BRITISH STANDARD

BS EN
10095:1999

Heat resisting steels and nickel alloys

The European Standard EN 10095:1999 has the status of a British Standard

ICS 77.140.10

National foreword

This British Standard is the English language version of EN 10095:1999. It supersedes BS 1449-2:1983, which is withdrawn, and the requirements for heat resisting steel 310S S31 detailed in BS 970-1 (Section 5):1996

The two steel specifications which were listed BS 1449-2 may be cross-referenced with their equivalents in BS EN 10095 as follows:

Steels in BS 1449-2		Nearest equivalent steel in BS EN 10095	
309S24	Cr Ni 23/14	X12CrNi23-13	1.4833
310S24	Cr Ni 24/20	X8CrNi25-21	1.4845

The UK participation in its preparation was entrusted to Technical Committee ISE/30, Stainless steels, which has the responsibility to:

— aid enquirers to understand the text;

— present to the responsible 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.

Cross-references

The British Standards which implement international or European publications referred to in this document may be found in the BSI Standards Catalogue under the section entitled “International Standards Correspondence Index”, or by using the “Find” facility of the BSI Standards Electronic Catalogue.

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Summary of pages

This document comprises a front cover, an inside front cover, the EN title page, pages 2 to 26, an inside back cover and a back cover.

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EUROPEAN STANDARD
NORME EUROPÉENNE
EUROPÄISCHE NORM

EN 10095

March 1999

ICS 77.120.40; 77.140.20

English version

Heat resisting steels and nickel alloys

Aciers et alliages de nickel réfractaires

Hitzebeständige Stähle und Nickellegierungen

This European Standard was approved by CEN on 1 March 1999.

CEN members are bound to comply with the CEN/CENELEC Internal Regulations which stipulate the conditions for giving this European Standard the status of a national standard without any alteration. Up-to-date lists and bibliographical references concerning such national standards may be obtained on application to the Central Secretariat or to any CEN member.

This European Standard exists in three official versions (English, French, German). A version in any other language made by translation under the responsibility of a CEN member into its own language and notified to the Central Secretariat has the same status as the official versions.

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CEN

European Committee for Standardization
Comité Européen de Normalisation
Europäisches Komitee für Normung

Central Secretariat: rue de Stassart 36, B-1050 Brussels

Ref. No. EN 10095:1999 E

Foreword

This European Standard has been prepared by Technical Committee ECISS/TC 23, Steels for heat treatment, alloy steels and free-cutting steels — Qualities and dimensions, the Secretariat of which is held by DIN.

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 September 1999, and conflicting national standards shall be withdrawn at the latest by September 1999.

This European Standard has been prepared under a mandate given to CEN by the European Commission and the European Free Trade Association. This European Standard is considered to be a supporting standard to those application and product standards which in themselves support an essential safety requirement of a New Approach Directive and which make reference to this European Standard.

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, Netherlands, Norway, Portugal, Spain, Sweden, Switzerland and the United Kingdom.

NOTE The clauses marked with a point (•) contain information relating to agreements which are to be made at the time of ordering. The clauses marked with two points (• •) contain information relating to agreements which may be made at the time of ordering.

Contents

1 Scope

1.1 This European Standard covers the grades of wrought steels and nickel alloys listed in Tables 1 to 3 which are usually employed for products, for which the main requirement is their resistance to the effects of hot gases and products of combustion at temperatures above 550 °C.

1.2 This EN 10095 specifies the technical delivery conditions for semi-finished products, for hot or cold rolled sheet/plate and strip, hot or cold formed bars, rods and sections of heat resisting steels and nickel alloys.

1.3 Some grades from EN 10088-1 and prEN 10028-7 may be used as heat resisting steels. These grades are listed in the informative annex D.

1.4 The general technical delivery conditions specified in EN 10021 apply in addition to the specifications of this European Standard, unless otherwise specified in this standard.

1.5 This European Standard does not apply to components manufactured by further processing the product forms listed in **1.2** with quality characteristics altered as a result of such further processing.

1.6 This European Standard is not intended for pressure purposes.

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 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.

EN 10002-1, *Metallic materials — Tensile testing — Part 1: Method of testing (at ambient temperature).*

EN 10002-5, *Metallic materials — Tensile testing — Part 5: Method of test at elevated temperature.*

EN 10003-1, *Metallic materials — Hardness test — Brinell — Part 1: Test method.*

EN 10021, *General technical delivery requirements for steel and iron products.*

EN 10027-1, *Designation systems for steels — Part 1: Steel names, principal symbols.*

EN 10027-2, *Designation systems for steels — Part 2: Numerical system.*

EN 10052, *Vocabulary of heat treatment terms for ferrous products.*

EN 10079, *Definition of steel products.*

EN 10163-2, *Delivery requirements for surface condition of hot rolled steel plates, wide flats and sections — Part 2: Plate and wide flats.*

EN 10204, *Metallic products — Types of inspection documents.*

EN 10221, *Surface quality classes for hot-rolled bars and rods — Technical delivery conditions.*

EN ISO 377, *Steel and steel products — Location and preparation of samples and test pieces for mechanical testing.*

EN ISO 9001, *Quality systems — Model for quality assurance in design/development, production, installation and servicing.*

EN ISO 9002, *Quality systems — Model for quality assurance in production, installation and servicing.*

EU 168-86[1)], *Iron and steel products — Inspection documents — Contents.*

ISO 14284, *Steel and iron — Sampling and preparation of samples for the determination of chemical composition.*

3 Definitions

For the purpose of this European Standard, the following definition applies in addition to the definitions given in EN 10021, EN 10052, EN 10079, EN ISO 377 and ISO 14284.

3.1

heat-resistance

property of materials that are used at above 550 °C (for steels: wustite point) due to their excellent resistance to the effects of hot gases and products of combustion as well as their resistance to the influence of molten salts and molten metals but also showing good mechanical properties during short and long-term stressing

[1)] •• It may be agreed at the time of ordering, until this EURONORM has been adopted as a European Standard, that either this Euronorm or a corresponding national standard should be applied.

4 Classification and designation

4.1 Classification

Materials covered in this European Standard are classified according to their structure into:

— ferritic steels;

— austenitic-ferritic steels;

— austenitic steels; and

— austenitic nickel alloys.

4.2 Designation

The names and numbers of the steels (see Table 1 and 2) were formed in accordance with EN 10027-1 and EN 10027-2 respectively.

NOTE Explanation on the designation of nickel alloys (see Table 3).

— name: The preceding chemical symbols indicate the main alloy elements and the figure immediately following indicates the average content of these alloys subsequently followed by the symbol for the other added important alloy elements.

— material number: The structure is set out according to EN 10027-2 with the number 2 for the material group number. This material group comprises chemically resistant and high temperature or heat resistant nickel and cobalt alloys.

5 Information to be supplied by the purchaser

5.1 • Mandatory information

The following information shall be supplied by the purchaser at the time of enquiry and order:

a) the quantity to be delivered;

b) the designation of the product form (e.g. bar or rod, strip or sheet);

c) where an appropriate dimensional standard is available (see annex A) the number of the standard and the indications required by this, also the nominal dimensions and tolerances;

d) the type of material (steel or nickel alloy);

e) the number of this European Standard (EN 10095);

f) the name or number of the steel grade or nickel alloy (see **4.2**);

g) if for the relevant grade in the table more than one treatment condition for the mechanical properties is covered, the symbol for the desired heat treatment condition or cold worked condition;

h) the desired process route (see symbols in Tables 7 and 8).

