

European Certified Reference Material (EURONORM-CRM) Certificate of Chemical Analysis

EURONORM-CRM No. 179-2 (toolsteel 1.2550)

Laboratory means (4 values), mass content in %

Line No.	C	Si	Mn	P	Cr	Mo	Ni	Cu	N	V	W
1	0.5775	-----	-----	0.0216	1.0417	0.0568	0.0722	0.1043	0.0059	0.1708	1.7480
2	0.5815	0.5447	-----	0.0233	1.0580	0.0603	0.0725	0.1053	0.0061	0.1809	1.7825
3	0.5867	0.5628	0.5212	0.0238	1.0600	0.0613	0.0726	0.1058	0.0063	0.1825	1.8190
4	0.5905	0.5722	0.5229	0.0247	1.0625	0.0618	0.0728	0.1058	0.0064	0.1839	1.8275
5	0.5921	0.5742	0.5280	0.0249	1.0630	0.0628	0.0729	0.1075	0.0065	0.1842	1.8325
6	0.5957	0.5747	0.5295	0.0253	1.0669	0.0654	0.0734	0.1080	0.0067	0.1850	1.8342
7	0.5967	0.5757	0.5300	0.0257	1.0675	0.0680	0.0738	0.1085	0.0068	0.1856	1.8445
8	0.5975	0.5759	0.5329	0.0258	1.0700	0.0684	0.0740	0.1085	0.0068	0.1858	1.8602
9	0.5977	0.5761	0.5355	0.0260	1.0701	0.0685	0.0742	0.1086	0.0069	0.1868	1.8675
10	0.5988	0.5762	0.5377	0.0261	1.0745	0.0694	0.0743	0.1088	0.0070	0.1870	1.8687
11	0.5990	0.5762	0.5387	0.0262	1.0764	0.0698	0.0748	0.1090	0.0071	0.1875	1.8727
12	0.5990	0.5782	0.5393	0.0266	1.0765	0.0710	0.0752	0.1095	0.0072	0.1893	1.8825
13	0.5990	0.5801	0.5395	0.0272	1.0772	0.0718	0.0754	0.1100	0.0072	0.1900	1.8850
14	0.5995	0.5811	0.5397	0.0273	1.0800	0.0720	0.0761	0.1101	0.0073	0.1900	1.8878
15	0.5995	0.5823	0.5400	0.0277	1.0863	0.0721	0.0769	0.1107	0.0073	0.1928	1.8907
16	0.6002	0.5825	0.5400	0.0279	1.0924	0.0723		0.1108	0.0074	0.1941	1.8912
17	0.6006	0.5825	0.5402	0.0283	1.0930	0.0726		0.1116	0.0074	0.1951	1.8932
18	0.6009	0.5837	0.5416	0.0289	1.1002	0.0733		0.1135		0.1953	1.8950
19	0.6015	0.5850	0.5430	0.0293	1.1032	0.0740		0.1135		0.1955	1.9003
20	0.6039	0.5850	0.5441	0.0300	1.1182	0.0758		0.1147		0.1964	1.9225
21	0.6075	0.5855	0.5456	0.0307	1.1425	0.0763		0.1148		0.1986	1.9375
22	0.6112	0.5945	0.5502	0.0310	1.1765	0.0765		0.1165		-----	1.9425
23	0.6114	0.5950	0.5532	-----	-----	0.0800		0.1175		-----	1.9566
24		0.5975	0.5602	-----	-----	-----		0.1185		-----	-----
M(M)	0.5977	0.5792	0.5388	0.0267	1.0844	0.0696	0.0741	0.1105	0.0068	0.1884	1.8714
s(M)	0.0081	0.0108	0.0093	0.0024	0.0302	0.0059	0.0014	0.0039	0.0005	0.0065	0.0496
s(w)	0.0029	0.0068	0.0033	0.0007	0.0101	0.0018	0.0009	0.0014	0.0002	0.0026	0.0134

M(M): Mean of the intra-laboratory means

s(M): Standard deviation of the intra-laboratory means

s(w): Intra-laboratory 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 omitted by either the Cochran or Grubbs test. Values given in *italic type* are for information only.

