

CERTIFICATE OF ANALYSIS

12X 10180 (batch D)

Certified Reference Material Information

Type: LOW-ALLOY STEEL (WROUGHT)

Form and Size: Disc, 40mm diameter

Manufactured by: Commercial Bar

Certified and Supplied by: MBH Analytical Ltd

Assigned Values

Percentage element by weight

Element	C	Si	S	P	Mn	Ni	Cr
Value ¹	0.179	0.286	0.0259	0.0148	0.807	0.0531	0.0251
Uncertainty ²	0.003	0.005	0.0012	0.0010	0.006	0.0011	0.0008

Element	Mo	Cu	Co	Al	Sn	As	N
Value ¹	0.0026	0.0663	0.0070	(0.003)	0.0033	0.0068	0.0070
Uncertainty ²	0.0002	0.0012	0.0005	-	0.0004	0.0005	0.0012

Note: values in parentheses are not certified; they are provided for information only

Definitions

- ¹ The assigned 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:

MBH ANALYTICAL LIMITED _____

on 11th February 2019

C Eveleigh

Method of Preparation

This reference material was produced from commercial bar to UNS G10180. Details of the production process are unknown.

Sampling

Samples for homogeneity checks and milled samples for chemical analysis were taken from multiple positions within the batch. Approximately 5% of all discs were taken for non-destructive homogeneity testing.

Homogeneity

The samples were checked for lateral 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. 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.

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: Steels are generally prepared by milling, turning or grinding. 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	C	Si	S	P	Mn	Ni	Cr
1	0.1703	0.2698	0.0221	0.0123	0.7920	0.0502	0.0231
2	0.1710	0.2723	0.0234	0.0127	0.7970	0.0503	0.0237
3	0.1741	0.2820	0.0240	0.0136	0.7998	0.0520	0.0237
4	0.1780	0.2832	0.0241	0.0140	0.8035	0.0520	0.0238
5	0.1782	0.2850	0.0248	0.0142	0.8077	0.0521	0.0238
6	0.1797	0.2853	0.0251	0.0145	0.8089	0.0524	0.0242
7	0.1800	0.2858	0.0252	0.0154	0.8090	0.0525	0.0252
8	0.1800	0.2880	0.0254	0.0155	0.8107	0.0535	0.0252
9	0.1802	0.2890	0.0263	0.0157	0.8120	0.0546	0.0254
10	0.1810	0.2938	0.0263	0.0158	0.8134	0.0549	0.0254
11	0.1823	0.2960	0.0267	0.0166	0.8160	0.0550	0.0260
12	0.1860	0.2970	0.0282	0.0174	0.8183	0.0556	0.0264
13	0.1880		0.0286			0.0558	0.0266
14			0.0288				0.0270
15			0.0289				0.0275
Mean	0.1791	0.2856	0.0259	0.0148	0.8074	0.0531	0.0251
Std Dev	0.0051	0.0084	0.0021	0.0015	0.0079	0.0019	0.0014
C _(95%)	0.0031	0.0052	0.0012	0.0010	0.0050	0.0011	0.0008

Sample	Mo	Cu	Co	Al	Sn	As	N
1	0.0020	0.0620	0.0055	0.0018	0.0023	0.0055	0.0056
2	0.0020	0.0635	0.0066	0.0018	0.0024	0.0056	0.0057
3	0.0022	0.0652	0.0068	0.0019	0.0025	0.0056	0.0057
4	0.0022	0.0653	0.0068	0.0019	0.0027	0.0057	0.0062
5	0.0025	0.0658	0.0068	0.0021	0.0028	0.0061	0.0063
6	0.0025	0.0660	0.0069	0.0023	0.0030	0.0061	0.0070
7	0.0026	0.0670	0.0069	0.0031	0.0032	0.0064	0.0072
8	0.0026	0.0672	0.0070	0.0033	0.0033	0.0067	0.0093
9	0.0026	0.0672	0.0071	0.0034	0.0036	0.0067	0.0097
10	0.0027	0.0678	0.0071	0.0034	0.0036		
11	0.0027	0.0682	0.0072	0.0035	0.0037		
12	0.0028	0.0682	0.0075		0.0039		
13	0.0028	0.0687	0.0075		0.0044		
14	0.0030		0.0076		0.0046		
15	0.0031		0.0080				
Mean	0.0026	0.0663	0.0070	0.0026	0.0033	0.0068	0.0070
Std Dev	0.0003	0.0020	0.0006	0.0007	0.0007	0.0005	0.0015
C _(95%)	0.0002	0.0012	0.0003	0.0005	0.0004	0.0004	0.0012

