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CERTIFICATE OF ANALYSIS

C12X 127480 (batch U)

Certified Reference Material Information

Type:	Low-Alloy Steel
Form:	Chippings
Produced by:	MBH Analytical Ltd
Certified and Supplied by:	MBH Analytical Ltd

Assigned Values

Percentage element by weight

Element	C	Si	S	P	Mn	Ni	Cr	Mo
Value [1]	**0.106**	**0.221**	**0.0497**	**0.0309**	**0.902**	**0.376**	**0.401**	**0.329**
Uncertainty [2]	0.002	0.004	0.0010	0.0006	0.004	0.004	0.003	0.004

Element	Cu	Co	V	W	Al	Ti	Sn	As
Value [1]	**0.347**	**0.323**	**0.0499**	**0.0463**	**0.111**	**0.105**	**0.0795**	**0.129**
Uncertainty [2]	0.004	0.003	0.0007	0.0008	0.003	0.003	0.0012	0.002

Definitions

[1] The certified values are the present best estimates of the true content for each element. They are derived from the results of an interlaboratory testing programme, detailed on page 3.

[2] The uncertainties are value judgements, based on the 95% confidence interval derived from the wet analysis results (page 3).

Certified by:

MBH ANALYTICAL LIMITED _____ on 13th August 2019

C Eveleigh

Usage

For use by analytical laboratories undertaking work involving the use of methods of analysis based on dissolution or combustion techniques.

Method of Preparation

This reference material originated as castings made from commercial metals and master alloys. The castings were surface cleaned, checked for homogeneity and converted into chippings. The chippings were sieved to remove material of less than 0.6mm particle size.

Sampling

The chippings were sampled after sieving, in accordance with BS6938.

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, using documented standard methods of analysis.

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

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.

Analytical Data

Percentage element by weight

Sample	C	Si	S	P	Mn	Ni	Cr	Mo
1	0.1020	0.2097	0.0470	0.0294	0.8941	0.3704	0.3924	0.3202
2	0.1032	0.2115	0.0476	0.0298	0.8956	0.3709	0.3960	0.3203
3	0.1044	0.2180	0.0480	0.0299	0.8970	0.3713	0.3970	0.3217
4	0.1044	0.2194	0.0485	0.0301	0.9007	0.3724	0.3980	0.3222
5	0.1045	0.2206	0.0489	0.0305	0.9013	0.3728	0.3995	0.3290
6	0.1050	0.2226	0.0491	0.0305	0.9020	0.3743	0.4000	0.3304
7	0.1064	0.2227	0.0492	0.0307	0.9031	0.3762	0.4027	0.3310
8	0.1070	0.2240	0.0495	0.0308	0.9066	0.3786	0.4033	0.3318
9	0.1070	0.2250	0.0500	0.0315	0.9070	0.3810	0.4035	0.3323
10	0.1071	0.2257	0.0501	0.0316	0.9106	0.3820	0.4037	0.3330
11	0.1073	0.2290	0.0511	0.0317		0.3840	0.4050	0.3357
12	0.1080		0.0519	0.0322			0.4053	0.3377
13	0.1100		0.0523	0.0328			0.4064	
14			0.0526					
Mean	**0.1059**	**0.2207**	**0.0497**	**0.0309**	**0.9018**	**0.3758**	**0.4010**	**0.3288**
Std Dev	0.0022	0.0059	0.0017	0.0010	0.0053	0.0049	0.0042	0.0061
C (95%)	0.0013	0.0039	0.0010	0.0006	0.0038	0.0033	0.0025	0.0039

