8, 9	photometric (diantipyryl methane)
Vanadium	1-8, 10	9, 11		
Magnesium	1-5, 7, 8	6, 9		
Boron	1-4, 6-9	5		
Zirconium	1-3, 5-7	4		
Nickel	2, 5, 6, 9, 10	-	1, 4, 7, 11	gravimetric (dimethyl glyoxime)
			3	volumetric (EDTA/DMGO)
			8	photometric (dimethyl glyoxime)

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 central portion 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 August 2035, although we reserve the right to make changes as issue revisions, in the intervening period.

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.