BRITISH STANDARD

BS EN 10295:2002

Heat resistant steel castings

The European Standard EN 10295:2002 has the status of a British Standard

ICS 77.140.80

BSI British Standards

National foreword

This British Standard is the official English language version of EN 10295:2002.

The UK participation in its preparation was entrusted to Technical Committee ISE/6, Steel castings, which has the responsibility to:

— aid enquirers to understand the text;

— present to the responsible international/European committee any enquiries on the interpretation, or proposals for change, and keep the UK interests informed;

— monitor related international and European developments and promulgate them in the UK.

A list of organizations represented on this committee can be obtained on request to its secretary.

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English version

Heat resistant steel castings

Aciers moulés réfractaires

Hitzebeständiger Stahlguss

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EUROPEAN COMMITTEE FOR STANDARDIZATION
COMITÉ EUROPÉEN DE NORMALISATION
EUROPÄISCHES KOMITEE FÜR NORMUNG

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Foreword

This document (EN 10295:2002) has been prepared by Technical Committee ECISS/TC 31 "Steel castings", the secretariat of which is held by AFNOR.

This European Standard shall be given the status of a national standard, either by publication of an identical text or by endorsement, at the latest by April 2003 and conflicting national standards shall be withdrawn at the latest by April 2003.

Annexes A, B, C, and D are informative.

According to the CEN/CENELEC Internal Regulations, the national standards organizations of the following countries are bound to implement this European Standard: Austria, Belgium, Czech Republic, Denmark, Finland, France, Germany, Greece, Iceland, Ireland, Italy, Luxembourg, Malta, Netherlands, Norway, Portugal, Spain, Sweden, Switzerland and the United Kingdom.

Introduction

This draft European Standard retains the same format for clauses as EN 1559-1 and EN 1559-2. It should be used in conjunction with these standards. Where no text is given under a clause heading, the corresponding clause of EN 1559-1 or EN 1559-2 applies.

The structure of this standard is as follows :

— clauses and sub-clauses preceded by ■ indicates no additional conditions to EN 1559-1 or EN 1559-2[1)] ;

— sub-clauses marked with one dot "•" indicate that conditions shall be agreed at the time of enquiry and order ;

— sub-clauses and paragraphs marked with two dots "••" indicate that conditions may be agreed at the time of enquiry and order (optional) ;

— sub-clauses without dot marking are mandatory.

1) When additional information is given in a clause or sub-clause of this standard (versus the same clause or sub-clause of EN 1559-1 or EN 1559-2) it is preceded by "In addition to EN 1559:...".

1 Scope

This European Standard is applicable to heat resistant steel castings, for general purposes (not for pressure applications) above 600 °C. It is also applicable to heat resistant nickel and cobalt base alloys.

This standard relates to castings manufactured from ferritic, austenitic-ferritic, austenitic steels, nickel and cobalt base alloys (characterised by their chemical composition [see Table 1] and mechanical properties [see Table 2]).

In cases where castings are joined by welding by the founder, this European Standard applies.

In cases where castings are welded :

— to wrought products (plates, tubes, forgings...) ;

— or by non founders;

this European Standard does not apply.

2 Normative references

This European Standard incorporates by dated or undated reference, provisions from other publications. These normative references are cited at the appropriate places in the text and the publications are listed hereafter. For dated references, subsequent amendments to or revisions of any of these publications apply to this European Standard only when incorporated in it by amendment or revision. For undated references the latest edition of the publication referred to applies (including amendments).

EN 1559-1, *Founding – Technical conditions of delivery – Part 1 : General.*

EN 1559-2, *Founding – Technical conditions of delivery – Part 2 : Additional requirements for steel castings.*

3 Terms and definitions

For the purposes of this European Standard the terms and definitions given in EN 1559-1:1997 and EN 1559-2:2000 apply.

4 Information to be supplied by the purchaser

See EN 1559-1 and EN 1559-2.

5 Designations

See EN 1559-1 and EN 1559-2.

6 Manufacture

6.1 Manufacturing process

6.1.1 Melting

In addition to EN 1559-2 :

— alternative processes are left to the discretion of the manufacturer.

6.1.2 Heat treatment

Unless otherwise agreed, the type of heat treatment for ferritic grades shall comply with Table 2. Heat treatment is mandatory where indicated. For non ferritic grades, their mechanical properties values do correspond to the "as cast" state.