EXAMPLE

10 t rounds of a steel grade with the name X10NiCrAlTi32-21 and the number 1.4876 as specified in EN 10095 of 50 mm diameter, dimensional tolerances as specified in EURONORM 60, in process route 1D.

10 t rounds EURONORM 60 – 50

steel EN 10095 – X10NiCrAlTi32-21 + 1D

or

10 t rounds EURONORM 60 – 50

steel EN 10095 – 1.4876 + 1D

5.2 •• Options

A number of options are specified in this European Standard and listed below. If the purchaser does not indicate his wish to implement one of these options, the supplier shall supply in accordance with the basis specification of this European Standard (see **5.1**):

a) any requirement concerning a special melting or forming process (see **6.1**);

b) any requirement relating to surface quality (see **7.4**);

c) any requirement concerning the issue of an inspection document (see **8.2**);

d) any requirement concerning the method of analysis to determine the product analysis (see **8.4.1**);

e) any requirement concerning special marking of the products (see **9.2**, **9.3** and Table 10).

6 Manufacturing process

6.1 •• General

Unless a special melting or forming process is agreed when ordering, the production process for steels and alloys conforming to this European Standard shall be at the discretion of the manufacturer.

6.2 • Delivery condition

The products shall be supplied in the delivery condition agreed in the order by reference to the process route given in Tables 7 and 8 and to the treatment conditions given in Table B.1.

7 Requirements

7.1 General

The supplier shall operate and certify a quality system in accordance with EN ISO 9002[2)].

7.2 Chemical composition

7.2.1 The chemical composition requirements given in Tables 1 to 3 apply with respect to the cast analysis.

7.2.2 The product analysis may deviate from the limiting values for the cast analysis given in Tables 1 to 3 by the values listed in Tables 4 and 5.

7.3 Mechanical properties

The mechanical properties at room temperature as specified in Table 6 apply for each specified heat treatment condition. This does not apply to the process route 1U (hot rolled, not heat treated, not descaled) and to semi-finished products.

• If by agreement at the time of ordering, the products are to be supplied in a non-heat-treated condition, the mechanical properties specified in Table 6 shall be obtainable from reference test pieces which have received the appropriate heat treatment (simulated heat treatment).

7.4 Surface quality

Slight surface imperfections, inherent in the production process, are permitted.

•• If more exact requirements for the surface quality are necessary, these shall be agreed at the time of enquiry and order.

When products are delivered in coil form, the degree and extent of such imperfections may be expected to be greater due to the impracticality of removing short lengths of coil. For hot rolled quarto-plates, the specification in EN 10163-2 class A3 applies unless otherwise stated.

For long products, where appropriate, the requirements shall be on the basis of EN 10221.

7.5 • Dimensions and tolerances on dimensions

The dimensions and the tolerances on dimensions are to be agreed at the time of enquiry and order, as far as possible with reference to the dimensional standards listed in annex A.

7.6 Calculation of mass and tolerances on mass

7.6.1 When calculating the nominal mass from the nominal dimensions the values given in Table B.5 shall be used as a basis for the density of the steel concerned.

7.6.2 • If the tolerances on mass are not specified in the dimensional standard listed in annex A, they shall be agreed at the time of enquiry and order.

8 Inspection and testing

8.1 General

The manufacturer shall carry out appropriate process control, inspection and testing to assure himself that the delivery complies with the requirements of the order.

This includes the following:

— a suitable frequency of verification of the dimensions of the products;

— an adequate intensity of visual examination of the surface quality of the products;

— an appropriate frequency and type of test to ensure that the correct grade is used.

The nature and frequency of these verifications, examinations and tests is determined by the manufacturer in the light of the degree of consistency that has been determined by the evidence of the quality system. In view of this, verifications by specific tests for these requirements are not necessary unless otherwise agreed.

8.2 •• Types and contents of inspection documents

8.2.1 At the time of ordering the issue of one of the inspection documents in accordance with EN 10204 may be agreed for each delivery.

8.2.2 If it is agreed to issue a test report 2.2 in accordance with EN 10204 it shall indicate the following information:

a) the information groups A, B and Z of EU 168;

b) the results of the cast analysis in accordance with the code numbers C71 to C92 in EU 168.

8.2.3 If the issuing of an inspection certificate 3.1.A, 3.1.B or 3.1.C according to EN 10204 or of an inspection report 3.2 according to EN 10204 has been agreed, specific inspections according to **8.3** are to be carried out and the following information shall be given in the inspection document with the code numbers and details required by EU 168:

a)
b) as under **8.2.2** a) and b);

c) the results of the mandatory tests marked in Table 9, second column, by an “m”;

d) the result of any optional test or inspection agreed when ordering.

[2)] This requirement is also fulfilled by a quality system in accordance with EN ISO 9001.

8.3 Specific inspection and testing

8.3.1 *Extent of testing*

The tests to be carried out, either mandatorily (m) or by agreement (o) and the composition and size of the test units, and the number of sample products, samples and test pieces to be taken are given on Table 9.

8.3.2 *Selection and preparation of samples and test pieces*

8.3.2.1 The specifications of EN ISO 377 and ISO 14284 shall be observed in sampling and sample preparation respectively. The stipulations in **8.3.2.2** apply additionally for the mechanical tests.

8.3.2.2 The test samples for the tensile test shall be taken in accordance with Figures 1 to 4 in such a way that for flat products, they are located half-way between the centre and a longitudinal edge.

The samples shall be taken from products in the delivery condition. If agreed, the samples may be taken before flattening for flat products or before straightening for bars. For samples to be given a simulated heat treatment the conditions for heat treatment shall be agreed with reference to Table B.1.

8.3.2.3 Samples for the hardness test, where requested, shall be taken from the same locations as those for the tensile test.

8.4 Test methods

8.4.1 •• Unless otherwise agreed when ordering, the choice of a suitable physical or chemical method of analysis to determine the product analysis is at the discretion of the manufacturer. In cases of dispute the analysis shall be carried out by a laboratory approved by the two parties. The method of analysis to be used shall be agreed, where possible with reference to appropriate European Standards or EURONORMS.

8.4.2 The tensile test at room temperature shall be carried out in accordance with EN 10002-1. Generally, this means using proportional test pieces having a gauge length $L_0 = 5{,}65\sqrt{S_0}$ (S_0 = cross-section of the test piece). In cases of doubt and in referee testing this type of test piece shall be used.

The tensile strength and elongation after fracture shall be determined and additionally for ferritic and austenitic-ferritic steels and for alloys the 0,2 % proof strength and for austenitic steels the 0,2 % and 1 % proof strength.

8.4.3 The Brinell hardness test shall be carried out in accordance with EN 10003-1.

8.4.4 Dimensions and dimensional tolerances of the products shall be tested in accordance with the requirements of the relevant dimensional standards, where available.

8.5 Retest

See EN 10021.

9 Marking

9.1 Marking shall be durable.

9.2 •• Unless otherwise agreed, the requirements listed in Table 10 apply.

