

# CERTIFICATE OF ANALYSIS

**23X 08811 (batch A)**

## Certified Reference Material Information

Type: Nickel Incoloy 800HT (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	Cu	Cr	Fe	Mo	Co
Value <sup>1</sup>	0.068	0.263	(0.0004)	0.0212	1.009	0.247	19.72	45.81	0.242	0.082
Uncertainty <sup>2</sup>	0.002	0.007	-	0.0008	0.008	0.004	0.06	0.09	0.004	0.003

Element	Ti	Al	Nb	V	W	Mg	Sn	B	N	Ni
Value <sup>1</sup>	0.543	0.453	0.009	0.060	0.0279	0.0044	0.0054	0.0038	0.0096	31.31
Uncertainty <sup>2</sup>	0.010	0.004	0.002	0.002	0.0013	0.0006	0.0005	0.0004	0.0006	0.10

## Definitions

- <sup>1</sup> 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.
- <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 30<sup>th</sup> June 2018  
C Eveleigh

## **Method of Preparation**

This reference material was produced from commercial barstock to 800HT, with composition to UNS N08811. The alloy was electric arc melted and AOD decarburized, bloom cast, hot rolled and annealed. The discs in this batch are the product of one length of bar from a single heat.

## **Sampling**

Samples for chemical analysis were taken from various positions within the bar. Approximately 5% 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, 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: Nickel-base 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.

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	Cu	Cr	Fe	Mo	Co
1	0.0621	0.2430	0.00020	0.0191	0.985	0.2337	19.580	45.660	0.2330	0.0751
2	0.0639	0.2482	0.00021	0.0199	0.997	0.2337	19.619	45.752	0.2336	0.0772
3	0.0645	0.2513	0.00030	0.0201	1.005	0.2390	19.650	45.753	0.2360	0.0778
4	0.0655	0.2570	0.00037	0.0205	1.005	0.2420	19.660	45.788	0.2401	0.0808
5	0.0656	0.2611	0.00047	0.0206	1.006	0.2422	19.690	45.790	0.2405	0.0822
6	0.0660	0.2635	0.00051	0.0207	1.009	0.2453	19.697	45.795	0.2410	0.0826
7	0.0667	0.2650	0.00060	0.0210	1.012	0.2486	19.714	45.820	0.2413	0.0826
8	0.0669	0.2650	0.00070	0.0218	1.014	0.2503	19.776	45.832	0.2421	0.0829
9	0.0678	0.2670		0.0218	1.016	0.2510	19.778	45.900	0.2440	0.0836
10	0.0685	0.2688		0.0220	1.022	0.2512	19.780	45.960	0.2454	0.0841
11	0.0709	0.2760		0.0226	1.032	0.2526	19.826		0.2468	0.0855
12	0.0716	0.2790		0.0228		0.2528	19.826		0.2470	0.0876
13	0.0731	0.2799		0.0229		0.2550			0.2474	0.0877
14	0.0736					0.2557			0.2506	
<b>Mean</b>	<b>0.0676</b>	<b>0.2634</b>	<b>0.00042</b>	<b>0.0212</b>	<b>1.009</b>	<b>0.2467</b>	<b>19.716</b>	<b>45.805</b>	<b>0.2421</b>	<b>0.0823</b>
<b>Std Dev</b>	0.0035	0.0114	0.00018	0.0012	0.012	0.0074	0.081	0.082	0.0053	0.0038
<b>C (95%)</b>	0.0020	0.0069	0.00015	0.0007	0.008	0.0043	0.051	0.059	0.0030	0.0023