6.2 Welding operations

6.2.1 General

See EN 1559-1 and EN 1559-2.

6.2.2 Production welding

In addition to EN 1559-2 :

•• Unless otherwise agreed welding is permitted. Welding conditions and post weld treatments are listed in Annex A, for information only. The grades not listed in Table A.1 are weldable without pre-heating and post treatment in general, but for complex castings and great wall thicknesses a pre-heating and post-stress relief annealing may be applied due to the low ductility at room temperature of these grades. Procedure is left to the discretion of the manufacturer.

6.3 Further processing

See EN 1559-1 and EN 1559-2.

7 Requirements

7.1 General

See EN 1559-1 and EN 1559-2.

7.2 Material

7.2.1 Chemical composition

In addition to EN 1559-2 :

— the chemical composition determined by a cast analysis shall comply with the values given in Table 1 ;

— limit deviations between the specified cast analysis and the check analysis on test blocks are indicated in EN 1559-2 ;

— elements unspecified in Table 1 shall not be intentionally added without agreement of the purchaser other than for the purpose of finishing the heat. If not otherwise agreed the maximum values as a mass fraction in % given in Table 3 shall apply.

7.2.2 Mechanical properties

7.2.2.1 The mechanical properties shall comply with the values given in Table 2. According to the grades they are determined either by hardness testing or by tensile testing, where these values are specified.

The yield strength values at room temperature correspond to 0,2 % proof strength ($R_{p0,2}$).

7.2.2.2 For use at elevated temperatures the values for creep stress are given in Table B.1 :

— rupture stress in 100 h and 1 000 h ;

— stress corresponding to 1 % elongation in 10 000 h.

These are mean values out of a scatter band of ± 20 %. Table B.1 is for information only.

7.2.3 Other properties

7.2.3.1 High temperature oxidation resistance

The maximum applicable operating temperatures (see Table C.1) are valid for oxidation resistance in clean natural air. In other atmospheres, these temperatures can differ widely. The definition for these temperatures is done by a test, where the loss of mass by oxidation is less than 1 gram per square meter and hour, and at a temperature of 50 K higher this loss is not more than 2 gram per square meter and hour. (For austenitic steel a loss of 1 gram per square meter and hour is equivalent to a loss of 1,1 mm wall thickness per year, for information).

7.3 Casting

See EN 1559-1 and EN 1559-2.

8 Testing and documents on material testing

8.1 General

See EN 1559-1 and EN 1559-2.

8.2 Inspection and testing

See EN 1559-1 and EN 1559-2.

8.3 Test unit sampling

See EN 1559-1 and EN 1559-2.

8.4 Samples (test blocks)

See EN 1559-1 and EN 1559-2.

8.5 Test methods

- a) tensile test at room temperature ;
- b) tensile test at elevated temperature ;

c) impact test not applicable ;

d) ferrite content not applicable ;

- e) hardness test ;
- f) homogeneity of test units (hardness test) ;
- g) pressure or leak testing ;

h) intergranular corrosion test not applicable ;

- i) tests for magnetic properties ;
- j) other tests.

8.6 Invalidation of tests

See EN 1559-1 and EN 1559-2.

8.7 Retests

See EN 1559-1 and EN 1559-2.

8.8 Sorting and reprocessing

See EN 1559-1 and EN 1559-2.

9 Marking

See EN 1559-1 and EN 1559-2.

10 Packaging and surface protection

See EN 1559-1 and EN 1559-2.

11 Complaints

See EN 1559-1 and EN 1559-2.

12 Supplementary information

Information on physical properties of the grades are given in Annex D.

Table 1 — Chemical composition (cast analysis) (as a mass fraction in %)