Additional values for information:
Ti: ca. 14 µg/g

Laboratory means (4 values), mass content in µg/g

Line No.	Bi	Cd	Ga	Nb	Pb	Sb	Te	Zn	S	Co	Hg	Se	Tl
1	< 0.05	< 0.01	10.10	10.88	0.92	14.95	< 0.10	1.35	3	111	< 0.02	0.03	< 0.05
2	0.06	< 0.01	12.11	12.66	1.00	15.05	< 0.10	1.80	3	126	< 0.05	0.45	0.07
3	0.07	0.03	12.20	13.25	1.04	15.75	< 0.20	1.86	3	132	0.08	0.85	< 0.10
4	0.09	0.04	12.24	13.28	1.05	16.44	< 0.50	2.03	3	135	< 0.10	< 2.00	< 0.10
5	< 0.10	0.06	12.39	14.48	1.06	16.83	< 0.50	2.05	3	136		< 2.00	< 0.10
6	< 0.10	< 0.10	12.54	14.60	1.16	17.05	0.70	2.14	4	136			< 0.10
7	< 0.10	< 0.10	13.00	14.84	1.23	17.23	< 1.00	2.28	4	140			< 0.20
8	< 0.10	0.19	13.54	15.00	1.30	17.28	< 1.00	2.48	5	140			0.34
9	< 0.10	< 0.20	14.26	-----	1.31	17.40	< 1.00	2.75	5	140			
10	< 0.20	0.22	16.48	15.50	1.50	18.00	< 2.00	2.85	5	140			
11	< 0.20		-----	16.42	1.60	18.01		2.88	5	141			
12	0.20		-----	17.06	1.62	-----		3.30	5	149			
13					1.98	18.25		-----	5	157			
14					-----	18.88			6	171			
15					-----	20.08			7	180			
16						21.00			8	183			
17									8	208			
18									8	228			
19									8				
20									10				
21									15				
M(M)	< 0.3	< 0.3	12.89	14.36	1.29	17.48	< 2.0	2.31					
s(M)			1.66	1.76	0.31	1.68		0.55					
s(w)			0.5	0.6	0.1	0.6		0.43					

CERTIFIED VALUES, mass content in %

	C	Si	Mn	P	Cr	Mo	Cu	V	W		Ni	N	
M(M)	0.598	0.579	0.539	0.0267	1.08	0.070	0.111	0.188	1.87		M(M)	0.0741	0.0068
s(M)	0.009	0.011	0.010	0.0024	0.03	0.006	0.004	0.007	0.05		C(95%)	0.0008	0.0003

CERTIFIED VALUES, mass content in µg/g

	Bi	Cd	Ga	Nb	Pb	Sb	Te	Zn
M(M)	< 0.3	< 0.3	12.9	14.4	1.3	17.5	< 2.0	2.3
C(95%)			1.2	1.3	0.2	1.0		0.4

C(95%) is the half-width confidence interval where t is the appropriate Student's t value and n is the number of acceptable laboratory means. For further information regarding the confidence interval for the certified value see ISO Guide 35:2006 sections 6.1 and 10.5.2.

$$C(95\%) = \frac{t \cdot s(M)}{\sqrt{n}}$$

This certified reference material was prepared and issued by:

The German Iron and Steel CRM Working Group

consisting of Bundesanstalt für Materialforschung und -prüfung (BAM), Berlin, Max-Planck-Institut für Eisenforschung GmbH (MPI), Düsseldorf
Steel institute VDEh, Düsseldorf

after approval by all the participating laboratories and all the producing organisations: (France- ArcelorMittal Maizières/CTIF; Germany-Iron and Steel CRM Working Group: Steel institute VDEh, Bundesanstalt für Materialforschung und -prüfung (BAM) & MPI für Eisenforschung; Nordic Countries-Nordic CRM Working Group)

Certificate updated in April 2020 with new data for Nickel, keeping the original data of the certificates dated March 1990 and addenda dated April 1998 and May 2000

Description of the sample

The sample is available in the form of fine chips (approx. 400 pieces per g) from which the fines passing a 0.5 mm high-grade steel sieve have been removed. The chemical analysis has been carried out on these chips. It is supplied in glass bottles containing 100 g. It is also supplied in the form of 38 mm dia discs (35 mm thick).

Sale of the reference material: Bundesanstalt für Materialforschung und -prüfung (BAM), Richard-Willstätter-Straße 11, 12489 Berlin (www.webshop.bam.de).

