

# Certified European Reference Material (EURONORM-CRM)

## Certificate of chemical analysis

### EURONORM-CRM No. 286-2 (High alloy steel, 1.4305)

Laboratory mean values (4 determinations), mass content in %

Line. No.	C	Si	Mn	P	S	Cr	Mo	Ni	Cu	Co	N	Sn	V
1	0.0598	0.3700	1.8761	0.0277	0.2910	17.502	0.3958	8.316	0.3578	0.1442	0.0326	0.0088	0.0894
2	0.0618	0.3734	1.8925	0.0286	0.2989	17.509	0.3976	8.345	0.3603	0.1443	0.0331	0.0089	0.0900
3	0.0625	0.3766	1.8949	0.0286	0.3003	17.514	0.4040	8.347	0.3607	0.1443	0.0339	0.0091	0.0919
4	0.0633	0.3833	1.8972	0.0290	0.3006	17.557	0.4041	8.387	0.3609	0.1451	0.0345	0.0091	0.0923
5	0.0638	0.3854	1.9055	0.0291	0.3007	17.560	0.4047	8.389	0.3618	0.1461	0.0345	0.0092	0.0927
6	0.0642	0.3861	1.9061	0.0295	0.3045	17.591	0.4059	8.405	0.3625	0.1466	0.0355	0.0093	0.0928
7	0.0642	0.3888	1.9074	0.0296	0.3052	17.602	0.4060	8.410	0.3633	0.1467	0.0356	0.0094	0.0933
8	0.0644	0.3898	1.9079	0.0297	0.3056	17.619	0.4078	8.422	0.3644	0.1469	0.0356	0.0096	0.0936
9	0.0651	0.3904	1.9105	0.0297	0.3058	17.623	0.4083	8.427	0.3665	0.1470	0.0360	0.0097	0.0939
10	0.0653	0.3924	1.9180	0.0299	0.3063	17.625	0.4098	8.438	0.3672	0.1470	0.0362	0.0097	0.0946
11	0.0658	0.3941	1.9196	0.0300	0.3065	17.652	0.4103	8.447	0.3673	0.1478	0.0364	0.0097	0.0947
12	0.0660	0.3964	1.9201	0.0306	0.3087	17.667	0.4118	8.476	0.3676	0.1480	0.0366	0.0097	0.0950
13	0.0663	0.3987	1.9240	0.0308	0.3098	17.699	0.4129	8.479	0.3711	0.1489		0.0098	0.0950
14		0.3998	1.9262	0.0314	0.3098	17.702	0.4170	8.483	0.3746	0.1492		0.0101	0.0967
15		0.4048	1.9267	0.0317	0.3109	17.731	0.4205	8.488	0.3747	0.1494		0.0105	0.0969
16		0.4050	1.9323	0.0318	0.3130	17.757	0.4232	8.490	0.3758	0.1502		0.0106	0.0970
17		0.4106	1.9367	0.0323	0.3158	17.793	0.4243	8.498	0.3783	0.1515		0.0111	0.0981
18		0.4108	1.9480	0.0332		17.825	0.4243	8.502	0.3785	0.1519			0.0995
19		0.4211	1.9519	0.0338		17.834	0.4251	8.533	0.3785	0.1527			0.1020
20			1.9725	0.0341			0.4278	---	0.3796	0.1530			0.1034
21							0.4358		0.3859	0.1540			
22									0.3884	0.1542			
23										0.1592			
M(M)	0.0640	0.3935	1.9187	0.0306	0.3055	17.651	0.4132	8.436	0.3703	0.1490	0.0350	0.0097	0.0951
s(M)	0.0019	0.0133	0.0226	0.0018	0.0060	0.104	0.0106	0.061	0.0088	0.0039	0.0013	0.0007	0.0037
s(w)	0.0015	0.0084	0.0115	0.0011	0.0030	0.086	0.0039	0.043	0.0045	0.0016	0.0004	0.0004	0.0010

Line No.	Al	Pb	W
1	0.00097	0.00019	0.0361
2	0.00127	0.00021	0.0393
3	0.00133	0.00022	0.0395
4	0.00143	0.00024	
5	0.00176		
6	0.00186		
7	0.00204		
8	0.00221		
9	0.00224		
10	0.00269		
11	0.00275		
12	0.00275		

M(M): Mean of the intralaboratory means  
s(M): Standard deviation of the intralaboratory means  
s(w): Intralaboratory standard deviation

Additional values for information:

Bi 0.000009; 0.000010  
Sb 0.0012; 0.0014  
Nb 0.0104; 0.0116  
Ti 0.00048  
Zn 0.0031  
Fe 70.33

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.