	Designation		Elements										
			C	Si	Mn	P	S	Cr	Mo	Ni	Nb	Co	Others
	Name	Number				max.	max.						
Ferritic and austenitic – ferritic grades	GX30CrSi7	1.4710	0,20 to 0,35	1,00 to 2,50	0,50 to 1,00	- 0,035	- 0,030	6,00 to 8,00	Max. 0,15	max. 0,50	- -	- -	- -
	GX40CrSi13	1.4729	0,30 to 0,50	1,00 to 2,50	max. 1,00	- 0,040	- 0,030	12,00 to 14,00	Max. 0,50	max. 1,00	- -	- -	- -
	GX40CrSi17	1.4740	0,30 to 0,50	1,00 to 2,50	max. 1,00	- 0,040	- 0,030	16,00 to 19,00	Max. 0,50	max. 1,00	- -	- -	- -
	GX40CrSi24	1.4745	0,30 to 0,50	1,00 to 2,50	max. 1,00	- 0,040	- 0,030	23,00 to 26,00	Max. 0,50	max 1,00	- -	- -	- -
	GX40CrSi28	1.4776	0,30 to 0,50	1,00 to 2,50	max. 1,00	- 0,040	- 0,030	27,00 to 30,00	Max. 0,50	max. 1,00	- -	- -	- -
	GX130CrSi29	1.4777	1,20 to 1,40	1,00 to 2,50	0,50 to 1,00	- 0,035	- 0,030	27,00 to 30,00	Max. 0,50	max. 1,00	- -	- -	- -
	GX160CrSi18	1.4743	1,40 to 1,80	1,00 to 2,50	max. 1,00	- 0,040	- 0,030	17,00 to 19,00	Max. 0,50	max. 1,00	- -	- -	- -
	GX40CrNiSi27-4	1.4823	0,30 to 0,50	1,00 to 2,50	max. 1,50	- 0,040	- 0,030	25,00 to 28,00	Max. 0,50	3,00 to 6,00	- -	- -	- -
Austenitic grades	GX25CrNiSi18-9	1.4825	0,15 to 0,35	0,50 to 2,50	max. 2,00	- 0,040	- 0,030	17,00 to 19,00	Max. 0,50	8,00 to 10,00	- -	- -	- -
	GX40CrNiSi22-10	1.4826	0,30 to 0,50	1,00 to 2,50	max. 2,00	- 0,040	- 0,030	21,00 to 23,00	Max. 0,50	9,00 to 11,00	- -	- -	- -
	GX25CrNiSi20-14	1.4832	0,15 to 0,35	0,50 to 2,50	max. 2,00	- 0,040	- 0,030	19,00 to 21,00	Max. 0,50	13,00 to 15,00	- -	- -	- -
	GX40CrNiSi25-12	1.4837	0,30 to 0,50	1,00 to 2,50	max. 2,00	- 0,040	- 0,030	24,00 to 27,00	Max. 0,50	11,00 to 14,00	- -	- -	- -
	GX40CrNiSi25-20	1.4848	0,30 to 0,50	1,00 to 2,50	max. 2,00	- 0,040	- 0,030	24,00 to 27,00	Max. 0,50	19,00 to 22,00	- -	- -	- -
	GX40CrNiSiNb24-24	1.4855	0,30 to 0,50	1,00 to 2,50	max. 2,00	- 0,040	- 0,030	23,00 to 25,00	Max. 0,50	23,00 to 25,00	0,80 to 1,80	- -	- -
	GX35NiCrSi25-21	1.4805	0,20 to 0,50	1,00 to 2,00	max. 2,00	- 0,040	- 0,030	19,00 to 23,00	Max. 0,50	23,00 to 27,00	- -	- -	- -
	GX40NiCrSi35-17	1.4806	0,30 to 0,50	1,00 to 2,50	max. 2,00	- 0,040	- 0,030	16,00 to 18,00	Max. 0,50	34,00 to 36,00	- -	- -	- -
	GX40NiCrSiNb35-18	1.4807	0,30 to 0,50	1,00 to 2,50	max. 2,00	- 0,040	- 0,030	17,00 to 20,00	Max. 0,50	34,00 to 36,00	1,00 to 1,80	- -	- -
	GX40NiCrSi38-19	1.4865	0,30 to 0,50	1,00 to 2,50	max. 2,00	- 0,040	- 0,030	18,00 to 21,00	Max. 0,50	36,00 to 39,00	- -	- -	- -
	GX40NiCrSiNb38-19	1.4849	0,30 to 0,50	1,00 to 2,50	max. 2,00	- 0,040	- 0,030	18,00 to 21,00	max. 0,50	36,00 to 39,00	1,20 to 1,80	- -	- -
	GX10NiCrSiNb32-20	1.4859	0,05 to 0,15	0,50 to 1,50	max. 2,00	- 0,040	- 0,030	19,00 to 21,00	max. 0,50	31,00 to 33,00	0,50 to 1,50	- -	- -
	GX40NiCrSi35-26	1.4857	0,30 to 0,50	1,00 to 2,50	max. 2,00	- 0,040	- 0,030	24,00 to 27,00	max. 0,50	33,00 to 36,00	- -	- -	- -
	GX40NiCrSiNb35-26	1.4852	0,30 to 0,50	1,00 to 2,50	max. 2,00	- 0,040	- 0,030	24,00 to 27,00	max. 0,50	33,00 to 36,00	0,80 to 1,80	- -	- -
	GX50NiCrCo20-20-20	1.4874	0,35 to 0,65	max. 1,00	max. 2,00	- 0,040	- 0,030	19,00 to 22,00	2,50 to 3,00	18,00 to 22,00	0,75 to 1,25	18,50 22,00	W:2,00 to 3,00
	GX50NiCrCoW35-25-15-5	1.4869	0,45 to 0,55	1,00 to 2,00	max. 1,00	- 0,040	- 0,030	24,00 to 26,00	- -	33,00 to 37,00	- -	14,00 16,00	W:4,00 to 6,00
	GX40NiCrNb45-35 [a]	1.4889	0,35 to 0,45	1,50 to 2,00	1,00 to 1,50	- 0,040	- 0,030	32,50 to 37,50	- -	42,00 to 46,00	1,50 to 2,00	- -	
Nickel and cobalt base alloys	G-NiCr28W	2.4879	0,35 to 0,55	1,00 to 2,00	max. 1,50	- 0,040	- 0,030	27,00 to 30,00	max. 0,50	47,00 to 50,00	- -	- -	Fe=bal W:4,00 to 6,00
	G-CoCr28	2.4778	0,05 to 0,25	0,50 to 1,50	1,50 max.	- 0,040	- 0,030	27,00 to 30,00	0,50 max.	4,00 max.	0,50 max.	48,0 to 52,0	Fe:bal
	G-NiCr50Nb	2.4680	max. 0,10	max. 1,00	max. 0,50	- 0,020	- 0,020	48,00 to 52,00	max. 0,50	bal.	1,00 to 1,80	- - -	Fe:max: 1,00 N:max. 0,16
	G-NiCr15	2.4815	0,35 to 0,65	1,00 to 2,50	max. 2,00	- 0,040	- 0,030	12,00 to 18,00	max. 1,00	58,00 to 66,00	- -	- -	Fe:bal

