ECISS

EUROPEAN COMMITTEE FOR IRON AND STEEL STANDARDISATION
COMITÉ EUROPÉEN DE NORMALISATION DU FER ET DE L'ACIER
EUROPÄISCHES KOMITEE FÜR EISEN-UND STAHLNORMUNG

EUROPEAN CERTIFIED REFERENCE MATERIAL (EURONORM – CRM)

CERTIFICATE OF CHEMICAL ANALYSIS

EURONORM – CRM No. 883-1, Blast furnace slag

LABORATORY MEANS (4 values) - Mass content in %

Line No	Fe	Si	Ca	Mg	Al	Ti	Mn	P	S	Na	K	V	Cr	Ni	Mo
1	0.9393	16.479	--	--	--	--	--	0.0029	1.0419	--	0.3668	--	0.0107	0.00048	<0.0003
2	0.9465	16.564	20.990	8.655	--	1.2783	0.5243	0.0030	1.0475	--	0.3683	0.1118	0.0112	0.00050	0.0003
3	0.9502	16.583	21.130	8.700	6.475	--	0.5278	0.0030	1.0483	0.2869	0.3750	0.1123	0.0113	0.00051	0.0003
4	0.9643	16.608	21.153	8.714	6.479	1.2918	0.5297	0.0030	1.0595	0.2902	0.3760	0.1155	0.0115	0.00052	0.0003
5	0.9676	16.625	--	8.741	6.488	1.2925	0.5310	0.0031	1.0600	0.2950	0.3766	0.1172	0.0116	0.00052	0.0003
6	0.9710	16.637	21.302	8.756	6.494	1.3109	0.5383	0.0031	1.0621	0.3001	0.3778	0.1174	0.0117	0.00053	0.0004
7	0.9738	16.641	21.313	8.863	6.503	1.3280	0.5383	0.0033	1.0728	0.3038	0.3894	0.1183	0.0118	0.00053	0.0004
8	0.9739	16.651	21.313	8.881	6.536	1.3320	0.5420	0.0033	1.0818	0.3180	0.3920	0.1206	0.0119	0.00055	0.0005
9	0.9774	16.663	21.314	8.908	6.545	1.3360	0.5434	0.0033	1.0838	0.3221	0.3923	0.1210	0.0121	0.00057	0.0005
10	0.9800	16.683	21.333	8.920	6.551	1.3433	0.5438	0.0038	1.1348	0.3223	0.3949	0.1215	0.0125	0.00058	<0.0008
11	0.9830	16.732	21.348	8.921	6.553	1.3458	0.5503	0.0038	1.1475	0.3223	0.3960	0.1218	0.0141	--	
12	0.9875	16.763	21.366	8.935	6.554	1.3463	0.5507	0.0041	1.1528	0.3249	0.4008	0.1238	0.0143		
13	0.9942	16.821	21.375	8.938	6.590	1.3470	0.5525	--	1.1575	0.3255	0.4009	0.1240	0.0146		
14	0.9948	16.890	21.415	8.945	6.592	1.3510	0.5575	--		0.3272	0.4029	0.1243	0.0150		
15	1.0041	--	21.489	8.991	6.620	1.3546	0.5578			0.3288	0.4070	--	0.0152		
16	1.0043	--	21.678	9.041	6.703	1.3692	0.5669			0.3292	0.4100	0.1255	0.0153		
17	1.0190			--	--	1.3700	0.5674			0.3296	0.4130	0.1287	0.0158		
18	1.0450						0.5679			0.3299	0.4158	0.1337	--		
19	--										0.4200	0.1344			
20	--											--			
M_M	**0.9820**	**16.667**	**21.323**	**8.861**	**6.549**	**1.3331**	**0.5464**	**0.0033**	**1.0885**	**0.3160**	**0.3934**	**0.1219**	**0.0130**	**0.00053**	**≤0.001**
s_M	0.0261	0.107	0.163	0.118	0.064	0.0280	0.0141	0.0004	0.0435	0.0153	0.0164	0.0065	0.0018	0.00004	
s_W	0.0119	0.155	0.152	0.053	0.079	0.0134	0.0058	0.0003	0.0147	0.0078	0.0080	0.0023	0.0008	0.00006	