Participating laboratories in certification 1990

Aciéries Aubert & Duval, Les Ancizes (France)
 Alstom Atlantique, Belfort (France)
 Böhler AG, Düsseldorf (Germany)
 Böhler GmbH, Kapfenberg (Austria)
 Bundesanstalt für Materialforschung und -prüfung (BAM), Berlin (Germany)
 CRM Centre de Recherches Métallurgiques, Liège (Belgium)
 CSM Centro Sviluppo Materiali S.p.A., Roma (Italy)
 Dantest-National Institute for Testing and Verification, Copenhagen (Denmark)
 Hoesch Stahl AG, Dortmund (Germany)
 Hoogovens Groep BV, IJmuiden (The Netherlands)
 Institut de Recherches de la Sidérurgie Française IRSID, Maizières-lès-Metz (France)
 Institut de Recherches de la Sidérurgie Française IRSID, Saint-Germain-en-Laye (France)
 J. & H.S. Pattinson, Newcastle upon Tyne (United Kingdom)
 Klöckner Stahl GmbH, Bremen (Germany)
 Krupp Stahl AG, Siegen (Germany)
 Laboratoire Boudet et Dussaix, Croissy sur Seine (France)
 Laborlux S.A., Esch/Alzette (Luxembourg)
 Max-Planck-Institut für Eisenforschung GmbH, Düsseldorf (Germany)
 NEI-International Research & Development Co., Newcastle upon Tyne (United Kingdom)
 Ridsdale & Co. Ltd., Middlesbrough (United Kingdom)
 Sanderson Kayser Ltd., Sheffield (United Kingdom)
 Soc. Terni S.p.A. Terni (Italy)
 SOLLAC, Florange (France)
 Staatliches Materialprüfungsamt Nordrhein-Westfalen (MPA NRW), Dortmund (Germany)
 Thyssen Stahl AG, Duisburg (Germany)
 UNIREC, Centre de Recherches d'Unieux, Firminy (France)
 Voest-Alpine AG, Linz/Donau (Austria)

Participating laboratories in the certification of nitrogen 1998

AG der Dillinger Hüttenwerke, Dillingen-Saar (Germany)
 Aubert & Duval, Aciérie des Ancizes, Les Ancizes (France)
 Böhler Edelstahl GmbH, Kapfenberg (Austria)
 Bundesanstalt für Materialforschung und -prüfung (BAM), Berlin (Germany)
 CTIF Centre Technique des Industries de la Fonderie, Sèvres (France)
 EWK Edelstahl Witten-Krefeld GmbH, Witten (Germany)
 Hoogovens Staal BV, IJmuiden (The Netherlands)
 Howmet Ltd., Exeter (United Kingdom)
 Hüttenwerke Krupp Mannesmann GmbH, Duisburg (Germany)
 Imphy SA, Imphy (France)
 Inco Test, Hereford (United Kingdom)
 Krupp Hoesch Stahl AG, Dortmund (Germany)
 Ridsdale & Co. Ltd., Middlesbrough (United Kingdom)
 SOLLAC, Florange (France)
 Voest-Alpine Stahl Linz GmbH, Linz (Austria)
 Willan Metals Ltd., Rotherham (United Kingdom)

Participating laboratories in the certification of trace elements 2000

AG der Dillinger Hüttenwerke, Dillingen-Saar (Germany)
 Aubert & Duval, Aciérie des Ancizes, Les Ancizes (France)
 Allvac Ltd., Sheffield, (United Kingdom)
 Böhler Edelstahl GmbH, Kapfenberg (Austria)
 Bundesanstalt für Materialforschung und -prüfung (BAM), Berlin (Germany)
 Centre Technique des Industries de la Fonderie (CTIF), Sèvres (France)
 Centro Nacional de Investigaciones Metalúrgicas (CENIM), Madrid (Spain)
 Hoogovens Staal BV, IJmuiden (The Netherlands)
 Imphy SA, Imphy (France)
 Institutet för Metallforskning (SIMR), Stockholm, (Sweden)
 Luxcontrol S.A., Esch-sur-Alzette (Luxembourg)
 Max-Planck-Institut für Eisenforschung GmbH, Düsseldorf (Germany)
 Onderzoek Centrum voor Aanwending van Staal (OCAS) NV, Zelzate (Belgium)
 Ridsdale & Co. Ltd., Middlesbrough (United Kingdom)
 Sheffield Hallam University, Materials Research Institute, Sheffield, (United Kingdom)
 SOLLAC-Florange, Florange (France)
 SOLLAC-Fos-sur-Mer, Fos-sur-Mer (France)
 Voest-Alpine Stahl Linz GmbH, Linz (Austria)

