

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

EURONORM-CRM No. 298-2 (Duplex Stainless Steel)

(Similar to EN 1.4410)

Laboratory means (4 values), mass content in %

Line No.	C	Si	Mn	P	S	Cr	Mo	Ni	Al	As	B	Co	Cu	N	Nb	Sn	Ti	V	W	Sb
1	0.0126	-----	0.7630	0.0197	0.0003	24.765	3.6986	6.8066	0.0131	-----	0.0020	0.0450	0.0988	0.2638	0.0008	-----	-----	0.0665	-----	0.0005
2	0.0129	0.3108	0.7720	0.0200	0.0004	24.807	3.7055	6.8097	0.0132	-----	0.0022	0.0457	0.0995	0.2666	0.0009	0.0026	0.0020	0.0685	0.0085	0.0006
3	0.0130	0.3158	0.7720	0.0200	0.0004	24.813	3.7211	6.8425	0.0136	0.0025	0.0022	0.0467	0.0999	0.2689	0.0010	0.0028	0.0020	0.0687	0.0085	0.0006
4	0.0133	0.3193	0.7730	0.0201	0.0005	24.816	3.7236	6.8461	0.0138	0.0027	0.0022	0.0473	0.1010	0.2709	0.0010	0.0028	0.0020	0.0689	0.0086	0.0006
5	0.0133	0.3225	0.7732	0.0202	0.0005	24.846	3.7513	6.8467	0.0138	0.0027	0.0023	0.0476	0.1012	0.2711	0.0010	0.0028	0.0021	0.0690	0.0088	0.0006
6	0.0136	0.3254	0.7743	0.0204	0.0005	24.847	3.7577	6.8525	0.0141	0.0028	0.0023	0.0477	0.1014	0.2745	0.0010	0.0029	0.0022	0.0693	0.0090	0.0006
7	0.0137	0.3258	0.7748	0.0209	0.0006	24.871	3.7660	-----	0.0142	0.0028	0.0023	0.0478	0.1023	0.2752	0.0010	0.0029	0.0023	0.0694	0.0091	0.0006
8	0.0137	0.3314	0.7759	0.0209	0.0007	24.895	3.7703	6.8745	0.0144	0.0028	0.0024	0.0479	0.1029	0.2756	0.0010	0.0029	0.0023	0.0695	0.0092	0.0006
9	0.0140	0.3332	0.7770	0.0210	0.0007	24.895	3.7951	6.8746	0.0150	0.0028	0.0024	0.0484	0.1032	0.2760	0.0010	0.0029	0.0023	0.0696	0.0093	0.0006
10	0.0142	0.3338	0.7843	0.0210	0.0010	24.992	3.7953	6.8747	0.0154	0.0028	0.0024	0.0487	0.1041	0.2796	0.0011	0.0029	0.0023	0.0698	0.0094	0.0007
11	0.0142	0.3394	0.7867	0.0214		24.999	3.7959	6.8791	0.0155	0.0029	0.0024	0.0489	0.1042	0.2839	0.0011	0.0030	0.0023	0.0700	0.0095	0.0007
12	0.0144	0.3410	0.7888	0.0217		25.015	3.8251	6.8926	0.0160	0.0029	0.0025	0.0493	0.1046	0.2871	0.0011	0.0030	0.0023	0.0703	0.0099	0.0008
13	0.0151	0.3410	0.7904	0.0220		25.019	3.8343	6.8979	0.0166	0.0030	0.0026	0.0494	0.1058	0.2932	0.0011	0.0030	0.0024	0.0708	0.0102	
14	0.0153	0.3432	0.7925	0.0226		25.031	3.8375	6.9104	0.0167	0.0032	0.0026	0.0496	0.1064	0.2953	0.0011	0.0030	0.0024	0.0710	0.0105	
15	0.0162	0.3490	0.7959	0.0229		25.050	3.8448	6.9220	0.0173		0.0027	0.0499	0.1065		0.0012	0.0030	0.0024	0.0722	0.0105	
16			0.7968				3.8698	6.9223			0.0028	0.0500	0.1065		0.0014	-----	0.0024	0.0726	0.0106	
17			0.7994					6.9225				0.0501	0.1088		-----		0.0025	0.0731	-----	
18			0.8045					6.9378					0.1103				0.0025	0.0737	-----	
19			0.8046										0.1110					0.0741		
20			0.8122										0.1118							
21													0.1119							
M(M)	0.0140	0.3308	0.7856	0.0210	0.0006	24.911	3.7807	6.8773	0.0148	0.0028	0.0024	0.0482	0.1049	0.2773	0.0011	0.0029	0.0023	0.0704	0.0094	0.0006
s(M)	0.0010	0.0114	0.0137	0.0010	0.0002	0.098	0.0528	0.0394	0.0014	0.0002	0.0003	0.0015	0.0041	0.0096	0.0002	0.0002	0.0002	0.0020	0.0008	0.0001
s(w)	0.0003	0.0055	0.0066	0.0003	0.0001	0.089	0.0257	0.0233	0.0006	0.0002	0.0002	0.0006	0.0010	0.0034	0.0001	0.0001	0.0002	0.0006	0.0004	0.0001

