

ECISS  
EUROPÄISCHES KOMITEE FÜR EISEN- UND STAHLNORMUNG  
COMITE EUROPEEN DE NORMALISATION DU FER ET DE L'ACIER  
EUROPEAN COMMITTEE FOR IRON AND STEEL STANDARDIZATION

European Certified Reference Material (EURONORM-CRM)

Certificate of Chemical Analysis

**EURONORM-CRM No. 284-3 (Highly alloyed steel 1.4571)**

Laboratory means (4 values), mass content in %

Line No.	C	Si	Mn	P	S	Cr	Mo	Ni	As	B	Co	Cu	N
1	0.0019	0.0396	0.0576	0.0042	0.0058	17.253	2.1975	11.977	0.00090	0.00013	0.0336	0.0094	0.0391
2	0.0020	0.0400	0.0576	0.0043	0.0059	17.273	2.1983	11.983	0.00105	0.00015	0.0347	0.0095	0.0395
3	0.0021	0.0400	0.0579	0.0044	0.0060	17.278	2.2000	11.988	0.00108	0.00018	0.0349	0.0095	0.0403
4	0.0021	0.0404	0.0585	0.0044	0.0062	-----	2.2057	11.997	0.00110	0.00018	0.0350	0.0097	0.0412
5	0.0021	0.0408	0.0593	0.0044	0.0064	17.298	2.2158	12.010	0.00113	0.00018	0.0353	0.0097	0.0414
6	0.0024	0.0417	0.0597	0.0045	0.0064	17.313	2.2179	12.022	0.00115	0.00020	0.0356	0.0097	0.0415
7	0.0024	0.0418	0.0597	0.0045	0.0064	17.313	2.2248	12.058	0.00123	0.00020	0.0356	0.0099	0.0418
8	0.0025	0.0425	0.0600	0.0046	0.0065	17.335	2.2263	12.088	0.00130	0.00023	0.0358	0.0100	0.0421
9	0.0025	0.0438	0.0605	0.0046	0.0065	17.341	2.2287	12.090	0.00132	0.00023	0.0359	0.0103	0.0424
10	0.0025	0.0441	0.0608	0.0046	0.0066	17.347	2.2291	12.098	0.00135	0.00030	0.0361	0.0103	0.0425
11	0.0026	0.0446	0.0617	0.0047	0.0066	17.369	2.2325	12.098	0.00140	-----	0.0361	0.0104	0.0427
12	0.0026	0.0451	0.0620	0.0049	0.0066	17.405	2.2377	12.105	0.00140	-----	0.0364	0.0105	0.0428
13	0.0029	0.0453	0.0628	0.0050	0.0068	17.421	2.2475	12.116	0.00140	-----	0.0365	0.0105	0.0429
14	0.0030	0.0471	-----	0.0050	0.0069	17.423	2.2475	12.123	0.00140	-----	0.0366	0.0107	0.0429
15	0.0033	0.0474	0.0630	0.0050	0.0070	17.425	2.2475	12.145	0.00150	-----	0.0367	0.0109	0.0436
16	-----	0.0483	0.0632	0.0050	0.0070	17.430	2.2502	12.146	0.00158	-----	0.0371	0.0110	-----
17	-----	0.0487	0.0634	0.0051	0.0070	17.457	2.2518	12.169	0.00160	-----	0.0372	0.0111	-----
18	-----	0.0488	0.0643	0.0051	0.0074	17.463	2.2575	12.169	0.00175	-----	0.0372	0.0112	-----
19	-----	0.0497	0.0645	0.0056	0.0077	17.468	2.2647	12.178	-----	-----	0.0376	0.0113	-----
20	-----	-----	0.0647	0.0056	-----	-----	2.2863	12.200	-----	-----	0.0388	0.0113	-----
21	-----	-----	0.0647	0.0056	-----	-----	2.2875	-----	-----	-----	0.0390	0.0114	-----
22	-----	-----	0.0658	0.0057	-----	-----	-----	-----	-----	-----	0.0391	0.0117	-----
23	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	0.0399	-----	-----
M(M)	0.0025	0.0442	0.0615	0.0049	0.0066	17.367	2.2359	12.088	0.00131	0.00020	0.0366	0.0105	0.0418
s(M)	0.0004	0.0034	0.0026	0.0005	0.0005	0.071	0.0260	0.072	0.00022	0.00005	0.0016	0.0008	0.0014
s(w)	0.0002	0.0010	0.0007	0.0002	0.0002	0.033	0.0101	0.040	0.00011	0.00004	0.0005	0.0003	0.0005