Participating laboratories in the recertification of nickel 2020

ALS Scandinavia AB, Luleå (Sweden)
 ArcelorMittal Research, Maizières-lès-Metz (France)
 ArcelorMittal Global R&D Gent, Zelzate (Belgium)
 Bundesanstalt für Materialforschung und -prüfung (BAM), Berlin (Germany)
 Deutsche Edelstahlwerke Specialty Steel GmbH & Co. KG, Witten (Germany)
 Höganäs Sweden AB, Höganäs (Sweden)
 Institute of Certified Reference Materials, Yekaterinburg (Russia)
 Kanthal AB, Hallstahammar (Sweden)
 Max-Planck-Institut für Eisenforschung GmbH, Düsseldorf (Germany)
 Swerim, Kista (Sweden)
 ThyssenKrupp Steel Europe AG, Duisburg (Germany)
 Ugitech, Grigny (France)
 voestalpine BÖHLER Edelstahl GmbH & Co KG, Kapfenberg (Austria)

Intended use & stability

ECRM 179-2 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 stoichiometric metals or 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 and dry atmosphere. When the bottle has been opened the lid should be secured immediately after use. If the contents should become discoloured (eg. oxidised) due to atmospheric contamination they should be discarded.

Traceability

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 below. 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.

Methods used

Element	Line number	Method
C	1	Gravimetry
	2	Combustion, Thermal conductivity
	3, 4, 7, 8, 10, 13, 14, 15, 16, 17, 18, 21, 22, 23	Combustion, Infrared absorption
	5, 6, 11	Combustion, Coulometric titration
	9, 12	Non-aqueous titration after absorption in organic solvent
	19, 20	Combustion, Conductimetry
Si	2, 4, 6, 7, 8, 9, 12, 14, 15, 16, 17, 18, 20, 22, 23	Gravimetry, dehydration with perchloric acid
	3, 11, 21	ICP-OES
	5, 10, 19	MAS, molybdenum blue, without extraction
	13	FAAS
	24	MAS, silicovanadomolybdate, extraction
Mn	3, 4, 10, 11, 16, 17, 18	FAAS
	5, 6, 7, 9, 12, 13, 19, 20, 21	MAS, oxidation with periodate
	8, 14, 22, 24	ICP-OES
	15, 23	MAS, oxidation with persulfate
P	1, 5, 10, 11	ICP-OES
	2, 6, 12, 18, 19	MAS, molybdenum blue, without extraction
	3, 13, 16	MAS, molybdenum blue, extraction
	4, 7, 8, 9, 14, 15, 17, 21, 22	MAS, phosphovanadomolybdate, extraction
	20	Acidimetric titration of ammonium phosphomolybdate
Cr	1	MAS, diphenylcarbazide
	2, 3, 6, 9, 10, 13, 15, 19, 20	Titration with Fe(II), oxidation with persulphate
	4	Titration with Fe(II), oxidation with peroxide
	5, 7, 8, 11, 12, 21	FAAS
	14, 16, 17, 18, 22	ICP-OES
Mo	1, 6, 8, 12, 16, 21	ICP-OES
	2, 5, 10, 14, 19, 20, 23	FAAS
	3, 4, 11, 15	MAS, thiocyanate in presence of Sn(II), without extraction
	7, 9, 17, 18, 22	MAS, thiocyanate in presence of Sn(II), extraction
	13	MAS, phenylhydrazine
Ni	1, 2, 4, 6, 7, 8, 9, 11, 12, 13, 15	ICP-OES
	3, 5	FAAS
	10	ICP-MS
	14	MAS, dimethylglyoxime, extraction
Cu	1, 2, 3, 4, 6, 7, 8, 9, 10, 11, 14, 16, 17, 18, 22	FAAS
	5, 12, 13, 15, 19, 20	ICP-OES
	21	MAS, cuproine, without extraction
	23	MAS, oxalyldihydrazide
	24	Titration with iodine, separation as sulphide
N	1, 2, 3, 4, 5, 6, 7, 8, 9, 11, 12, 13, 14, 15, 16	Thermal conductivity, decomposition in graphite crucible
	10, 17	Titration, Acidimetric titration after distillation, visual detection
V	1, 11, 18	Titration with Fe(II), oxidation with Mn(VII)
	2, 6, 15	MAS, N-benzoylphenylhydroxylamine, extraction
	3, 5, 8, 12, 14, 20, 21	ICP-OES
	4, 7, 10, 16, 17, 19	FAAS
	9	MAS, dimethylnaphtidine
	13	MAS, phoshovanadotungstate
W	1, 8, 9, 20	ICP-OES
	2, 6, 16	FAAS
	3, 4	Gravimetry, WO ₃
	5, 11, 18, 19	MAS, thiocyanate, sodium hydroxide separation
	7, 10, 12, 13, 14, 15, 17, 21, 23	MAS, thiocyanate formed in a strongly acid reducing medium
	22	X-Ray fluorescence
Bi	1	FAAS, hydride
	2, 3, 5, 10, 11	ETAAS
	4, 6, 7, 8, 9, 12	ICP-MS
Cd	1, 2, 3, 4, 5, 6	ETAAS
	7, 8, 9	ICP-MS
	10	FAAS