Line No.	Ga	Re	Pb	Pt	Zn	Zr
1	0.0031	0.00029	0.000008	0.000015	0.00008	0.00007
2	0.0039	0.00035	< 0.00001	0.000017	0.00016	0.00008
3	0.0040		0.000013		0.00028	< 0.0001
4	0.0041		0.000020		0.00048	0.00014
5	0.0041		0.000020		0.00062	
6			< 0.0001		0.00073	
7			< 0.0001		0.00075	
8					0.00075	
9					0.00081	
10					0.00091	
11					0.00097	

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 omitted by either the Cochran or Grubbs test.

CERTIFIED VALUES, mass content in %

	C	Si	Mn	P	S	Cr	Mo	Ni	Al	As
M(M)	0.0140	0.331	0.786	0.0210	0.0006	24.91	3.781	6.877	0.0148	0.0028
C(95%)	0.0006	0.007	0.007	0.0006	0.0002	0.06	0.029	0.021	0.0008	0.0002
	B	Co	Cu	N	Nb	Sn	Ti	V	W	Sb
M(M)	0.0024	0.0482	0.105	0.277	0.0011	0.0029	0.0023	0.0704	0.0094	0.0006
C(95%)	0.0002	0.0008	0.002	0.006	0.0001	0.0001	0.0001	0.0010	0.0005	0.0001

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 35:2017.

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

This certified reference material was prepared and issued by:



Närpiöntie 2, 64200 Närpiö, Finland

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.



Närpiö, November 2021

Description of the sample

The ECRM 298-2 is available in the form of milling chips in bottles containing 100 g. It is also available as 38 mm diameter discs 25 mm thick. The chips were passed through a 2000 µm aperture sieve and further sieving was carried out to exclude chips passing through a 250 µm aperture sieve.

Participating laboratories

AB Sandvik Materials Technology, Sandviken (Sweden)
 AG der Dillinger Hüttenwerke, Dillingen (Germany)
 ALS Scandinavia AB, Luleå (Sweden)
 ArcelorMittal Maizières Research SA, Maizières-lès-Metz (France)
 BDG-Service GmbH, Düsseldorf (Germany)
 Bruker AXS GmbH, Karlsruhe (Germany)
 Bundesanstalt für Materialforschung und -prüfung (BAM), Berlin (Germany)
 Cogne Acciai Speciali, Aosta (Italy)
 Dunafer Labor Nonprofit Ltd., Dunaújváros (Hungary)
 ELTRA GmbH, Haan (Germany)
 ESAB AB, Göteborg (Sweden)
 Höganäs Sweden AB, Höganäs (Sweden)
 IFW Dresden e.V., Dresden (Germany)
 Inspectorate Griffith India Pvt. Ltd., Bhubaneswar Laboratory, Bhubaneswar (India)
 Institute of Certified Reference Materials, Yekaterinburg (Russia)
 Kanthal, Hallstahammar (Sweden)
 Narema, Närpiö (Finland)
 Naval Group Research, Bouguenais (France)
 MPI für Eisenforschung GmbH, Düsseldorf (Germany)
 Outokumpu Stainless AB, Avesta (Sweden)
 Ridsdale & Co Ltd, Middlesbrough (United Kingdom)
 SpectroChem, Turku (Finland)
 SSAB Europe, Borlänge (Sweden)
 SSAB Special Steels, Oxelösund (Sweden)
 Swerim AB, Kista (Sweden)
 voestalpine Böhler Edelstahl GmbH & Co KG, Kapfenberg (Austria)
 Uddeholms AB, Hagfors (Sweden)
 Ugitech, Ugine Cedex (France)
 VDM Metals GmbH, Werdohl (Germany)