[a] This grade is a new alloy. For example, for service temperatures below 1 000 °C, it can be advisable to restrict the limits for Cr from 29,00 to 32,00 % by mass and for Si from 1,00 to 1,50 % by mass, because unfavourable conditions can result in embrittlement.

Table 2 — Mechanical properties at room temperature

	Designation		Heat treatment		Tensile test			Hardness
			Symbol	Temperature	$R_{po,2}$ MPa [a]	R_m MPa [a]	A %	HB
	Name	Number		°C	min.	min.	min.	max.
Ferritic and austenitic – ferritic grades	GX30CrSi7 [b]	1.4710	+ A [c]	800 to 850	-	-	-	300
	GX40CrSi13	1.4729	+ A [c]	800 to 850	-	-	-	300
	GX40CrSi17	1.4740	+ A [c]	800 to 850	-	-	-	300
	GX40CrSi24	1.4745			-	-	-	[d]
	GX40CrSi28	1.4776			-	-	-	[d]
	GX130CrSi29	1.4777			-	-	-	[d]
	GX160CrSi18	1.4743			-	-	-	[d]
	GX40CrNiSi27-4	1.4823		No	250	550	3	[d]
Austenitic grades	GX25CrNiSi18-9	1.4825			230	450	15	-
	GX40CrNiSi22-10	1.4826		heat	230	450	8	-
	GX25CrNiSi20-14	1.4832			230	450	10	-
	GX40CrNiSi25-12	1.4837			220	450	6	-
	GX40CrNiSi25-20	1.4848		treatment	220	450	8	-
	GX40CrNiSiNb24-24	1.4855			220	450	4	-
	GX35NiCrSi25-21	1.4805			220	430	8	-
	GX40NiCrSi35-17	1.4806			220	420	6	-
	GX40NiCrSiNb35-18	1.4807			220	420	4	-
	GX40NiCrSi38-19	1.4865			220	420	6	-
	GX40NiCrSiNb38-19	1.4849			220	420	4	-
	GX10NiCrSiNb32-20	1.4859			180	440	20	-
	GX40NiCrSi35-26	1.4857			220	440	6	-
	GX40NiCrSiNb35-26	1.4852			220	440	4	-
	GX50NiCrCo20-20-20	1.4874			320	420	6	-
	GX50NiCrCoW35-25-15-5	1.4869			270	480	5	-
	GX40NiCrNb45-35	1.4889			240	440	3	-
Nickel and cobalt base alloys	G-NiCr28W	2.4879			240	440	3	-
	G - CoCr28	2.4778			235	490	6	-
	G-NiCr50Nb	2.4680			230	540	8	-
	G-NiCr15	2.4815			200	400	3	-