Line No	Ba	Sr	Zr	*F*	*C*	*Zn*	*Pb*	*As*	*B*	*Ce*	*Li*
1	--	--	--	--	*0.100*	*0.0004*	*0.00004*	*0.00002*	*0.0050*	*0.0101*	*0.0035*
2	0.0393	--	0.0230	--	*0.122*	*0.0004*	*<0.00005*	*0.00004*	*0.0051*	--	*0.0051*
3	0.0395	0.0354	0.0237	*<0.02*	*0.126*	*0.0005*	*0.00007*	*0.00007*	*0.0054*	*0.0131*	*0.0058*
4	0.0398	0.0365	0.0241	*0.0380*	*0.128*	*<0.0007*	*0.00010*	*0.00023*	*0.0058*	*0.0135*	*0.0060*
5	0.0410	0.0368	0.0247	*0.0393*	*0.135*	*0.0008*	*0.00020*	*<0.0005*	*0.0069*	*0.0135*	*0.0061*
6	0.0435	0.0369	0.0268	*0.0393*	*0.144*	*0.0008*	*<0.0005*	*<0.0007*	*0.0070*	*0.0145*	*0.0061*
7	0.0446	0.0373	0.0272		*0.146*	*0.0009*	*<0.0007*	--	*0.0078*	*0.0149*	*0.0066*
8	0.0448	0.0373	0.0273		*0.153*	*<0.0010*			*0.0079*	*0.0169*	*0.0077*
9	0.0450	0.0375	0.0288		*0.158*	*0.0012*					--
10	0.0451	0.0388	0.0290			*0.0012*					
11	0.0453	0.0388	0.0311			*0.0015*					
12	0.0458	0.0391	0.0321			*0.0019*					
13	0.0458	0.0393	0.0331								
14	0.0476	0.0395									
15		0.0403									
M_M	**0.0436**	**0.0380**	**0.0276**								
s_M	0.0028	0.0015	0.0034								
s_W	0.0017	0.0008	0.0011								

M_M: Mean of the intralaboratory means

s_M: Standard deviation of the intralaboratory means

s_W: Intralaboratory standard deviation

The laboratory mean values have been examined statistically to eliminate outlying values. Where a "---" appears in the table it indicates that an outlying value has been eliminated by either the Cochran or Grubbs Test. Values reported as "less than" by the participating laboratories have not been taken into account in the statistical calculations.

Additional values from laboratories for information (in µg/g)

Be: 0.0006; Bi: 0.000001; Cd: 0.00002; Co: 0.00006; Cs: 0.00003; Cu: 0.0001; Hf: 0.0008; Hg: 0.000001; Nb: 0.002; Rb: 0.001; Sb: 0.000002; Sc: 0.003; Se: 0.0004; Ta: 0.0001; Te: 0.000003; Th: 0.008; U: 0.001; W: 0.00002; Y: 0.006

CERTIFIED VALUES - Mass content in %

	Fe	Si	Ca	Mg	Al	Ti
M_M	**0.9820**	**16.67**	**21.32**	**8.86**	**6.55**	**1.3331**
C(95 %)	**0.0130**	**0.07**	**0.10**	**0.07**	**0.04**	**0.0155**

	Mn	P	S	Na	K	V
M_M	**0.546**	**0.0033**	**1.0885**	**0.316**	**0.393**	**0.122**
C(95 %)	**0.008**	**0.0003**	**0.0273**	**0.009**	**0.008**	**0.004**

	Cr	Ni	Mo	Ba	Sr	Zr
M_M	**0.0130**	**0.00053**	**≤0.001**	**0.0436**	**0.0380**	**0.0276**
C(95 %)	**0.0009**	**0.00003**		**0.0017**	**0.0009**	**0.0022**

The half-width confidence interval $C(95\%) = \frac{t \times s_M}{\sqrt{n}}$ where "t" is the appropriate Student's t value and "n" is the number of acceptable mean values

For further information regarding the confidence interval for the certified value see ISO Guide 35:2006 sections 6.1 and 10.5.2