9.3 •• The method and the extent of marking and the material of marking shall, unless otherwise agreed, be at the option of the manufacturer.

9.4 As an alternative for items that are wrapped, bundled or boxed, or where the surface is ground or polished, the marking may be applied to the packaging, or to a tag securely attached to it.

Dimensions in millimetres

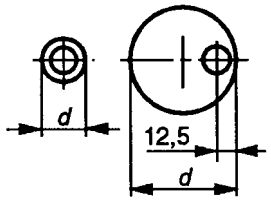
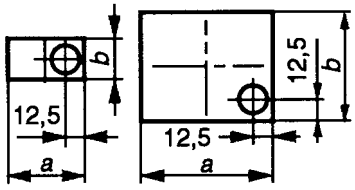
Type of test	Round cross-section products		Rectangular cross-section products	
Tensile	$d \leq 25$	$25 < d \leq 160$	$b \leq 25$ $a \geq b$	$25 < b \leq 160$ $a \geq b$
				

Figure 1 — Position of test pieces for steel bars and rods ≤ 160 mm diameter or thickness (longitudinal test pieces)

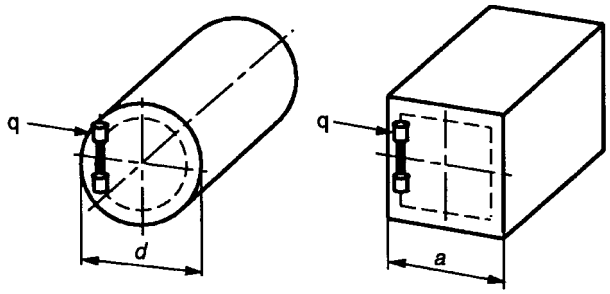
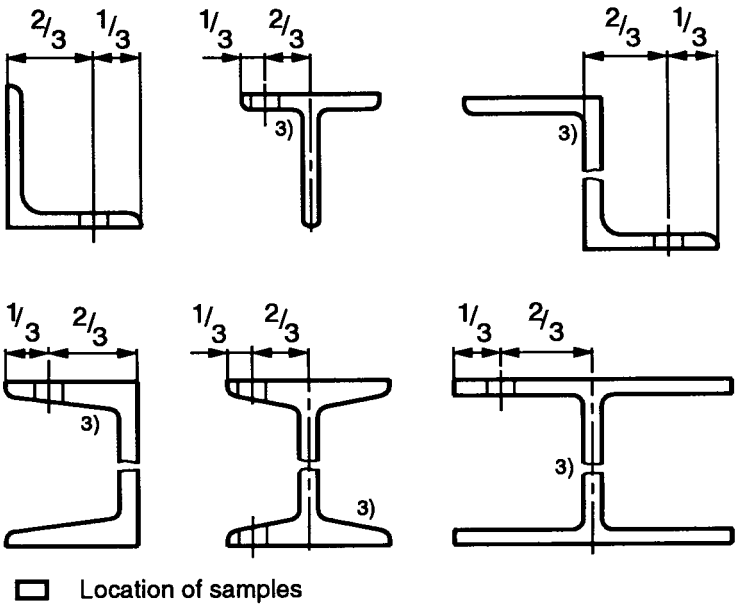
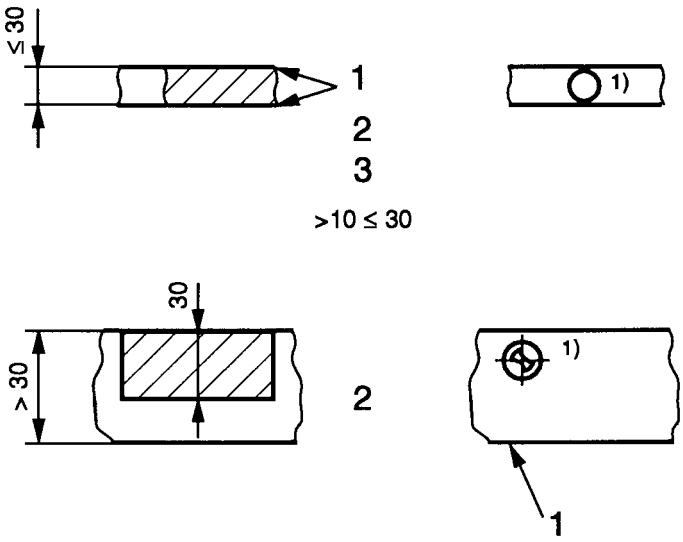


Figure 2 — Position of test pieces for steel bars > 160 mm diameter or thickness [transverse test pieces (q)]



[3)] By agreement, the sample can be taken from the web, at a quarter of the total height.

Figure 3 — Position of test pieces for beams, channels, angles, T sections and Z sections

Type of test piece	Thickness products	Direction of the longitudinal axis of the test pieces in relation to the principal direction of rolling at a product width of		Distance of test piece from the rolled surface
	mm	< 300 mm	≥ 300 mm	mm
Tensile[1)]	≤ 30	longitudinal	transverse	
	> 30			

1. Rolled surface
2. Or
3. For

[1)] In cases of doubt or dispute the gauge length shall be $L_o = 5{,}65\sqrt{S_o}$ for test piece from products ≥ 3 mm.
For products < 3 mm thickness, non-proportional test pieces with a gauge length of 80 mm and a width of 20 mm shall be used, but test pieces with a gauge length of 50 mm and a width of 12,5 mm may also be applied. For products with a thickness of 3 mm to 10 mm, flat proportional test pieces with two rolled surfaces and a maximum width of 30 mm shall be used. For products with a thickness > 10 mm, one of the following proportional test pieces may be used:

— either a flat test piece with a maximum thickness of 30 mm; the thickness may be reduced to 10 mm by machining, but one rolled surface must be preserved; or

— a round test piece with a diameter of ≥ 5 mm, the axis of which shall be located as near as possible to a plane in the outer third of half the product thickness.

Figure 4 — Position of the tensile test pieces in flat products

Table 1 — Chemical composition (cast analysis)[1)] of ferritic heat-resisting steels

Steel designation		% by mass							
Name	Number	C	Si	Mn max.	P max.	S max.	Cr	Al	Others
X10CrAlSi7	1.4713	max. 0,12	0,50 to 1,00	1,00	0,040	0,015	6,00 to 8,00	0,50 to 1,00	
X10CrAlSi13	1.4724	max. 0,12	0,70 to 1,40	1,00	0,040	0,015	12,00 to 14,00	0,70 to 1,20	
X10CrAlSi18	1.4742	max. 0,12	0,70 to 1,40	1,00	0,040	0,015	17,00 to 19,00	0,70 to 1,20	
X10CrAlSi25	1.4762	max. 0,12	0,70 to 1,40	1,00	0,040	0,015	23,00 to 26,00	1,20 to 1,70	
X18CrN28	1.4749	0,15 to 0,20	max. 1,00	1,00	0,040	0,015	26,00 to 29,00	—	N: 0,15 to 0,25
X3CrAlTi18-2	1.4736	max. 0,04	max. 1,00	1,00	0,040	0,015	17,00 to 18,00	1,70 to 2,10	$0{,}2 + 4(C + N) \leq Ti \leq 0{,}80$

[1)] Elements not listed in the table may not be intentionally added to the steel without the agreement of the purchaser except for finishing the cast. All appropriate precautions are to be taken to avoid addition of such elements from scrap and other materials used in production which would impair mechanical properties and the suitability of the steel.