[a] 1MPa = 1 N/mm^2

[b] If this grade is used for wear-resistant castings, then they can be delivered without heat treatment.

[c] + A means : Annealing

[d] Castings may be also supplied in the annealed condition in which case a maximum hardness value may be agreed.

Table 3 — Maximum contents of unspecified elements as a mass fraction in %

Grades	Elements				
	W	Nb	V	Cu	Co
Ferritic and austenitic-ferritic steel grades	0,20	0,20	0,08	0,20	0,50
Austenitic steel grades, nickel and cobalt-base alloys	0,60	0,60	0,12	0,25	1,00

Annex A
(informative)

Welding conditions

Table A.1 – Welding conditions

Designation		Preheat	Post weld
Name	Number	Temperature [a] °C	heat treatment
GX30CrSi7	1.4710	300 to 500	Stress relief annealing at 760 °C to 800 °C
GX40CrSi13	1.4729	300 to 500	Stress relief annealing at 760 °C to 800 °C
GX40CrSi17	1.4740	300 to 500	Stress relief annealing at 760 °C to 800 °C
GX40CrSi24	1.4745	700 to 800	Slow cooling in furnace
GX40CrSi28	1.4776	700 to 800	Slow cooling in furnace
GX130CrSi29	1.4777	700 to 800	Slow cooling in furnace
GX160CrSi18	1.4743	300 to 500	Stress relief annealing at 760 °C to 800 °C

[a] The welded area in the casting should never be allowed to cool down below the min. preheat temperature before the casting is put in the furnace for post weld heat treatment.

Annex B
(informative)

Creep properties

Mean creep stress (MPa) for :

— rupture in 100 h and 1 000 h (σ_r) ;

— 1 % elongation in 10 000 h ($\sigma_{1\ \%}$).