This certified reference material was prepared in accordance with the recommendations set out in ISO Guides 30 – 35 and issued by:

swerea|KIMAB

Isafjordsgatan 28A, SE 164 40, Kista, Sweden

On behalf of: The Iron and Steel Nomenclature Co-ordinating Committee (COCOR) of the ECISS, after approval by all the participating laboratories and all the producing organisations.
(France- ArcelorMittal Maizières/CTIF; Germany-Iron and Steel CRM Working Group: Stahlinstitut VDEh, BAM Bundesanstalt für Materialforschung und -prüfung & MPI für Eisenforschung; Nordic Countries-Nordic CRM Working Group)

JUNE 2015

EURONORM – CRM No. 883-1

METHODS USED

Element	Line number	Methods
Fe	1.6.8.9.13.14.18	XRF
	2.3.4.5.7.10.15.16	ICP-OES
	11	ICP-MS
	12	FAAS
	17	Titration with Cr (VI) after reduction with Sn (II)
Si	1.3.7.10.11.12	XRF
	2.5.6.8.9.14	ICP-OES
	4	Gravimetry, dehydration with sulphuric acid
	13	Gravimetry, dehydration with perchloric acid
Ca	2.4.9.10.11.13	ICP-OES
	3.6.7.8.12.15.16	XRF
	14	Gravimetry after precipitation as oxalate
Mg	2.6.7.10.11.15	XRF
	3.4.8.9.12.13.14.16	ICP-OES
	5	Gravimetry, magnesium ammonium phosphate
Al	3.4.5.7.9.13.15	ICP-OES
	6.8.10.11.14.16	XRF
	12	FAAS, without separation
Ti	2.4.5.6.9.10.14.15.16	ICP-OES
	7.8.11.12.13.17	XRF
Mn	2.4.5.7.10.11.12.14.16.17	ICP-OES
	3.6.8.9.13	XRF
	15	FAAS
	18	ICP-MS
P	1.2.9.11	ICP-OES
	3.4.8	XRF
	5.6.10	ICP-MS
	7.12	MAS, phosphovanadomolybdate, extraction
S	1.4	Gravimetry as $BaSO_4$ without separation
	2.3.7.8.10.11.12.13	Combustion, infrared absorption
	5.6	ICP-OES
	9	XRF
Na	3.5.9.10.11.17.18	ICP-OES
	4.6.8.13.15.16	FAAS
	7.14	XRF
	12	ICP-MS
K	1.3.6.8.9.11.13	ICP-OES
	2.4.7.10.15.18	FAAS
	5.19	ICP-MS
	12.14.16.17	XRF
V	2.3.4.5.6.8.10.14.17.18.19	ICP-OES
	7	ICP-MS
	9.11.12.13.16	XRF
Cr	1.4.5.6.7.8.9.10.11.12.14.15.17	ICP-OES
	2	FAAS
	3.16	XRF
	13	ICP-MS
Ni	1.2.5.6.9	ICP-MS
	3.4.7.8.10	ICP-OES
Mo	1.5.8.9.10	ICP-OES
	2.3.4.6.7	ICP-MS
Ba	2.13	ICP-MS
	3.5.6.7.8.9.10.11.12	ICP-OES
	4.14	XRF
Sr	3.5.6.7.8.11.12.14	ICP-OES
	4.10.13.15	XRF
	9	ICP-MS
Zr	2.3.4.5.9.10.13	ICP-OES
	6.7.8	XRF
	11.12	ICP-MS
F	*3*	*MAS, alizarin, pyrohydrolysis*
	4.5	*Ion chromatography*
	6	*Titration with Th (IV), visual end point, separation of interfering ions*
C	*1.2.3.4.5.8.9*	*Combustion, infrared absorption*
	6.7	*Combustion, non-aqueous titration after absorption in organic solvent*
Zn	*1.2.3.11*	*ICP-MS*
	4.5.6.7.8	*ICP-OES*
	9.10.12	*FAAS*
Pb	*1*	*ETAAS*
	2.3.4.	*ICP-MS*
	5.7	*ICP-OES*
	6	*FAAS*
As	*1*	*ETAAS*
	2.4	*ICP-MS*
	3	*MAS, diethyldithiocarbamate, separation as arsine*
	5.6	*ICP-OES*
B	*1.7.8*	*ICP-MS*
	2.3.4	*MAS, curcumin*
	5.6	*ICP-OES*
Ce	*1.3.5.6.8*	*ICP-OES*
	4.7	*ICP-MS*
Li	*1.2.3.5.7.8.9*	*ICP-OES*
	4.6	*ICP-MS*