Table 2 — Chemical composition (cast analysis)[1] of austenitic-ferritic and austenitic heat-resisting steels

Steel designation		% by mass								
Name	Number	C	Si	Mn	P max.	S max.	Cr	Ni	N	Others
Austenitic heat-resisting steels										
X8CrNiTi18-10	1.4878	max. 0,10	max. 1,00	max. 2,00	0,045	0,015	17,00 to 19,00	9,00 to 12,00		Ti: $5 \times \%\ C \leq Ti \leq 0{,}80$
X15CrNiSi20-12	1.4828	max. 0,20	1,50 to 2,50	max. 2,00	0,045	0,015	19,00 to 21,00	11,00 to 13,00	max. 0,11	
X9CrNiSiNCe21-11-2	1.4835	0,05 to 0,12	1,40 to 2,50	max. 1,00	0,045	0,015	20,00 to 22,00	10,00 to 12,00	0,12 to 0,20	Ce: 0,03 to 0,08
X12CrNi23-13	1.4833	max. 0,15	max. 1,00	max. 2,00	0,045	0,015	22,00 to 24,00	12,00 to 14,00	max. 0,11	
X8CrNi25-21	1.4845	max. 0,10	max. 1,50	max. 2,00	0,045	0,015	24,00 to 26,00	19,00 to 22,00	max. 0,11	
X15CrNiSi25-21	1.4841	max. 0,20	1,50 to 2,50	max. 2,00	0,045	0,015	24,00 to 26,00	19,00 to 22,00	max. 0,11	
X12NiCrSi35-16	1.4864	max. 0,15	1,00 to 2,00	max. 2,00	0,045	0,015	15,00 to 17,00	33,00 to 37,00	max. 0,11	
X10NiCrAlTi32-21	1.4876	max. 0,12	max. 1,00	max. 2,00	0,030	0,015	19,00 to 23,00	30,00 to 34,00		Al: 0,15 to 0,60 Ti: 0,15 to 0,60
X6NiCrNbCe32-27	1.4877	0,04 to 0,08	max. 0,30	max. 1,00	0,020	0,010	26,00 to 28,00	31,00 to 33,00	max. 0,11	Al: max. 0,025 Ce: 0,05 to 0,10 Nb: 0,60 to 1,00
X25CrMnNiN25-9-7	1.4872	0,20 to 0,30	max. 1,00	8,00 to 10,00	0,045	0,015	24,00 to 26,00	6,00 to 8,00	0,20 to 0,40	
X6CrNiSiNCe19-10	1.4818	0,04 to 0,08	1,00 to 2,00	max. 1,00	0,045	0,015	18,00 to 20,00	9,00 to 11,00	0,12 to 0,20	Ce: 0,03 to 0,08
X6NiCrSiNCe35-25*)	1.4854	0,04 to 0,08	1,20 to 2,00	max. 2,00	0,040	0,015	24,00 to 26,00	34,00 to 36,00	0,12 to 0,20	Ce: 0,03 to 0,08
X10NiCrSi35-19	1.4886	max. 0,15	1,00 to 2,00	max. 2,00	0,030	0,015	17,00 to 20,00	33,00 to 37,00	max. 0,11	
X10NiCrSiNb35-22	1.4887	max. 0,15	1,00 to 2,00	max. 2,00	0,030	0,015	20,00 to 23,00	33,00 to 37,00	max. 0,11	Nb: 1,00 to 1,50
Austenitic-ferritic heat-resisting steel										
X15CrNiSi25-4	1.4821	0,10 to 0,20	0,8 to 1,50	max. 2,00	0,040	0,015	24,50 to 26,50	3,50 to 5,50	max. 0,11	

[1] Elements not listed in the table may not be intentionally added to the steel without the agreement of the purchaser except for finishing the cast. All appropriate precautions are to be taken to avoid addition of such elements from scrap and other materials used in production which would impair mechanical properties and the suitability of the steel.

*) Patented steel grade.

Table 3 — Chemical composition (cast analysis)[1] of austenitic nickel alloys

Alloy designation		% by mass															
Name	Number	C	Mn max.	Si max.	P max.	S max.	Ni	Cr	Co	Fe	Mo	Al	Ti	Cu max.	Nb + Ta	B max.	Ce
NiCr15Fe	2.4816	0,05 to 0,10	1,00	0,50	0,020	0,015	min. 72,00	14,00 to 17,00	[2]	6,00 to 10,00		max. 0,30	max. 0,30	0,50			
NiCr20Ti	2.4951	0,08 to 0,15	1,00	1,00	0,020	0,015	Rest	18,00 to 21,00	max 5,00	max. 5,00		max. 0,30	0,20 to 0,60	0,50			
NiCr22Mo9Nb	2.4856	0,03 to 0,10	0,50	0,50	0,020	0,015	min. 58,00	20,00 to 23,00	max. 1,00	max. 5,00	8,00 to 10,00	max. 0,40	max. 0,40	0,50	3,15 to 4,15		
NiCr23Fe	2.4851	0,03 to 0,10	1,00	0,50	0,020	0,015	58,00 to 63,00	21,00 to 25,00	[2]	max. 18,00		1,00 to 1,70	max. 0,50	0,50		0,006	
NiCr28FeSiCe	2.4889	0,05 to 0,12	1,00	2,50 to 3,00	0,020	0,010	min. 45,00	26,00 to 29,00	[2]	21,00 to 25,00				0,30			0,03 to 0,09

[1] Elements not listed in the table may not be intentionally added to the alloy without the agreement of the purchaser except for finishing the cast. All appropriate precautions are to be taken to avoid addition of such elements from scrap and other materials used in production which would impair mechanical properties and the suitability of the alloy.

[2] A maximum of 1,5 % Co is allowed and counted as nickel. Reporting of cobalt is not required.

Table 4 — Permissible deviations between specified analysis and product analysis for the steels (see Tables 1 and 2)

Element	Cast analysis (Specified limits) %		Permissible deviations[1] from the specified composition %
C		≤ 0,030	±0,005
	> 0,030	≤ 0,20	±0,01
	> 0,20	≤ 0,30	±0,02
Si		≤ 1,00	±0,05
	> 1,00	≤ 2,50	±0,10
Mn		≤ 1,00	+0,03
	> 1,00	≤ 2,00	+0,04
	> 2,00	≤ 10,00	±0,10
P		≤0,045	+0,005
S		≤ 0,015	+0,003
	> 0,015	≤ 0,030	+0,005
N	≥ 0,05	≤ 0,40	±0,02
Al		≤ 0,15	±0,05
	> 0,15	≤ 2,10	±0,10
Cr		≤ 10,00	±0,10
	> 10,00	≤ 15,00	±0,15
	> 15,00	≤ 20,00	±0,20
	> 20,00	≤ 29,00	±0,25
Ni		≤ 1,00	±0,03
	> 1,00	≤ 5,00	±0,07
	> 5,00	≤ 10,00	±0,10
	> 10,00	≤ 20,00	±0,15
	> 20,00	≤ 32,00	±0,20
	> 32,00	≤ 37,00	±0,25
Nb		≤ 1,00	±0,05
Ti		≤ 0,80	±0,05
Ce		≤ 0,10	±0,01

[1] If several product analyses are carried out on one cast, and the contents of an individual element determined lies outside the permissible range of the chemical composition specified for the cast analysis, then it is only allowed to exceed the permissible maximum value or to fall short of the permissible value but not both for one cast.