Table B.1 – Creep properties

		Temp. °C	600 °C			700 °C			800 °C			900 °C			1 000 °C			1 100 °C		
		Stress	σ_r		$\sigma_{1\ \%}$	σ_r		$\sigma_{1\%}$	σ_r		$\sigma_{1\ \%}$	σ_r		$\sigma_{1\ \%}$	σ_r		$\sigma_{1\%}$	σ_r		$\sigma_{1\ \%}$
		Load time (h)	100	1 000	10 000	100	1 000	10 000	100	1000	10 000	100	1 000	10 000	100	1 000	10 000	100	1 000	10 000
	Designation																			
	Name	Number																		
Ferritic and austenitic – ferritic grades	GX30CrSi7	1.4710	-	-	19	-	-	8	-	-	2,5	-	-	-	-	-	-	-	-	-
	GX40CrSi13	1.4729	120	75	22	28	21	9	10	7	3,5	-	-	1	-	-	-	-	-	-
	GX40CrSi17	1.4740	-	-	22	-	-	9	-	-	3,5	-	-	1	-	-	-	-	-	-
	GX40CrSi24	1.4745	-	-	22	-	-	9	-	-	3,5	-	-	1	-	-	-	-	-	-
	GX40CrSi28	1.4776	-	40	26	25	21	11	-	-	5	8	6,5	1,5	-	-	-	-	-	-
	GX130CrSi29	1.4777	-	-	26	-	-	11	12	11	5	7	5	1,5	-	-	-	-	-	-
	GX160CrSi18	1.4743	-	-	25	-	-	10	-	-	4	-	-	1,5	-	-	-	-	-	-
	GX40CrNiSi27-4	1.4823	100	80	28	45	-	15	25	-	8	15	5	4	-	-	1	-	-	-
Austenitic grades	GX25CrNiSi18-9	1.4825	-	220	78	120	90	44	60	50	22	40	30	9	-	-	-	-	-	-
	GX40CrNiSi22-10	1.4826	-	-	82	-	-	46	-	-	23	-	-	10	-	-	-	-	-	-
	GX25CrNiSi20-14	1.4832	-	-	82	-	-	46	-	-	23	-	-	10	-	-	-	-	-	-
	GX40CrNiSi25-12	1.4837	-	-	-	100	80	50	70	40	26	45	25	13	26	15	6	-	-	-
	GX40CrNiSi25-20	1.4848	-	-	-	100	80	65	75	50	36	47	28	17	28	16	7	12	6	2,5
	GX40CrNiSiNb24-24	1.4855	-	-	-	170	125	80	97	70	46	60	45	22	32	23	7,5	-	10	-
	GX35NiCrSi25-21	1.4805	-	-	-	-	-	80	-	70	45	-	45	22	-	23	7,5	-	10	-
	GX40NiCrSi35-17	1.4806	-	-	-	-	80	55	90	50	30	48	30	17	28	17	6	-	6	3
	GX40NiCrSiNb35-18	1.4807	-	-	-	180	140	-	110	70	-	60	35	-	35	20	-	18	10	-
	GX40NiCrSi38-19	1.4865	-	-	-	-	80	55	90	50	32	48	30	18	28	17	7	-	6	3
	GX40NiCrSiNb38-19	1.4849	-	-	-	-	93	60	93	-	38	49	36	20	-	-	8	-	-	-
	GX10NiCrSiNb32-20	1.4859	-	-	-	135	105	64	84	60	36	49	36	15,5	26	14	5	-	-	-
	GX40NiCrSi35-26	1.4857	-	-	-	-	-	70	-	-	40	-	-	20	-	-	8	-	-	-
	GX40NiCrSiNb35-26	1.4852	-	-	-	155	120	72	90	70	41	49	38	22	30	20	9	15	8,3	3
	GX50NiCrCo20-20-20	1.4874	-	-	-	-	-	-	135	100	-	80	60	27	-	32	17	-	-	-
	GX50NiCrCoW35-25-15-5	1.4869	-	-	-	-	-	-	-	-	-	-	-	-	-	-	17	-	-	6
	GX40NiCrNb45-35	1.4889	-	-	-	-	-	-	-	-	-	50	35	-	25	20	8	13	9	-
Nickel and cobalt base alloys	G-NiCr28W	2.4879	-	-	-	-	-	70	-	80	41	-	45	22	-	23	10	-	10	4
	G-CoCr28	2.4778	-	-	-	-	-	70	-	-	34	48	25	16	23	12	9,5	-	-	4
	G-NiCr50Nb	2.4680	-	-	-	170	110	71	105	70	38	60	38	18	30	15	6,8	-	6	-
	G-NiCr-15	2.4815	-	-	-	-	-	-	-	-	-	60	24	-	20	13	-	-	-	-

Annex C
(informative)

Maximum use temperatures

Table C.1 – Maximum use temperatures

	Designation		Max. temperature in air
	Name	Number	°C
Ferritic and austenitic – ferritic grades	GX30CrSi7	1.4710	750
	GX40CrSi13	1.4729	850
	GX40CrSi17	1.4740	900
	GX40CrSi24	1.4745	1 050
	GX40CrSi28	1.4776	1 150
	GX130CrSi29	1.4777	1 100
	GX160CrSi18	1.4743	900
	GX40CrNiSi27-4	1.4823	1 100
Austenitic grades	GX25CrNiSi18-9	1.4825	900
	GX40CrNiSi22-10	1.4826	950
	GX25CrNiSi20-14	1.4832	950
	GX40CrNiSi25-12	1.4837	1 050
	GX40CrNiSi25-20	1.4848	1 100
	GX40CrNiSiNb24-24	1.4855	1 050
	GX35NiCrSi25-21	1.4805	1 000
	GX40NiCrSi35-17	1.4806	1 000
	GX40NiCrSiNb35-18	1.4807	1 000
	GX40NiCrSi38-19	1.4865	1 020
	GX40NiCrSiNb38-19	1.4849	1 020
	GX10NiCrSiNb32-20	1.4859	1 050
	GX40NiCrSi35-26	1.4857	1 100
	GX40NiCrSiNb35-26	1.4852	1 100
	GX50NiCrCo20-20-20	1.4874	1 150
	GX50NiCrCoW35-25-15-5	1.4869	1 200
	GX40NiCrNb45-35	1.4889	1 160
Nickel and cobalt base alloys	G-NiCr28W	2.4879	1 150
	G-CoCr28	2.4778	1 200 [a]
	G-NiCr50Nb	2.4680	1 050 [b]
	G-NiCr-15	2.4815	1 100

[a] For cyclic heatings the maximum temperature in air is 1 100 °C.