Element	Line number	Method
Ga	1, 3	ETAAS
	2, 4, 5, 6, 7, 9, 10	ICP-MS
	8	FAAS
Nb	1, 2, 4, 6, 7, 8, 12	ICP-MS
	3, 5, 10, 11	ICP-OES
Pb	1, 2, 5, 6, 8, 11, 12	ETAAS
	3, 4, 7, 9, 10	ICP-MS
	13	FAAS
Sb	1, 5	FAAS
	2, 4, 6, 10, 13, 14	ETAAS
	3, 7, 8, 9, 11, 15, 16	ICP-MS
Te	1, 3, 5, 10	ETAAS
	2, 4, 6, 7, 8, 9	ICP-MS
Zn	1, 2, 6, 9, 10	FAAS
	3, 7, 8, 11, 12	ICP-MS
	4, 5	ETAAS
S	1, 2, 3, 4, 5, 6, 9, 12, 13, 14, 15, 16, 17, 18, 19, 20	<i>Combustion, Infrared absorption</i>
	7, 10	<i>Combustion, Conductimetry</i>
	8	<i>Gravimetry as BaSO₄ after chromatographic separation of SO₄²⁻ on alumina</i>
	11	<i>MAS, methylene blue, separation of sulphide</i>
	21	<i>Acidimetric titration after adsorption in H₂O₂ or AgNO₃</i>
Co	1, 2, 3, 4, 7, 9, 13, 14, 16, 17, 18	FAAS
	5, 10, 15	ICP-OES
	6	<i>MAS, 1-nitroso-2-naphthol</i>
	8	<i>MAS, nitroso R salt</i>
	11	<i>MAS, isonitrosomalonylguanidine</i>
	12	ETAAS
Hg	1, 2	<i>AAS, cold vapour</i>
	3, 4	ICP-MS
Se	1	<i>FAAS, hydride</i>
	2, 4, 5	ETAAS
	3	ICP-MS
Tl	1, 2, 4	ETAAS
	3, 5, 6, 7, 8	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 Spectrometry

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 and CEN/TR 10350, both of which are available from the national standards body in your country. Further information and advice on this or other Certified Reference Materials or Reference Materials produced by the German CRM working group may be obtained from the address above.

Angaben über Herstellung, Zertifizierung und Bezugsmöglichkeiten dieser Europäischen Zertifizierten Referenzmaterialien (EURONORM-ZRM) sowie über die Anwendungen der in diesem Zertifikat enthaltenen statistischen Daten sind erhältlich beim Hersteller dieses zertifizierten Referenzmaterials, dessen Adresse auf diesem Zertifikat angegeben ist oder sie finden sich in den CEN-Reports CEN/TR 10317 und CEN/TR 10350, beide zu beziehen durch die nationalen Normenorganisationen.

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D'autres informations et avis au sujet de ce Matériau de Référence Certifié, ou de tout autre Matériau de Référence Certifié ou Matériau de Référence produits par le Groupe de travail allemand pour les MRC sidérurgiques, peuvent être demandés en contactant l'adresse figurant plus haut dans ce Certificat.

För information angående tillverkning, certifiering och anskaffning av dessa europeiska certifierade referensmaterial (EURONORM CRM) och för användning av statistisk information, som angivits i detta certifikat, refereras antingen till producenten av detta certifierade referensmaterial eller till Teknisk Rapport CEN/TR 10317 och CEN/TR 10350 som kan erhållas från den nationella standardiseringsorganisationen.

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The German Iron and Steel CRM Working Group

The Working Group is composed of
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Max-Planck-Institut für Eisenforschung GmbH (MPI), Düsseldorf
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