MBH ANALYTICAL LTD

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CERTIFICATE OF ANALYSIS

13X 12535 (batch BE)

Certified Reference Material Information

Type:	STAINLESS STEEL (CHILL CAST)
Form and Size:	Disc ~40mm ~~D~~diameter
Manufactured by:	Polycast Ltd
Certified and Supplied by:	MBH Analytical Ltd

Assigned Values

Percentage element by weight

Element	C	Si	S	P	Mn	Ni	Cr	Mo	Cu
Value [1]	**0.229**	**1.407**	**0.0591**	**0.0400**	**0.342**	**14.798**	**16.95**	**4.0869**	**0.129930**
Uncertainty [2]	0.006	0.006	0.0015	0.0010	0.006	0.043	0.06	0.0324	0.00172

Element	Co	V	Sn	Al	Ti	Ta	B	N
Value [1]	**0.1460**	**0.25162**	**0.0194**	**0.194~~(0.199)~~**	**0.6251**	**~~(0.020)~~**	**0.0051**	**0.029**
Uncertainty [2]	0.00327	0.0033	0.0006	0.010-	0.012	-	0.0004	0.002

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

Definitions

[1] 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.

[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 25th April 2016

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Method of Preparation

This reference material was produced from commercial-purity metals and master alloys. The discs are the product of one melt poured into a sequence of multiple chill moulds with feeding systems designed to ensure sound discs. Approximately 2mm has been removed from the cast faces of the discs to minimise surface effects.

Sampling

Samples for chemical analysis were taken from various positions throughout the batch. At least 15% 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. Multiple measurements were taken from each surface under test.

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: Steels are generally prepared by linishing, grinding, turning or milling. 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 optical emission spectroscopy, 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.

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Analytical Data

Percentage element by weight

Sample	C	Si	S	P	Mn	Ni	Cr	Mo	Cu
1	0.2170	1.3900	0.0550	0.0392	0.3270	14.7273	16.830	4.0290	0.1258
2	0.2192	1.4000	0.0553	0.0395	0.3270	14.750	16.840	4.0500	0.1260
3	0.2200	1.4010	0.0568	0.0397	0.3283	14.750	16.874	4.0523	0.1280
4	0.22215	1.4040	0.0572	0.0399	0.330298	14.771	16.920	4.0680	0.1283
5	0.2284	1.4050	0.0575	0.0400	0.3373	14.790	16.940	4.0684	0.1299
6	0.2313	1.4070	0.0583	0.0401	0.3380	14.800	16.989	4.0720	0.1300
7	0.2320	1.4110	0.0597	0.0401	0.3452	14.810	17.011	4.0950	0.1302
8	0.2330	1.4120	0.0600	0.0404	0.3470	14.810	17.012	4.0990	0.1304
9	0.23765	1.4167	0.0601	0.0408	0.3480	14.811	17.020	4.1170	0.1309
10	0.2390	1.4200	0.0606		0.34986	14.8273	17.030	4.11768	0.1319
11	0.2421		0.0607		0.3512		17.032	4.1250	0.1320
12			0.0608		0.3513			4.1340	0.1325
13			0.0616		0.3530				0.1330
14			0.0632		0.3560				
Mean	**0.2291**	**1.4067**	**0.0591**	**0.0400**	**0.3420**	**14.7859**	**16.954**	**4.0856**	**0.1299**
Std Dev	0.00986	0.00988	0.0024	0.0005	0.01105	0.033	0.078	0.03384	0.0023
C (95%)	0.00658	0.0063	0.0014	0.0004	0.0061	0.024	0.052	0.02152	0.0014

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Sample	Co	V	Sn	Al	Ti	Ta	B	N
1	0.1380	0.2428	0.0184	0.17869	0.6120.5995	0.0175	0.0042	0.0245
2	0.1382	0.2436	0.0185	0.179680	0.6130.6010	0.0183	0.0046	0.0250
3	0.1393	0.2460	0.0188	0.1860	0.6180.6120	0.0201	0.0048	0.0279
4	0.1447	0.2476	0.0190	0.1900	0.6180.6133	0.0203	0.0049	0.0290
5	0.1450	0.2510	0.0191	0.1970	0.6250.6176	0.0208	0.0049	0.0293
6	0.1454	0.2520	0.0192	0.1972	0.6270.6180	0.0210	0.0051	0.0305
7	0.1459	0.2520	0.0198	0.1980	0.6300.6250	0.0225	0.0051	0.0320
8	0.1466	0.2530	0.0199	0.2000	0.6340.6274		0.0052	0.0322
9	0.1473	0.2537	0.0199	0.2001	0.6350.6301		0.0056	
10	0.1478	0.2540	0.0200	0.20659	0.6420.6335		0.0062	
11	0.1485	0.2580	0.0209	0.2064	0.6350			
12	0.1487	0.2580		0.2130	0.6421			
13	0.1500	0.2585		0.2170				
14	0.1508			0.2180				
15	0.1540							
Mean	**0.1460**	**0.2516**	**0.0194**	**0.19941**	**0.62512**	**0.0201**	**0.0051**	**0.0288**
Std Dev	0.0046	0.0053	0.0008	0.012509	0.01033	0.0017	0.0005	0.0029
C (95%)	0.0025	0.0032	0.0005	0.00672	0.00785	0.0016	0.0004	0.0024

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Note: $C_{(95\%)}$ is the 95% half-width confidence interval derived from the equation:

$$C_{(95\%)} = (t \times SD)/\sqrt{n}$$