Abbreviations:

ETAAS	Electrothermal Atomic Absorption Spectrometry
FAAS	Flame Atomic Absorption Spectrometry
ICP-OES	Inductively Coupled Plasma – Optical Emission Spectrometry
ICP-MS	Inductively Coupled Plasma – Mass Spectrometry
MAS	Molecular Absorption Spectrophotometry
XRF	X-ray Fluorescence Spectrometry

DESCRIPTION OF THE SAMPLE

The sample consists of powder that has been homogenised and sieved. From the material the fines passing a nominal 100 µm sieve have been removed. It is supplied in bottles containing 100 g.

INTENDED USE & STABILITY

ECRM 883-1 is intended for the verification of analytical methods, such as those used by the participating laboratories, for the calibration of analytical instruments in cases where the calibration with primary substances (pure metals or stoichiometric compounds) is not possible and for establishing values for secondary reference materials.

It will remain stable provided that the bottle remains sealed and is stored in a cool, dry atmosphere. When the bottle has been opened the lid should be secured immediately after use. If the content should become discoloured (e.g. oxidised) due to atmospheric contamination it should be discarded.

TRACEABILITY

The traceability of ECRM 883-1 has been established in accordance with principles of ISO Guides 30 – 35 and the International vocabulary of basic and general terms in metrology.

The assigned values for each material are achieved by inter-laboratory characterization, each laboratory using the method of their choice, details of which are given above. These methods are either stoichiometric analytical techniques or methods which are calibrated against pure metals or stoichiometric compounds. Most methods used were either international or national standard methods or methods which are technically equivalent.

PARTICIPATING LABORATORIES

AG der Dillinger Hüttenwerke, Dillingen/Saar (Germany)
ALS Scandinavia AB, Luleå (Sweden)
A.M.C.O. united samplers and assayers GmbH, Duisburg (Germany)
AMG Superalloys UK Limited, Rotherham (UK)
ArcelorMittal Maizières Research SA, Maizières-lès-Metz (France)
ArcelorMittal, Dunkerque (France)
ArcelorMittal, Tubarão (Brazil)
BAM Bundesanstalt für Materialforschung und -prüfung, Berlin (Germany)
Chemad GmbH, Duisburg (Germany)
FEhS – Institut für Baustoff-Forschung, Duisburg (Germany)
GFE Fremat GmbH, Freiberg (Germany)
Industeel France - Le Creusot, Le Creusot (France)
Lucideon, Stoke-on-Trent (UK)
Muldenhütten Recycling und Umwelttechnik GmbH, Freiberg (Germany)
Ovako Sweden AB, Hofors (Sweden)
Pattinson & Stead (2005) Ltd., Middlesbrough (UK)
Ridsdale & Co. Ltd., Middlesbrough (UK)
SSAB Europe Oy, Raahe (Finland)
SSAB Special Steels, Oxelösund (Sweden)
Swerea KIMAB AB, Kista (Sweden)
ThyssenKrupp Steel Europe AG, Duisburg (Germany)
Umicore Precious Metals, Hoboken (Belgium)
voestalpine Stahl GmbH, Linz (Austria)
Weser-Metall GmbH, Nordenham (Germany)

FURTHER INFORMATION

For information regarding the preparation, certification and supply of these European Certified Reference Materials (EURONORM-CRMs) and the use of the statistical information given on this certificate, please refer either to the producer of this Certified Reference Material or to Technical Reports CEN/TR 10317:2014 and CEN/TR 10350:2013, both of which are available from the national standards body in your country. (In the UK this is the BSI, 389 Chiswick High Road, London W4 4AL).
Further information and advice on this or other Certified Reference Materials or Reference Materials produced by Swerea KIMAB AB, may be obtained from the address below.

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Karin Ingelgård/Michael Granfors
Responsible for CRM certification

Swerea KIMAB AB
Isafjordsgatan 28A
SE 164 40 Kista, Sweden
E-mail: crm@swerea.se
Website: www.swereakimab.se