Sample	Cu	Co	V	W	Al	Ti	Sn	As
1	0.3340	0.3174	0.0484	0.0448	0.1030	0.0996	0.0765	0.1227
2	0.3377	0.3177	0.0486	0.0450	0.1050	0.1008	0.0767	0.1250
3	0.3413	0.3209	0.0487	0.0450	0.1052	0.1020	0.0770	0.1260
4	0.3413	0.3230	0.0488	0.0451	0.1068	0.1030	0.0774	0.1272
5	0.3422	0.3234	0.0492	0.0454	0.1069	0.1045	0.0796	0.1278
6	0.3425	0.3240	0.0493	0.0458	0.1076	0.1050	0.0796	0.1282
7	0.3450	0.3240	0.0494	0.0458	0.1090	0.1054	0.0797	0.1283
8	0.3470	0.3256	0.0495	0.0464	0.1094	0.1065	0.0798	0.1300
9	0.3501	0.3256	0.0497	0.0467	0.1150	0.1070	0.0805	0.1312
10	0.3515	0.3280	0.0498	0.0474	0.1160	0.1078	0.0811	0.1314
11	0.3547		0.0508	0.0477	0.1161	0.1080	0.0813	0.1320
12	0.3550		0.0510	0.0478	0.1165	0.1084	0.0813	0.1330
13	0.3555		0.0515	0.0485	0.1167		0.0830	0.1340
14	0.3560		0.0522		0.1180			
15			0.0522					
Mean	**0.3467**	**0.3230**	**0.0499**	**0.0463**	**0.1108**	**0.1048**	**0.0795**	**0.1290**
Std Dev	0.0072	0.0034	0.0013	0.0013	0.0053	0.0029	0.0020	0.0033
C (95%)	0.0042	0.0024	0.0007	0.0008	0.0031	0.0019	0.0012	0.0020

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	Milperra, NSW, Australia	NATA accreditation 0492
Genitest, Inc	Montreal, Canada	PRI accreditation 123077
Shanghai Jinyi Test Technology Co	Shanghai, China	CNAL accreditation 0783
Shandong Metallurgical & Science Research	Jinan, Shandong, China	CNAS accreditation 1461
Bureau Veritas CPS Pvt Ltd	Chennai, India	NABL accreditation 0025
TCR Engineering Services Ltd	Mumbai, India	NABL accreditation 0367
Raghavendra Spectrometallurgical Lab.	Bangalore, India	NABL accreditation 0371
Instytut Metalurgii Zelaza	Gliwice, Poland	PCA accreditation AB554
Tec-Eurolab	Campogalliano, Italy	ACCREDIA accreditation 52
London & Scandinavian Met Co Ltd	Rotherham, England	
Coleshill Laboratories Ltd	Birmingham, England	
Analyticka Laborator Lithea sro	Brno, Czech Republic	

Note: to achieve the above accreditation (UKAS, 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 (infra-red detection)
Silicon	1-4, 6, 11	-	5, 7, 10	gravimetric (perchloric acid)
			8, 9	photometric (molybdenum blue)
Sulfur	2, 7	-	1, 3-6, 8-14	combustion (infra-red detection)
Phosphorus	1-5, 10, 11, 13	-	6, 9, 12	volumetric (alkalimetric)
			7, 8	photometric (molybdenum blue)
Manganese	1-7, 10	9	8	photometric (periodate)
Nickel	1, 3, 4, 6-8, 10	2, 5	9, 11	photometric (dimethyl glyoxime)
Chromium	1, 2, 5, 7-9, 12, 13	4, 6	3	photometric (diphenyl carbazide)
			10, 11	volumetric (FAS)
Molybdenum	2, 3, 6-9, 11, 12	1, 4	5, 10	photometric (thiocyanate)
Copper	2-4, 7-12	1, 5, 13	6, 14	photometric (BCO)
Cobalt	1, 3, 5, 7-10	2	4	photometric (2β naphthol)
			6	volumetric (iodine)
Vanadium	1-6, 8-12, 14, 15	7, 13		
Tungsten	1-4, 6-9, 12, 14	11	5	ICP-MS
			10	photometric (thiocyanate)
Aluminium	1-9, 11, 13	10, 12	14	photometric (chrome azurol S)
Titanium	1, 2, 4, 7, 9-12	3, 5	6	photometric (diantipyryl methane)
			8	ICP-MS
Tin	1,2, 4-11	3, 12, 13		
Arsenic	2-12	1, 13		

Notes

This Certified Reference Material was originally analysed in October 2015. This version of the certificate covers usage of the product as chippings for 'wet' analysis. The batch has been 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 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 initial analysis. Technical support for this certification will therefore expire in October 2035, although we reserve the right to make changes as issue revisions, in the intervening period.

This sample is also available in the form of solid discs for OES and XRF analysis.

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.