Table 5 — Permissible deviations between specified analysis and product analysis for the nickel alloys (see Table 3)

Element	Cast analysis % by mass		Permissible deviations[1] from the specified composition % by mass
C		≤ 0,15	±0,01
Si		≤ 0,50	±0,03
	> 0,50	≤ 1,00	±0,05
Mn		≤ 1,00	+0,03
P		≤ 0,020	+0,005
S		≤ 0,015	+0,005
Al		≤ 0,40	+0,05
	> 0,40	≤ 1,70	±0,10
B		≤ 0,006	+0,000 5
Ce		≤ 0,09	±0,005
Co		≤ 1,00	±0,03
	> 1,00	≤ 5,00	±0,05
Cr		≤ 15,00	±0,15
	> 15,00	≤ 20,00	±0,20
	> 20,00	≤ 29,00	±0,25
Cu		≤ 0,50	±0,03
Fe		≤ 5,00	±0,07
	> 5,00	≤ 10,00	±0,10
Mo		≤ 10,00	±0,15
Nb + Ta		≤ 4,15	±0,15
Ni	> 40,00	≤ 60,00	±0,35
	> 60,00	≤ 80,00	±0,45
Ti		≤ 0,30	±0,03
	> 0,30	≤ 0,60	±0,04

[1] If several product analyses are carried out on one cast, and the contents of an individual element determined lies outside the permissible range of the chemical composition specified for the cast analysis, then it is only allowed to exceed the permissible maximum value or to fall short of the permissible value but not both for one cast.

Table 6 — Mechanical properties at room temperature for the heat resisting steels and nickel alloys in the usual delivery condition (see Table B.1)

Designation		Product		Heat treatment condition	HB max. 1) 2) 3)	Proof strength		Tensile strength R_m N/mm^2	A % min.			
Name	Number	Form	Thickness a or diameter d mm			$R_{p0,2}$ N/mm^2 min. 3)	$R_{p1,0}$ N/mm^2 min. 3)	1)	Long products 3)	Flat products $0,5 \leq a < 3$ l, tr	Flat products $3 < a$ l	Flat products $3 < a$ tr
Ferritic heat resisting steels												
X10CrAlSi7	1.4713	flat products	$a \leq 12$	+A	192	220		420 to 620	20	—	20	15
X10CrAlSi13	1.4724			+A	192	250		450 to 650	15	13	15	15
X10CrAlSi18	1.4742	bars	$d \leq 25$	+A	212	270		500 to 700	15	13	15	15
X10CrAlSi25	1.4762			+A	223	280		520 to 720	10	13	15	15
X18CrN28	1.4749	rods and sections	$d \leq 25$	+A	212	280		500 to 700	15	13	15	15
X3CrAlTi18-2	1.4736			+A	200	280		500 to 650	—	25	25	25
Austenitic heat resisting steels												
X8CrNiTi18-10	1.4878			+AT	215	190	230	500 to 720	40 1)	40	40	
X15CrNiSi20-12	1.4828			+AT	223	230	270	550 to 750	30 1)	28	30	
X9CrNiSiNCe21-11-2	1.4835	flat products	$a \leq 75$	+AT	210	310	350	650 to 850	40 1)	37	40	
X12CrNi23-13	1.4833			+AT	192	210	250	500 to 700	35 1)	33	35	
X8CrNi25-21	1.4845			+AT	192	210	250	500 to 700	35 1)	33	35	
X15CrNiSi25-21	1.4841			+AT	223	230	270	550 to 750	30 1)	28	30	
X12NiCrSi35-16	1.4864	bars	$d \leq 160$	+AT	223	230	270	550 to 750	30 1)	28	30	
X10NiCrAlTi32-21	1.4876			+AT	192	170	210	450 to 680	30 1)	28	30	
X6NiCrNbCe32-27	1.4877			+AT	223	180	220	500 to 750	35 1)	—	—	
X25CrMnNiN25-9-7	1.4872			+AT	311	500	540	850 to 1 050	25 1)	—	—	
X6CrNiSiNCe19-10	1.4818			+AT	210	290	330	600 to 800	40 1)	30	40	
X6NiCrSiNCe35-25	1.4854	rods and sections	$d \leq 25$	+AT	210	300	340	650 to 850	40 1)	40	40	
X10NiCrSi35-19	1.4886			+AT	200	270	300	500 to 650	40	—	—	
X10NiCrSiNb35-22	1.4887			+AT	200	270	300	500 to 650	40	—	—	

1) The maximum HB values may be raised by 100 units or the maximum tensile strength value may be raised by 200 N/mm^2 and the minimum elongation value be lowered to 20 % for sections and bars of ≤ 35 mm thickness having a final cold deformation.

2) For guidance only.

3) For rods, only the tensile strength values apply.

Table 6 — Mechanical properties at room temperature for the heat resisting steels and nickel alloys in the usual delivery condition (see Table B.1) *(continued)*

Designation		Product		Heat treatment condition	HB max. 1) 2) 3)	Proof strength $R_{p0,2}$ N/mm^2 min. 3)	Tensile strength R_m N/mm^2 1)	A % min			
Name	Number	Form	Thickness a or diameter d mm					Long products 3)	Flat products		
									$0{,}5 \leq a < 3$	$3 \leq a$	
									l, tr	l	tr
Austenitic-ferritic heat resisting steel											
X15CrNiSi25-4	1.4821	flat products	$a \leq 12$	+AT	235	400	600 to 850	16	—	16	12
		bars	$d \leq 60$								
		rods	$d \leq 25$								
Heat resisting nickel alloys											
NiCr15Fe	2.4816	flat products	$a \leq 75$	+A	200	240	550 to 850	30	30	30	—
		bars	$d \leq 160$								
		rods	$d \leq 25$								
NiCr20Ti	2.4951	flat products	$a \leq 75$	+AT	230	240	650 to 850	30	—	30	—
		bars	$d \leq 160$								
		rods	$d \leq 25$								
NiCr22Mo9Nb	2.4856	flat products	$3 \leq a < 75$	+A	240	380	760 to 1 000	—	—	30	30
			$a < 3$			415	820 to 1 050	—	30	—	—
		bars	$100 < d \leq 250$			345	760 to 1 000	25	—	—	—
			$d \leq 100$			415	820 to 1 050	30	—	—	—
		rods	$d \leq 25$			415	820 to 1 050	30	—	—	—
NiCr23Fe	2.4851	flat products	$a \leq 75$	+AT	220	205	550 to 750	30	—	30	30
		bars	$d \leq 160$								
		rods	$d \leq 25$								
NiCr28FeSiCe	2.4889	flat products	$a \leq 50$	+AT	220	240	620 to 820	35	35	35	35
		bars	$d \leq 160$								

1) The maximum HB values may be raised by 100 units or the maximum tensile strength value may be raised by 200 N/mm^2 and the minimum elongation value be lowered to 20 % for sections and bars of ≤ 35 mm thickness having a cold deformation.