Line No.	Sn	Ti	W
1	0.00048	0.0037	0.0031
2	0.00058	0.0039	0.0032
3	0.00060	0.0042	0.0037
4	0.00060	0.0043	0.0037
5	0.00065	0.0047	0.0037
6	0.00065	0.0048	0.0037
7	0.00073	0.0049	0.0038
8	0.00073	0.0051	0.0040
9	0.00076	0.0051	0.0041
10	0.00078	0.0052	0.0042
11	0.00080	0.0054	0.0042
12	0.00083	0.0054	0.0043
13	0.00086	0.0055	0.0043
14	0.00095	0.0058	0.0045
15	0.00108	0.0058	0.0046
16	-----	0.0058	-----
17	-----	0.0059	-----
18	-----	-----	-----
19	-----	-----	-----
20	-----	-----	-----
21	-----	-----	-----
M(M)	0.00074	0.0050	0.0039
s(M)	0.00016	0.0007	0.0005
s(w)	0.00007	0.0002	0.0003

Al	Nb	V	Zr
0.0010	0.0003	0.0038	0.00007
0.0013	0.0005	0.0043	0.00010
0.0017	0.0005	0.0044	0.00013
0.0017	0.0005	0.0044	0.00015
0.0018	0.0005	0.0045	0.00016
0.0020	0.0005	0.0048	0.00030
0.0020	0.0006	0.0048	0.00033
0.0020	0.0007	0.0048	0.00043
0.0021	0.0007	0.0048	0.00043
0.0023	0.0007	0.0049	0.00045
0.0025	0.0009	0.0049	0.00045
0.0026	0.0009	0.0049	0.00053
0.0026	0.0010	0.0052	-----
0.0027	0.0011	0.0053	-----
0.0027	0.0011	0.0054	-----
0.0029	0.0011	0.0057	-----
0.0032	0.0013	0.0058	-----
0.0032	-----	0.0059	-----
0.0033	-----	0.0061	-----
0.0035	-----	-----	-----
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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. Values given in *italic* type are for information only.

Additional values for information:  
Sb: 0.00036; 0.00037  
Ga: 0.0016  
Pb: 0.0003  
Ir: 0.000005  
Re: 0.0005

**CERTIFIED VALUES, mass content in %**

	C	Si	Mn	P	S	Cr	Mo	Ni	As	B	Co	Cu	N	Sn	Ti	W
<b>M(M)</b>	<b>0.0025</b>	<b>0.0442</b>	<b>0.0615</b>	<b>0.0049</b>	<b>0.0066</b>	<b>17.37</b>	<b>2.236</b>	<b>12.09</b>	<b>0.00131</b>	<b>0.00020</b>	<b>0.0366</b>	<b>0.0105</b>	<b>0.0418</b>	<b>0.00074</b>	<b>0.0050</b>	<b>0.0039</b>
<b>C(95%)</b>	0.0003	0.0017	0.0012	0.0003	0.0003	0.04	0.012	0.04	0.00011	0.00004	0.0007	0.0004	0.0008	0.00009	0.0004	0.0003

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 in accordance with the recommendations set out in ISO Guides 30 – 35 and issued by:

**The German Iron and Steel CRM Working Group**

comprising of Bundesanstalt für Materialforschung und -prüfung (BAM), Berlin, Max-Planck-Institut für Eisenforschung GmbH (MPI), Düsseldorf and Steel institute VDEh (Committee of chemists), Düsseldorf (management for the working group)

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: Bundesanstalt für Materialforschung und -prüfung (BAM), MPI für Eisenforschung and Steel institute VDEh; Nordic Countries-Nordic CRM Working Group)

Düsseldorf, April 2016

## Description of the sample

The sample is available in the form of fine powder. It is supplied in glass bottles containing 100 g. The material is also supplied in the form of 39 mm dia discs (28 mm thick) which were produced by hot isostatic pressing of the powder.

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)).

## Intended use & stability

ECRM 284-3 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 solid (disc) sample is intended for establishing and checking the calibration of optical emission and X-ray spectrometers for the analysis of samples of similar materials. The "as received" working surface of the sample should be finished before use to remove any protective coating. It will remain stable provided that it is not subjected to excessive heat (eg, during preparation of the working surface).