#### CERTIFIED VALUES, mass content in %

	C	Si	Mn	P	S	Cr	Mo	Ni	Cu	Co	N	Sn	V
<b>M(M)</b>	<b>0.0640</b>	<b>0.394</b>	<b>1.919</b>	<b>0.0306</b>	<b>0.305</b>	<b>17.65</b>	<b>0.413</b>	<b>8.436</b>	<b>0.370</b>	<b>0.1490</b>	<b>0.0350</b>	<b>0.0097</b>	<b>0.0951</b>
<b>C(95%)</b>	0.0012	0.007	0.011	0.0009	0.004	0.06	0.005	0.030	0.004	0.0017	0.0009	0.0004	0.0017

C(95%) is the half-width confidence interval 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.

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

Berlin, March 2023



This certified reference material was prepared and issued by Bundesanstalt für Materialforschung und -prüfung (BAM), Berlin after approval by all the participating laboratories and all the producing organisations: (France - ArcelorMittal Maizières; Germany - Bundesanstalt für Materialforschung und -prüfung (BAM); Nordic Countries - Nordic CRM Working Group).

## Description of the sample

The ECRM 286-2 is available in the form of milling chips in bottles containing 100 g. The chips were passed through a 250 µm aperture sieve.

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

## Participating laboratories

Alleima Tube AB, Sandviken (Sweden)  
AG der Dillinger Hüttenwerke, Dillingen-Saar (Germany)  
ALS Scandinavia AB, Luleå (Sweden)  
ArcelorMittal Research, Maizières-lès-Metz (France)  
BDG-Service GmbH, Düsseldorf (Germany)  
Bundesanstalt für Materialforschung und -prüfung (BAM), Berlin (Germany)  
Cogne Acciai Speciali, Aosta (Italy)  
Dunafer Labor Nonprofit Ltd., Dunaújváros (Hungary)  
Elementar Analysensysteme GmbH, Langenselbold (Germany)  
Eltra GmbH, Haan (Germany)  
Höganäs Sweden AB, Höganäs (Sweden)  
Horn & Co. Analytics GmbH, Siegen (Germany)  
Horn & Co. Analytics GmbH, Wenden-Hünsborn (Germany)  
Horn & Co. Analytics GmbH, Wetzlar (Germany)  
Horn & Co. Analytics GmbH, Witten (Germany)  
IFW Dresden e.V., Dresden (Germany)  
Inspectorate Griffith India Pvt. Ltd., Bhubaneswar Laboratory, Bhubaneswar (India)  
Kanthal, Hallstahammar (Sweden)  
Łukasiewicz Research Network – Institute for Ferrous Metallurgy, Gliwice (Poland)  
Max-Planck-Institut für Eisenforschung GmbH, Düsseldorf (Germany)  
Narema, Närpiö (Finland)  
revierlabor, Essen (Germany)  
Saarstahl AG, Völklingen (Germany)  
VDM Metals GmbH, Werdohl (Germany)  
voestalpine Böhler Edelstahl GmbH & Co KG, Kapfenberg (Austria)  
voestalpine Stahl Linz GmbH, Linz (Austria)

## Intended use and stability

This ECRM 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.

The minimum sample intake from the homogeneity test is 200 mg.

This certificate is valid until there is a revocation from the producer of the material.

## Homogeneity

The homogeneity of the reference material was tested on 10 samples taken from the total batch. The mass fractions of the elements of interest were determined either by ICP-OES or combustion analysis. No evidence of inhomogeneities was found. Therefore, no inhomogeneity contribution was included in the uncertainty.