2) For guidance only.

3) For rods, only the tensile strength values apply.

Table 7 — Type of process route and surface finish of sheet, plate and strip[1)]

	Abbreviation[2)]	Type of treatment	Surface finish	Notes
Hot rolled	1U	Hot rolled, not heat treated, not descaled	Covered with the rolling scale	Suitable for products which are to be further worked, e.g. strip for re-rolling
	1C	Hot rolled, heat treated, not descaled	Covered with the rolling scale	Suitable for parts which will be descaled or machined in subsequent production or for certain heat-resisting applications
	1E	Hot rolled, heat treated, mechanically descaled	Free of scale	The type of mechanical descaling, e.g. coarse grinding or shot blasting, depends on the steel and the product and is left to the manufacturer's discretion, unless otherwise agreed
	1D	Hot rolled, heat treated, pickled	Free of scale	Usually standard for most grades to ensure good corrosion resistance; also common finish for further processing. It is permissible for grinding marks to be present. Not as smooth as 2D or 2B
Cold rolled	2C	Cold rolled, heat treated, not descaled	Smooth with scale from heat treatment	Suitable for parts which will be descaled or machined in subsequent production or for certain heat-resisting applications
	2E	Cold rolled, heat treated, mechanically descaled	Rough and dull	Usually applied to grades with a scale which is very resistant to pickling solutions. May be followed by pickling
	2D	Cold rolled, heat treated, pickled	Smooth	Finish for good ductility, but not as smooth as 2B

Table 7 — Type of process route and surface finish of sheet, plate and strip[1] *(continued)*

	Abbreviation[2]	Type of treatment	Surface finish	Notes
Cold rolled	2B	Cold rolled, heat treated, pickled, skin passed	Smoother than 2D	Most common finish for most grades to ensure good corrosion resistance, smoothness and flatness. Also common finish for further processing
	2R	Cold rolled, bright annealed[3]	Smooth, bright, reflective	Smoother and brighter than 2B. Also common finish for further processing
Special finishes	1G or 2G	Ground[4]	[5]	Grade of grit or surface roughness can be specified. Unidirectional texture, not very reflective
	1J or 2J	Brushed[4] or dull polished[4]	Smoother than ground[5]	Grade of brush or polishing belt or surface roughness can be specified. Unidirectional texture, not very reflective
	1P or 2P	Bright polished[4]	[5]	Mechanical polishing. Process or surface roughness can be specified. Non-directional finish, reflective with high degree of image clarity
	2F	Cold rolled, heat treated, skin passed on roughened rolls	Uniform non-reflective matt surface	Heat treatment by bright annealing or by annealing and pickling

[1] Not all process routes and surfaces finishes are available for all grades.

[2] First digit, 1 = hot rolled; 2 = cold rolled

[3] May be skin passed.

[4] One surface only, unless specifically agreed at the time of enquiry and order.

[5] Within each finish description, the surface characteristics can vary, and more specific requirements may need to be agreed between manufacturer and purchaser (e.g. grade of grit or surface roughness).

Table 8 — • Type of process route and surface finish for long products[1)]

	Abbreviation[2)]	Type of process route	Surface finish	Form of product			Notes
				Rods	Bars sections	Semi-finish products	
Hot formed	1U	Hot formed, not heat treated, not descaled	Covered with scale; (spot ground if necessary)	X	X	X	Suitable for products to be further hot formed. For semi-finished products, ground on all sides can be specified
	1C	Hot formed, heat treated[3)], not descaled	Covered with scale (spot ground if necessary)	X	X	X	Suitable for products to be further processed. For semi-finished products, ground on all sides can be specified
	1E	Hot formed, heat treated[3)], mechanically descaled	Largely free of scale (but some black spots may remain)	X	X	X	The type of mechanical descaling, e.g. grinding, peeling or shot blasting is left to the manufacturer's discretion unless otherwise agreed. Suitable for products to be further processed
	1D	Hot formed, heat treated[3)], pickled	Free of scale	X	X	—	Tolerance ≥ IT 14[5)6)]
	1X	Hot formed, heat treated[3)], rough machined (peeled or rough turned)	Metallically clean	—	X	—	Tolerance ≥ IT 12[5)6)]
Cold processed	2H	Heat treated[3)], mechanically or chemically descaled, cold processed[4)]	Smooth and bright. Substantially smoother than finishes 1E, 1D or 1X	—	X	—	On products formed by cold drawing without subsequent heat treatment, the tensile strength is substantially increased, particularly on austenitic structure, depending on the degree of forming. Tolerance IT 9 to IT 11[5)6)]
	2D	Cold processed[4)], heat treated[3)], pickled, (skin passed)	Smoother than finishes 1E or 1D	—	X	—	Finish for good ductility (cold heading)
	2B	Heat treated[3)], machined (peeled), mechanically smoothed	Smoother and brighter than finishes IE, 1D, 1X	—	X	—	Pre-finish for close ISO-tolerances. Tolerance IT 9 to IT 11[5)6)]

[1)] Not all process routes and surface finish are available for all steels.

[2)] First digit: 1 = hot formed; 2 = cold processed.

[3)] On ferritic, austenitic and austenitic-ferritic grades, the heat treatment may be omitted if the conditions for hot forming and subsequent cooling are such that the requirements for the mechanical properties of the product are obtained.

[4)] The type of cold forming processing, e.g. cold drawing, turning, or centreless grinding, is left to the manufacturer's discretion, provided that the requirements concerning tolerances on dimensions and surface roughness are respected.

[5)] Specific tolerance within the ranges shall be agreed upon at the time of enquiry and order.

[6)] For information.

Table 9 — Tests to be carried out, test units and extent of testing in specific testing

Test	[1)]	Test unit	Product forms	Number of test piece per sample
			Flat products, rods, bars and sections	
Chemical analysis	m	cast	The cast analysis is given by the manufacturer[2)]	[2)]
Tensile test at room temperature	m	batch[3)]	1 sample per 30 t; maximum of 2 per test unit	1

[1)] Tests marked with an "m" (mandatory) shall be carried out as specific tests. In all cases, optional tests shall be carried out as specific tests only if agreed at the time of ordering.

[2)] A product analysis may be agreed at the time of ordering; the extent of testing shall be specified at the same time.

[3)] Each batch consists of products coming from the same cast having been subject to the same heat treatment cycle in the same furnace. In the case of a continuous furnace or in process annealing a batch is the lot heat treated without intermission with the same process parameters.
The shape and size of cross-sections of products in a single batch may be different providing that the ratio of the largest to the smallest areas shall be equal or less than three.

Table 10 — •• Marking of the products

Marking of	Products	
	with specific testing[1)]	without specific testing[1)]
Manufacturer's name, trade mark or logo	+	+
Number or name of the grade	+	+
Cast number	+	+
Identification number[2)]	+	(+)

[1)] The symbols in the table mean:
+ = the marking shall be applied;
(+) = the marking shall be applied if so agreed, or at the manufacturer's discretion.

[2)] If specific tests are to be carried out, the numbers or letters used for identification shall allow the product(s) to be related to the relevant inspection certificate or inspection report.