Intended use & stability

ECRM 298-2 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 (e.g. 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, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 14	Combustion, infrared absorption
	13	Non-aqueous titration after absorption in organic solvent
	15	Combustion, manometry after freezing out CO ₂
Si	2	ICP-MS
	3, 4, 5, 6, 9, 10, 14	Gravimetry, dehydration with perchloric acid
	7, 8, 11, 12, 13, 15	ICP-OES
Mn	1, 4, 5, 6, 7, 8, 9, 10, 11, 12, 16, 17, 18, 19	ICP-OES
	2, 14	FAAS
	3, 13	MAS, periodate oxidation
	15	ICP-MS
	20	Titration with arsenite, oxidation with persulphate
P	1, 3, 5, 8, 12, 13, 14, 15	ICP-OES
	2	MAS, molybdenum blue, extraction
	4, 10	MAS, phosphovanadomolybdate, extraction
	6, 7, 11	ICP-MS
	9	Acidimetric titration of ammonium phosphomolybdate

Element	Line number	Method
S	1, 2, 3, 4, 5, 6, 7, 8, 9 10	Combustion, infrared absorption Combustion, UV detection
Cr	1, 4, 6, 7, 9, 10, 11 2, 3, 5, 8, 12, 13, 14, 15	Titration with Fe (II), oxidation with persulphate ICP-OES
Mo	1, 2, 3, 4, 5, 8, 9, 10, 11, 12, 13, 14, 16 6 7 15	ICP-OES MAS, thiocyanate in presence of ascorbic acid, extraction FAAS MAS, thiocyanate in presence of Sn (II), extraction
Ni	1 2, 4, 5, 8, 10, 11, 14, 15, 16, 17 3, 6, 9, 12, 13 18	Titration with dichromate, separation with dimethylglyoxime ICP-OES Gravimetry, dimethylglyoxime MAS, dimethylglyoxime, extraction
Al	1, 3, 6 2, 4, 5, 8, 9, 10, 11, 13, 14, 15 7 12	ICP-MS ICP-OES FAAS, without separation ETAAS
As	3, 4, 5, 6, 8, 9, 10, 12 7, 11, 13 14	ICP-MS ETAAS ICP-OES
B	1, 7, 9, 11, 13, 15, 16 2, 3, 4, 5, 8, 10, 14 6, 12	ICP-OES ICP-MS MAS, curcumin
Co	1, 3, 4, 5, 6, 7, 8, 9, 12, 13, 14, 15, 16, 17 2 10 11	ICP-OES ETAAS ICP-MS FAAS
Cu	1, 4, 6, 7, 9, 10, 11, 14, 15, 16, 17, 18, 19, 20 2, 8, 13 3, 5, 12, 21	ICP-OES ICP-MS FAAS
N	1, 2, 4, 5, 6, 7, 8, 9, 11, 12, 13 3 10 14	Thermal conductivity, decomposition in graphite crucible MAS, Nessler reagent, distillation MAS, indophenol blue, distillation Acidimetric titration after distillation, visual end point
Nb	1, 2, 4, 5, 6, 7, 9, 10, 14 3, 8, 11, 12, 13, 15, 16	ICP-OES ICP-MS
Sn	2, 6, 8, 9, 12, 14, 15 3 4, 5, 10, 11, 13 7	ICP-MS ETAAS ICP-OES FAAS
Ti	2, 8, 10, 12, 14, 17 3, 4, 5, 6, 7, 9, 11, 13, 15, 16	ICP-MS ICP-OES
V	1, 2, 4, 5, 6, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18 3, 7, 8 19	ICP-OES ICP-MS FAAS
W	2, 3, 4, 5, 6, 7, 9, 11, 13, 14, 15 8, 10, 12, 16	ICP-OES ICP-MS
Sb	1, 2, 3, 4, 5, 6, 7, 8, 9 10, 11 12	ICP-MS ETAAS ICP-OES
Ga	1, 3, 4, 5 2	ICP-MS ICP-OES
Re	1, 2	ICP-MS
Pb	1, 2, 3, 5, 6 4	ICP-MS ETAAS
Pt	1, 2	ICP-MS
Zn	1, 2, 4, 11 3 5, 6, 8, 9, 10 7	ICP-MS FAAS ICP-OES ETAAS
Zr	1, 2, 3 4	ICP-MS ICP-OES

Abbreviations:

FAAS	Flame Atomic Absorption Spectrometry
ICP-OES	Inductively Coupled Plasma - Optical Emission Spectrometry
ICP-MS	Inductively Coupled Plasma - Mass Spectrometry
ETAAS	Electrothermal Atomic Absorption 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 Narema may be obtained from the address below.

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Michael Granfors
Responsible for CRM certification

Oy Narema Ab
Närpiöntie 2
FIN-64200 Närpiö, Finland
E-mail: crm@narema.fi
Website: www.narema.fi