## Traceability

The assigned values for this 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, 3, 4, 7, 10, 12	Combustion, infrared absorption, calibration with $\text{CaCO}_3$
	2	Combustion, infrared absorption, gas calibration
	5	Combustion, infrared absorption, calibration with $\text{Na}_2\text{CO}_3$
	6	Combustion, infrared absorption, calibration with $\text{NaHCO}_3$
	8, 9	Combustion, infrared absorption, calibration with $\text{BaCO}_3$
	11	Combustion, infrared absorption, calibration with $\text{K}_2\text{CO}_3$
	13	Combustion, infrared absorption, calibration with sucrose
Si	1, 2, 8, 9, 10, 11, 12, 13, 14, 18	ICP-OES
	3, 4, 5, 16, 17	Gravimetry, dehydration with perchloric acid
	6	Gravimetry, dehydration with sulfuric acid
	7	Gravimetry, dehydration with hydrochloric acid
	15	XRF
	19	ICP-MS
Mn	1, 2, 3, 4, 5, 6, 10, 11, 12, 15, 16, 18, 19, 20	ICP-OES
	7	FAAS
	8	Titration with arsenite, persulphate oxidation
	9, 17	MAS, periodate oxidation
	13	XRF
	14	ICP-MS
P	1, 3, 4, 5, 8, 10, 11, 12, 15, 16, 17, 18	ICP-OES
	2	Acidimetric titration of ammonium phosphomolybdate
	6, 7, 12, 13, 20	ICP-MS
	9	MAS, molybdenum blue, extraction
	14	MAS, phosphovanadomolybdate, extraction
	19	XRF
S	1, 10, 15	ICP-OES
	2	Combustion, infrared absorption, calibration with $\text{CsSO}_4$
	3, 7, 9, 13	Combustion, infrared absorption, calibration with $\text{BaSO}_4$
	4, 12	Combustion, infrared absorption, calibration with $\text{Na}_2\text{SO}_4$
	5	ICP-MS
	6, 8, 11, 14, 17	Combustion, infrared absorption, calibration with $\text{K}_2\text{SO}_4$
	16	Combustion, infrared absorption, calibration with sulphur
Cr	1, 2, 5, 8, 10, 11, 12, 13, 15, 16, 18	ICP-OES
	3	XRF
	4	Titration with $\text{Fe(II)}$ , oxidation with peroxide
	6, 9, 14, 17, 19	Titration with $\text{Fe(II)}$ , oxidation with persulphate
	7	Titration with permanganate, oxidation with persulphate
Mo	1	XRF
	2, 3, 4, 5, 6, 7, 8, 9, 10,	ICP-OES
	11, 12, 13, 15, 16, 17, 18, 21	
	14, 19	ICP-MS
	20	FAAS
Ni	1, 3, 4, 6, 8, 9, 12, 13, 14, 16, 19	ICP-OES
	2, 5, 10, 11, 15	Gravimetry, dimethylglyoxime
	7	MAS, dimethylglyoxime, extraction
	17, 18	XRF
Cu	1, 2, 3, 4, 6, 8, 9, 10, 11, 12, 13, 14,	ICP-OES
	15, 18, 19, 20, 21	
	5, 22	ICP-MS
	7	XRF
	16, 17	FAAS
Co	1, 4, 5, 7, 8, 9, 10, 11, 12, 13, 14, 15	ICP-OES
	16, 17, 19, 20, 21, 22	
	2	XRF
	3, 18	FAAS
	6, 23	ICP-MS

Element	Line number	Method
N	1, 2, 7, 10, 11	Thermal conductivity, decomposition in graphite crucible, calibration with KNO <sub>3</sub>
	3	Thermal conductivity, decomposition in graphite crucible, calibration with Pb(NO <sub>3</sub> ) <sub>2</sub>
	4	Thermal conductivity, decomposition in graphite crucible, gas calibration
	5, 6	Thermal conductivity, decomposition in graphite crucible, calibration with Si-nitride
	8, 9	Thermal conductivity, decomposition in graphite crucible, calibration with NaNO <sub>3</sub>
	12	Acidimetric titration, visual end point
Sn	1, 3, 8, 9, 15, 16	ICP-MS
	2, 4, 5, 6, 7, 10, 11, 12, 13, 14, 17	ICP-OES
V	1, 3, 4, 5, 6, 7, 8, 9, 10, 11, 13, 14, 15, 16, 17, 18, 20	ICP-OES
	2	XRF
	12	FAAS
	19	ICP-MS
Al	1, 2, 5	ICP-MS
	3, 4	ETAAS
	6, 8, 9, 10, 11, 12	ICP-OES
	7	FAAS
Pb	1, 2, 3	ICP-MS
	4	ETAAS
Bi	1, 2	ICP-MS
Sb	1, 2	ICP-MS
W	1, 3	ICP-OES
	2	ICP-MS
Nb	1	ICP-OES
	2	ICP-MS
Zn, Ti		ICP-MS
Fe		ICP-OES

**Abbreviations:**

ETAAS:	Electrothermal atomic absorption spectrometry	ICP-MS:	Inductively coupled plasma – Mass spectrometry
FAAS:	Flame atomic absorption spectrometry	MAS	Spectrophotometry
ICP-OES:	Inductively coupled plasma - optical emission spectrometry	XRF	X-Ray fluorescence

## 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 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.

Weitere Informationen und Hinweise zu diesem oder anderen zertifizierten Referenzmaterialien oder Referenzmaterialien können unter der oben angegebenen Adresse erhalten werden.

Pour disposer d'informations sur la fabrication, la certification et la distribution des Matériaux de Référence Certifiés Européens (EURONORM-MRC) ainsi que sur l'utilisation des informations statistiques données sur ce certificat, se reporter soit au producteur de ce Matériau de Référence Certifié, soit aux Rapports Techniques CEN/TR 10317 et CEN/TR 10350. On peut se procurer ces deux documents auprès des organismes nationaux de normalisation.

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 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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## **Bundesanstalt für Materialforschung und -prüfung (BAM), Berlin**

Dr. Sebastian Recknagel  
Project Leader CRM