[b] This grade is used in cases of oil-ash attack up to a maximum temperature of 950 °C.

Annex D
(informative)

Physical properties

Table D.1 – Physical properties

	Designation		Density	Specific heat	Thermal conductivity W/(m·K) at :				Thermal expansion 10^{-6} K^{-1} from 20 °C to :		
	Name	Number	Kg/dm^3	J/(kg·K) at 20 °C	20 °C	100 °C	800 °C	1 000 °C	400 °C	800 °C	1 000 °C
Ferritic and austenitic – ferritic grades	GX30CrSi7	1.4710	7,7	460	24	–	–	–	12,5	13,5	–
	GX40CrSi13	1.4729	7,7	460	24	24,8	30	–	12,5	13,5	–
	GX40CrSi17	1.4740	7,7	460	–	20	–	–	12,5	13,5	–
	GX40CrSi24	1.4745	7,6	500	18,8	–	–	–	12,5	14	16
	GX40CrSi28	1.4776	7,6	500	18,8	21	–	–	11,5	14	16
	GX130CrSi29	1.4777	7,6	500	18,8	–	–	–	11,5	14	16
	GX160CrSi18	1.4743	7,7	500	18,8	–	–	–	12,5	13,5	–
	Gx40CrNiSi27-4	1.4823	7,6	500	16,7	21	35	39,6	13	14,5	16,6
Austenitic grades	GX25CrNiSi18-9	1.4825	7,8	500	14,8	15,5	26	30	17,4	18,3	18,8
	GX40CrNiSi22-10	1.4826	7,8	500	14	15	25,4	28,8	17,2	18,3	18,8
	GX25CrNiSi20-14	1.4832	7,8	500	14	15	25,4	28,8	17,2	18,3	19,3
	GX40CrNiSi25-12	1.4837	7,8	500	14	15	25,4	28,8	17,5	18,4	19,3
	GX40CrNiSi25-20	1.4848	7,8	500	14,6	16,7	25	28	17	18	19
	GX40CrNiSiNb24-24	1.4855	8,0	500	14	15,5	24,5	27,7	16,8	18	18,5
	GX35NiCrSi25-21	1.4805	8,0	500		14	23,8	27,7	16,4	17,5	18,2
	GX40NiCrSi35-17	1.4806	8,0	500	12	12,3	23	26,8	15,3	17	17,6
	GX40NiCrSiNb35-18	1.4807	8,0	500	12	12,3	23	26,8	15,3	17	17,6
	GX40NiCrSi38-19	1.4865	8,0	500	12	12,2	23,3	26,5	15,3	17	17,6
	GX40NiCrSiNb38-19	1.4849	8,0	500	12	12,3	23,3	26,5	15,3	17	17,6
	GX10NiCrSiNb32-20	1.4859	8,0	500	12,8	13	25,1	–	17,6	18,7	19,5
	GX40NiCrSi35-26	1.4857	8,0	500	12,8	13	23,8	27,7	15,7	17,4	18,3
	GX40NiCrSiNb35-26	1.4852	8,0	500	12,8	13	23,5	27,7	16	17,8	18,6
	GX50NiCrCo20-20-20	1.4874	8,0	460	-	13,8	25	–	15,2	16,5	17,0
	GX50NiCrCoW35-25-15-5	1.4869	8,2	500	10	12,6	-	28	–	–	17,3
	GX40NiCrNb45-35	1.4889	8,0	500	-	11,3	30,6	36,1	14,3	15,3	15,7
Nickel and cobalt base alloys	G-NiCr28W	2.4879	8,2	500	11	11,3	30,6	36,1	14,4	15,7	16,3
	G-CoCr28	2.4778	8,1	500	8,5	–	21	–	15	16	17
	G-NiCr50Nb	2.4680	8,0	450	14,2	–	–	-	13	15	15
	G-NiCr-15	2.4815	8,3	460	–	12,5	24	27,5	13,3	15,3	16,5

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