## Traceability

**The traceability of ECRM 284-3 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 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.

## Participating laboratories

AB Sandvik Materials Technology, Sandviken (Sweden)  
 AG der Dillinger Hüttenwerke, Dillingen/Saar (Germany)  
 ALS Scandinavia laboratory, Luleå (Sweden)  
 Aperam Alloys Imphy, Imphy (France)  
 Aperam Isbergues, Isbergues (France)  
 ArcelorMittal Eisenhüttenstadt Forschungs- und Qualitätszentrum GmbH, Eisenhüttenstadt (Germany)  
 ArcelorMittal Maizières Research SA, Maizières-lès-Metz (France)  
 AUBERT et DUVAL, Les Ancizes (France)  
 Böhler Edelstahl GmbH & Co KG, Kapfenberg (Austria)  
 Bundesanstalt für Materialforschung und -prüfung (BAM), Berlin (Germany)  
 Centre Technique des Industries de la Fonderie, Sèvres (France)  
 DCNS RESEARCH, Bouguenais (France)  
 Deutsche Edelstahlwerke GmbH, Witten (Germany)  
 ELTRA GmbH Applikationslabor, Haan (Germany)  
 H.C. Starck GmbH, Goslar (Germany)  
 Hoesch Hohenlimburg GmbH, Hagen (Germany)  
 Höganäs AB, Höganäs (Sweden)  
 ICRM, Yekaterinburg (Russland)  
 IfG Service GmbH, Düsseldorf (Germany)  
 INDUSTRIEEL France (ArcelorMittal), Le Creusot (France)  
 Leibniz-Institut für Festkörper- und Werkstoffforschung IFW, Dresden, (Germany)  
 Max-Planck Institut für Eisenforschung GmbH, Düsseldorf (Germany)  
 Saarstahl AG, Völklingen (Germany)  
 Sandvik Heating Technology AB, Hallstahammar (Sweden)  
 ThyssenKrupp Steel Europe AG, Duisburg (Germany)  
 Ugitech SA, Ugine CEDEX (France)  
 VDM Metals GmbH, Werdohl (Germany)  
 voestalpine Stahl GmbH, Linz (Austria)

## Methods used

Element	Line number	Method
C	1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15	Combustion, Infrared absorption
Si	1, 4, 12, 16 2, 5, 9, 18 3 6, 7, 8, 10, 13, 14, 15, 17 11 19	MAS, molybdenum blue, without extraction Gravimetry, dehydration with perchloric acid FAAS ICP-OES XRF ICP-MS
Mn	1, 2, 11, 12 3, 4, 5, 6, 7, 8, 9, 10, 13, 15, 16, 17, 18, 19, 20, 22 21	MAS, periodate oxidation ICP-OES FAAS
P	1, 3, 4, 6, 10, 11, 13, 15, 16, 18, 20 2 5, 8, 12, 17 7, 9, 21, 22 14 19	ICP-OES MAS, molybdenum blue, extraction MAS, phosphovanadomolybdate, extraction MAS, molybdenum blue, without extraction GD-MS ICP-MS
S	1, 2, 3, 4, 5, 6, 7, 9, 10, 11, 12, 13, 14, 15, 16, 19 8, 17  18	Combustion, Infrared absorption MAS, methylene blue, evolution as H <sub>2</sub> S in hypophosphoric and formic acid ICP-MS
Cr	1, 2, 7, 8, 12, 17, 18 3, 6, 10, 11, 13, 14, 15, 16, 19 5 9	Titration with Fe(II), oxidation with persulphate ICP-OES Titration with Fe(II), oxidation with perchloric acid XRF
Mo	1, 2, 3, 5, 7, 8, 9, 10, 11, 12, 14, 15, 16, 17, 18, 19, 20, 21 4  6 13	ICP-OES  MAS, thiocyanate in the presence of ascorbic acid, extraction XRF FAAS
Ni	1, 2, 3, 6, 7, 10, 11, 13, 15, 16, 18, 19, 20 4, 5, 8, 9, 14 12 17	ICP-OES Gravimetry, dimethylglyoxime XRF MAS, dimethylglyoxime, extraction
As	1, 4, 8, 12, 15, 16 2, 3, 6, 13, 14, 17, 18 5 7, 10, 11 9	ICP-OES ETAAS AAS, evolution as arsine ICP-MS GD-MS
B	1, 3, 8, 10 4, 5, 6, 9 2, 7	ICP-OES MAS, curcumin ICP-MS
Co	1, 2, 3, 4, 6, 9, 10, 11, 12, 14, 15, 16, 18, 19, 21, 22, 23 5, 8, 17 7 13 20	ICP-OES FAAS MAS, nitroso R salt ICP-MS GD-MS
Cu	1, 2, 3, 5, 6, 7, 8, 9, 11, 12, 14, 15, 17, 18, 19, 20 4 10, 13, 22 16 21	ICP-OES GD-MS FAAS ICP-MS MAS, diethyldithiocarbamate, extraction
N	1, 2, 4, 5, 6, 7, 8, 9, 10, 12, 15 3  11  13, 14	Thermal conductivity, decomposition in a graphite crucible Potentiometric titration, specific ion electrode end point, distillation Acidimetric titration after distillation, potentiometric detection Acidimetric titration after distillation, visual detection
Sn	1, 6, 10, 12, 13 2 3, 4, 7, 11 5, 9, 14, 15 8	ETAAS GD-MS ICP-OES ICP-MS FAAS, extraction with TOPO/KI/MIBK