Sample	Ti	Al	Nb	V	W	Mg	Sn	B	N	Ni
1	0.5243	0.4471	0.0062	0.0567	0.0250	0.0030	0.0045	0.0031	0.0086	31.123
2	0.5294	0.4480	0.0071	0.0572	0.0267	0.0033	0.0047	0.0032	0.0089	31.160
3	0.5310	0.4482	0.0080	0.0593	0.0268	0.0039	0.0051	0.0036	0.0092	31.210
4	0.5350	0.4507	0.0088	0.0598	0.0271	0.0039	0.0052	0.0036	0.0094	31.219
5	0.5440	0.4523	0.0095	0.0600	0.0284	0.0044	0.0053	0.0037	0.0095	31.240
6	0.5507	0.4530	0.0102	0.0604	0.0285	0.0044	0.0053	0.0039	0.0096	31.313
7	0.5520	0.4550	0.0107	0.0606	0.0287	0.0046	0.0054	0.0040	0.0104	31.333
8	0.5544	0.4586	0.0107	0.0607	0.0289	0.0050	0.0055	0.0041	0.0109	31.348
9	0.5623	0.4591	0.0108	0.0618	0.0292	0.0050	0.0057	0.0044		31.409
10		0.4607		0.0648	0.0292	0.0055	0.0058	0.0047		31.412
11						0.0056	0.0067			31.430
12										31.490
<b>Mean</b>	<b>0.5426</b>	<b>0.4533</b>	<b>0.0091</b>	<b>0.0601</b>	<b>0.0279</b>	<b>0.0044</b>	<b>0.0054</b>	<b>0.0038</b>	<b>0.0096</b>	<b>31.307</b>
<b>Std Dev</b>	0.0132	0.0049	0.0017	0.0023	0.0014	0.0008	0.0006	0.0005	0.0008	0.117
<b>C (95%)</b>	0.0101	0.0035	0.0013	0.0016	0.0010	0.0006	0.0004	0.0004	0.0006	0.074

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  
Sheffield Analytical Services  
Metals Technology (Testing) Ltd  
Laboratory Testing, Inc  
Genitest, Inc  
Shanghai Jinyi Test Tech Co  
Shandong Metallurgical & Science Research  
Raghavendra SpectroMet Laboratory  
TCR Engineering Services Ltd  
Instytut Metalurgii Zelaza  
Tec-Eurolab  
INCDMNR-IMNR  
Mineral & Metallurgical Laboratories  
AMG Superalloys UK Ltd  
Analyticka Laborator Lithea sro

Middlesbrough, England  
Sheffield, England  
Sheffield, England  
Hatfield, PA, USA  
Montreal, Canada  
Shanghai, China  
Jinan, Shandong, China  
Bangalore, India  
Mumbai, India  
Gliwice, Poland  
Campogalliano, Italy  
Pantelimon, Romania  
Bangalore, India  
Rotherham, England  
Brno, Czech Republic

UKAS accreditation 0239  
UKAS accreditation 0012  
UKAS accreditation 0963  
A2LA accreditation 0117  
PJ accreditation L17-153  
CNAS accreditation L0041  
CNAS accreditation 1461  
NABL accreditation 0371  
NABL accreditation 0367  
PCA accreditation AB554  
ACCREDIA accreditation 52

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
Carbon	-	-	all combustion (infra-red detection)
Silicon	1, 2, 4, 6, 8, 10, 11	-	3, 5, 12, 13 gravimetric (perchloric acid)
Sulfur	6	-	7, 9 photometric (molybdenum blue)
Phosphorus	1, 4, 5, 7-13	-	1-5, 7, 8 combustion (infra-red detection)
Manganese	2, 3, 5, 6, 8-11	-	2, 3 photometric (molybdenum blue)
Copper	1-5, 7, 10-12, 14	6, 8	6 volumetric (alkalimetric)
Chromium	1-4, 6, 8, 10	-	1, 4 volumetric (arsenite)
Iron	1, 3, 6, 8-10	7	7 photometric (periodate)
Molybdenum	2-5, 7-11, 13	14	9 electrogravimetric
Cobalt	1, 3, 4, 6, 7, 9, 10, 12, 13	2, 5	13 photometric (BCO)
Titanium	1-4, 8, 9	6	5, 7, 9, 11, 12 volumetric (ferrous ammonium sulfate)
Aluminium	1-10	-	2 photometric (sulfosalicylic acid)
Niobium	1-3, 5-9	-	4, 5 volumetric (dichromate)
Vanadium	1-10	-	1, 12 photometric (thiocyanate)
Tungsten	1-10	-	6 gravimetric
Magnesium	1-7, 9, 11	8, 10	8, 11 photometric (5-chloro-PADAB)
Tin	1, 2, 4, 6-11	3	5, 7 photometric (diantipyryl methane)
Boron	1-10	-	5 ICP-MS
Nitrogen	-	-	1, 6 photometric (Nessler reagent)
Nickel	1, 5, 6, 8, 12	2	2-5, 7, 8 inert gas fusion (thermal conductivity)
			3, 4, 7, 9-11 gravimetric (dimethyl glyoxime)

## Notes

This Certified Reference Material has been produced and certified in accordance with the requirements of ISO Guide 34, ISO Guide 31 and ISO Guide 35, 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, ~6 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. This certification will therefore expire in June 2038, although we reserve the right to make changes as issue revisions, in the intervening period.

The testing, 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.