Annex A (informative)
Applicable dimensional standards

EU 17-70, *Wire rod in general purpose non-alloy steel for cold drawing or forming — Tolerances, dimensions.*

EU 58-78, *Hot rolled flats for general purposes.*

EU 59-78, *Hot rolled square bars for general purposes.*

EU 60-77, *Hot rolled round bars for general purposes.*

EU 61-82, *Hot rolled steel hexagons.*

EU 65-80, *Hot rolled round steel bars for screws and rivets.*

EN 10029, *Hot rolled steel plates 3 mm thick or above; tolerances on dimensions, shape and mass.*

EN 10048, *Hot rolled narrow steel strip: tolerances on dimensions and shape.*

EN 10051:1991 + A1:1997, *Continuously hot rolled uncoated plate, sheet and strip of non-alloy and alloy steels; tolerances on dimensions and shape.*

EN 10258, *Cold rolled stainless steel narrow strip — Tolerances on dimensions and shape.*

EN 10259, *Cold rolled stainless steel wide strip and plate/sheet — Tolerances on dimensions and shape.*

Annex B (informative)
Technical information on heat resisting steels and nickel alloys

B.1 Introduction

Property values listed in the preceding specification are requirements of delivery. Property values indicated in this annex are not requirements of delivery. The data in this annex are provided only as a guide to the relative performance of the different steels and alloys. Users should assure themselves of the actual properties achieved in practice.

B.2 Heat treatment

Information on heat treatment is given in Table B.1.

B.3 Heat resistance and embrittlement

The steels and alloys given in Tables 1 to 3 have, by virtue of their alloy content, an increased resistance to attack by hot gases and combustion products. This resistance and, consequently, the maximum service temperature of the materials is, however, largely dependent on the conditions of attack. For use in hot air under conditions where the mechanical stresses (see Tables B.3 and B.4) are unimportant with regard to service life, the maximum service temperature indicated in Table B.2 can be taken as a guide.

A warning is given that where the material is to be used in atmospheres other than hot air, then the values in Table B.2 should not be taken as applicable for the maximum temperature of use. In such cases, the rate of oxidation of the steels and alloys can be significantly increased, depending on their chemical composition, so that as a consequence the maximum temperature of use can be reduced by up to 200 °C lower than the temperatures in Table B.2.

A further warning is given for service temperatures of 600 °C to 950 °C accompanied by sigmaphase- and/or carbide-embrittlement, the latter especially in the case of ferritic steels above about 20 % Cr. The precipitation of these intermetallic phases reduces the effective chromium-contents, thus lowering heat-resistance besides the risk of brittle failure.

Note that ferritic steels operating at service temperatures in the range 350 °C to 550 °C may be subject to embrittlement. This must be considered in handling and maintenance work.

B.4 Creep resistance

In Tables B.3 and B.4, the average values of the strength for 1 % elongation ($R_{p1,0}$) and rupture (R_m) after durations of 1 000 h or 10 000 h and 100 000 h are given for guidance only. The governing factors, besides the total straining during operation, are particularly the oxidation conditions.

B.5 Physical properties

In Table B.5, the physical properties of the steels and nickel alloys are given for guidance.

B.6 Technological properties

B.6.1 The steels and alloys are suitable for hot working. The optimum hot working conditions shall, where necessary, be requested from the manufacturer.

B.6.2 The steels and alloys are suitable for cold forming. It is, however, recommended that ferritic steels may be annealed before working. Furthermore, the tendency of austenitic steels to work-harden should be noted.

B.6.3 The steels and alloys may generally be welded by the usual welding processes. It is, however, recommended that users who have no experience in welding these materials should consult the suppliers regarding appropriate welding conditions.

B.6.4 Additionally, the tendency of ferritic steels to grain growth when being annealed or welded should be taken into account.

Table B.1 — Heat treatment (for guidance only)

Designation		Heat treatment		
Name	Number	Symbol[1]	Temperature[2] °C	Type of cooling[3]
Ferritic heat resisting steels				
X10CrAlSi7	1.4713	+A	780 to 840	a, w[4]
X10CrAlSi13	1.4724	+A	800 to 860	a, w[4]
X10CrAlSi18	1.4742	+A	800 to 860	a, w[4]
X10CrAlSi25	1.4762	+A	800 to 860	a, w[4]
X18CrN28	1.4749	+A	800 to 860	a, w[4]
X3CrAlTi18-2	1.4736	+A	870 to 930	a
Austenitic heat resisting steels[6]				
X8CrNiTi18-10	1.4878	+AT	1 020 to 1 120	w, a[5]
X15CrNiSi20-12	1.4828	+AT	1 050 to 1 150	w, a[5]
X9CrNiSiNCe21-11-2	1.4835	+AT	1 020 to 1 120	w, a[5]
X12CrNi23-13	1.4833	+AT	1 050 to 1 150	w, a[5]
X8CrNi25-21	1.4845	+AT	1 050 to 1 150	w, a[5]
X15CrNiSi25-21	1.4841	+AT	1 050 to 1 150	w, a[5]
X12NiCrSi35-16	1.4864	+AT	1 020 to 1 120	w, a[5]
X10NiCrAlTi32-21	1.4876	+AT	1 050 to 1 150	w, a[5]
X6NiCrNbCe32-27	1.4877	+AT	1 050 to 1 150	w, a[5]
X25CrMnNiN25-9-7	1.4872	+AT	1 050 to 1 150	w, a[5]
X6CrNiSiNCe19-10	1.4818	+AT	1 020 to 1 120	w, a[5]
X6NiCrSiNCe35-25	1.4854	+AT	1 100 to 1 150	w, a[5]
X10NiCrSi35-19	1.4886	+AT	1 050 to 1 150	w, a[5]
X10NiCrSiNb35-22	1.4887	+AT	1 050 to 1 150	w, a[5]
Austenitic-ferritic heat resisting steel				
X15CrNiSi25-4	1.4821	+AT	1 000 to 1 100	w, a[5]
Heat resisting nickel alloys				
NiCr15Fe	2.4816	+A	950 to 1 000	w, a[5]
NiCr20Ti	2.4951	+AT	1 000 to 1 050	w, a[5]
NiCr22Mo9Nb	2.4856	+A	950 to 1 000	w, a[5]
NiCr23Fe	2.4851	+AT	1 100 to 1 200	w, a[5]
NiCr28FeSiCe	2.4889	+AT	1 150 to 1 200	w, a[5]

[1] A = annealed; AT = solution annealed.

[2] If heat treatment is carried out in a continuous furnace, the upper part of the range specified is usually preferred or even exceeded.

[3] a = air; w = water.

[4] In special cases furnace cooling is also permitted.

[5] Cooling sufficiently rapid.

[6] Heat treatment is not required in each case since the material will be exposed to high temperature when in operation.