Element	Line number	Method
Ti	1, 2, 3, 4, 6, 7, 8, 9, 10, 11, 12, 13, 15, 16, 17 5, 14	ICP-OES ICP-MS
W	1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 14, 15 13	ICP-OES GD-MS
Al <sub>tot</sub>	1, 3, 5, 7, 11, 12, 13, 14, 15, 16, 18, 19, 20 2, 4, 10 6, 9 8, 17	ICP-OES ICP-MS ETAAS FAAS
Nb	1, 2, 3, 5, 8, 9, 10, 12, 13, 14, 15, 16, 17 4, 6, 7 11	ICP-OES ICP-MS GD-MS
V	1, 3, 4, 5, 6, 7, 8, 9, 11, 12, 13, 14, 15, 16, 17, 18, 19 2 10	ICP-OES GD-MS ICP-MS
Zr	1, 2, 4, 5 3, 6, 7, 8, 9, 10, 11, 12	ICP-MS ICP-OES

#### Abbreviations:

AAS: Atomic Absorption Spectrometry  
 ETAAS: Electrothermal Atomic Absorption Spectrometry  
 FAAS: Flame Atomic Absorption Spectrometry  
 ICP-MS: Inductively Coupled Plasma - Mass Spectrometry

ICP-OES: Inductively Coupled Plasma - Optical Emission Spectrometry  
 GD-MS: Glow Discharge Mass Spectrometry  
 MAS: Molecular Absorption Spectrometry  
 XRF: X-Ray Fluorescence 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 10317:2014 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 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 10317:2014 und CEN/TR 10350:2013, beide zu beziehen durch die nationalen Normenorganisationen (in Deutschland bei der Vertriebsstelle des DIN: Beuth-Verlag GmbH, Burggrafenstraße 4-10, 10787 Berlin).

Weitere Informationen und Hinweise zu diesem oder anderen durch die Arbeitsgemeinschaft "Zertifiziertes Referenzmaterial Eisen und Stahl" hergestellten 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 10317:2014 et CEN/TR 10350:2013. On peut se procurer ces deux documents auprès des organismes nationaux de normalisation. (Pour la France: AFNOR, 11 Avenue Francis de Pressensé, 93571 – St Denis la Plaine Cedex).

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 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 10317:2014 och CEN/TR 10350:2013 som kan erhållas från den nationella standardiseringsorganisationen. (Sverige: SIS, S:t Paulsgatan 6, SE-118 80 Stockholm, Finland: SFS, PL. 116, FIN-002 41, Helsingfors, Danmark: DS, Kollegievej 6, DK-Charlottenlund 2920, Norge: NSF, Drammensveien, 145 A, Postboks 353 Skøyen, NO-0213 Oslo, Island: STRI, Holtagardar, IS-104 Reykjavik).

Ytterligare information och rådfrågan om detta eller andra Certifierade Referensmaterial/Referensmaterial, producerade av den tyska arbetsgruppen för CRM, kan erhållas från angiven adress på certifikatet enligt ovan.

#### The German Iron and Steel CRM Working Group

The Working Group is composed of  
 Bundesanstalt für Materialforschung und -prüfung (BAM), Berlin  
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 Steel institute VDEh (Committee of chemists), Düsseldorf (management for the working group)

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