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

Element Ltd
 Sheffield Analytical Services
 Metals Technology (Testing) Ltd
 Anchorcert Analytical
 Universal Scientific Laboratory Pty Ltd
 Genitest, Inc
 Shanghai Jinyi Test Tech Co
 Luo Yang Copper
 Raghavendra SpectroMet Laboratory
 TCR Engineering Services Ltd
 Gesra Labs India Pvt
 Instytut Metalurgii Zelaza
 Tec-Eurolab
 TUV Nord Czech
 INCDMNR-IMNR
 Mineral & Metallurgical Laboratories
 AMG Superalloys UK Ltd
 Analyticka Laborator Lithea sro

Middlesbrough, England
 Sheffield, England
 Sheffield, England
 Birmingham, England
 Milperra, NSW, Australia
 Montreal, Canada
 Shanghai, China
 Luo Yang, He Nan, China
 Bangalore, India
 Mumbai, India
 Chennai, India
 Gliwice, Poland
 Campogalliano, Italy
 Brno, Czech Republic
 Pantelimon, Romania
 Bangalore, India
 Rotherham, England
 Brno, Czech Republic

UKAS accreditation 0239
 UKAS accreditation 0012
 UKAS accreditation 0963
 UKAS accreditation 0667
 NATA accreditation 0492
 PJ accreditation L17-153
 CNAS accreditation 0041
 CNAL accreditation 0173
 NABL accreditation 0371
 NABL accreditation 0367
 NABL accreditation 6238
 PCA accreditation AB554
 ACCREDIA accreditation 52
 CAI accreditation L1060

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 (IR or volumetric detection)
Silicon	1, 2, 4-8, 10	-	3, 9	gravimetric (perchloric acid)
			5, 11, 12	photometric (molybdenum blue)
Sulfur	4, 11	-	1-3, 5-10, 12-15	combustion (IR or volumetric detection)
Phosphorus	1, 3, 4, 7-10	-	2, 11, 12	volumetric (alkalimetric)
			5, 6	photometric (molybdenum blue)
Manganese	3-6, 8, 10-12	2	1	photometric (periodate)
			7, 9	volumetric (arsenite)
Nickel	1-3, 5, 6, 8-11, 13	4	7, 12	photometric (dimethyl glyoxime)
Chromium	2, 3, 5-8, 10-12, 14, 15	1, 4, 9	13	volumetric (ferrous ammonium sulfate)
Molybdenum	2, 3, 6-11, 13-15	5	1, 4, 12	photometric (thiocyanate)
Copper	1, 5-10, 12, 13	2, 4, 11	3	photometric (BCO)
Cobalt	1, 4-8, 10, 12-15	3, 9, 11	2	gravimetric
Aluminium	2-4, 6-11	1, 5		
Tin	1-6, 8, 10-14	7, 9		
Arsenic	1-3, 5, 6, 8, 9	4, 7		
Nitrogen	-	-	1, 3-7, 9	inert gas fusion (thermal conductivity)
			2, 8	photometric (Nessler reagent)

Notes

This Certified Reference Material has been produced and certified, wherever possible, in accordance with the requirements of ISO 17034 and the associated Guides, 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 approximately 6mm 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 February 2039, although we reserve the right to make changes as issue revisions, in the intervening period.

The procurement, 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.