Table B.2 — Maximum application temperature T_a for air (for guidance only)[1)]

Designation		T_a max.
Name	Number	°C
Ferritic heat resisting steels		
X10CrAlSi7	1.4713	800[2)]
X10CrAlSi13	1.4724	850[2)]
X10CrAlSi18	1.4742	1 000[2)]
X10CrAlSi25	1.4762	1 150[2)]
X18CrN28	1.4749	1 100
X3CrAlTi18-2	1.4736	1 000
Austenitic heat resisting steels		
X8CrNiTi18-10	1.4878	850[2)]
X15CrNiSi20-12	1.4828	1 000[2)]
X9CrNiSiNCe21-11-2	1.4835	1 150
X12CrNi23-13	1.4833	1 000[2)]
X8CrNi25-21	1.4845	1 050[2)]
X15CrNiSi25-21	1.4841	1 150[2)]
X12NiCrSi35-16	1.4864	1 100[2)]
X10NiCrAlTi32-21	1.4876	1 100[2)]
X6NiCrNbCe32-27	1.4877	1 150[2)]
X25CrMnNiN25-9-7	1.4872	1 150[2)]
X6CrNiSiNCe19-10	1.4818	1 050
X6NiCrSiNCe35-25	1.4854	1 170
X10NiCrSi35-19	1.4886	1 100
X10NiCrSiNb35-22	1.4887	1 100
Austenitic-ferritic heat resisting steel		
X15CrNiSi25-4	1.4821	1 100[2)]
Heat resisting nickel alloys		
NiCr15Fe	2.4816	1 150[2)]
NiCr20Ti	2.4951	1 150
NiCr22Mo9Nb	2.4856	1 000
NiCr23Fe	2.4851	1 200[2)]
NiCr28FeSiCe	2.4889	1 200

[1)] See **B.3**.

[2)] The loss of metal caused by scaling does not exceed 1 g/m^2·h at T_a, and does not exceed 2 g/m^2 at T_a + 50 °C on average for a period of 120 h with four intermediate coolings.

Table B.3 — Creep properties (for guidance only)
Estimated average value of the strength for 1 % elongation at elevated temperature[1)]

Strength in N/mm^2

Designation		Heat treatment	Elongation 1 % in 1 000 h						Elongation 1 % in 10 000 h						Elongation 1 % in 100 000 h					
Name	Number		500 °C	600 °C	700 °C	800 °C	900 °C	1000 °C	500 °C	600 °C	700 °C	800 °C	900 °C	1000 °C	500 °C	600 °C	700 °C	800 °C	900 °C	1000 °C
Ferritic heat resisting steels																				
X10CrAlSi7	1.4713																			
X10CrAlSi13	1.4724																			
X10CrAlSi18	1.4742	+A	80	27,5	8,5	3,7	1,8		50	17,5	4,7	2,1	1,0							
X10CrAlSi25	1.4762																			
X18CrN28	1.4749																			
X3CrAlTi18-2	1.4736																			
Austenitic heat resisting steels																				
X8CrNiTi18-10	1.4878	+AT		110	45	15				85	30	10								
X15CrNiSi20-12	1.4828	+AT		120	50	20	8			80	25	10	4							
X9CrNiSiNCe21-11-2	1.4835	+AT		170	66	31	15,5	(8)		126	45	19	10	(5)		80	26	11	6	(3)
X12CrNi23-13	1.4833	+AT		100	40	18	8			70	25	10	5							
X8CrNi25-21	1.4845	+AT		100	45	18	10			90	30	10	4							
X15CrNiSi25-21	1.4841	+AT		105	50	23	10	3		95	35	10	4							
X12NiCrSi35-16	1.4864	+AT		105	50	25	12			80	35	15	5			40	14	4	1,5	
X10NiCrAlTi32-21	1.4876	+AT		130	70	30	13			90	40	15	5							
X6NiCrNbCe32-27	1.4877	+AT																		
X25CrMnNiN25-9-7	1.4872	+AT			55	15	4				34	8	2							
X6CrNiSiNCe19-10	1.4818	+AT		147	61	25	9	(2,5)		126	42	15	5	(1,7)		80	26	9	3	(1,0)
X6NiCrSiNCe35-25	1.4854	+AT		150	60	26	12,5	6,5		88	34	15	8	4,5		52	21	9,7	5,1	3,0
X10NiCrSi35-19	1.4886	+AT		110	60	25	12			60	35	20	10	(4)						
X10NiCrSiNb35-22	1.4887	+AT		110	60	25	12			60	35	20	10	(4)						
Austenitic-ferritic heat resisting steel																				
X15CrNiSi25-4	1.4821	+AT	80	27,5	8,5	3,7	1,8		50	17,5	4,7	2,1	1,0							
Heat resisting nickel alloys																				
NiCr15Fe	2.4816	+A							153	91	43	18	8		126	66	28	12	4	
NiCr28FeSiCe	2.4889	+AT									25	11,9	5,9	3,1			16	7,2	3,5	1,9

[1)] Values in parentheses involve time and/or stress extrapolation.

Table B.4 — Creep properties (for guidance only)
Estimated average value of the strength for rupture at elevated temperature [1)]

Strength in N/mm^2

Designation		Heat treatment	Rupture in 1 000 h						Rupture in 10 000 h						Rupture in 100 000 h					
Name	Number		500 °C	600 °C	700 °C	800 °C	900 °C	1000 °C	500 °C	600 °C	700 °C	800 °C	900 °C	1000 °C	500 °C	600 °C	700 °C	800 °C	900 °C	1000 °C
Ferritic heat resisting steels																				
X10CrAlSi7	1.4713																			
X10CrAlSi13	1.4724																			
X10CrAlSi18	1.4742	+A	160	55	17	7,5	3,6		100	35	9,5	4,3	1,9		55	20	5	2,3	1,0	
X10CrAlSi25	1.4762																			
X18CrN28	1.4749																			
X3CrAlTi18-2	1.4736																			
Austenitic heat resisting steels																				
X8CrNiTi18-10	1.4878	+AT		200	88	30				142	48	15				65	22	10		
X15CrNiSi20-12	1.4828	+AT		190	75	35	15			120	36	18	8,5			65	16	7,5	3	
X9CrNiSiNCe21-11-2	1.4835	+AT		238	105	50	24	(12)		157	63	27	13	(7)		88	35	15	8	(4)
X12CrNi23-13	1.4833	+AT		190	75	35	15			120	36	18	8,5			65	16	7,5	3	
X8CrNi25-21	1.4845	+AT		170	80	35	15			130	40	18	8,5			80	18	7	3	
X15CrNiSi25-21	1.4841	+AT		170	90	40	20	5		130	40	20	10			80	18	7	3	
X12NiCrSi35-16	1.4864	+AT		180	75	35	15			125	45	20	8			75	25	7	3	1,5
X10NiCrAlTi32-21	1.4876	+AT		200	90	45	20			152	68	30	10			114	48	21	8	
X6NiCrNbCe32-27	1.4877	+AT								175	80	24	10	(3,5)		140	52	16	5	(1,5)
X25CrMnNiN25-9-7	1.4872	+AT			80	26	11				45	12	5							
X6CrNiSiNCe19-10	1.4818	+AT		238	105	46	18	(7)		157	63	25	10	(4)		88	35	14	5	(1,5)
X6NiCrSiNCe35-25	1.4854	+AT		200	84	41	22	12		127	56	28	15	8		80	36	18	9,2	4,8
X10NiCrSi35-19	1.4886	+AT		190	80	43	22			130	55	26	13							
X10NiCrSiNb35-22	1.4887	+AT		190	80	43	22			130	55	26	13							
Austenitic-ferritic heat resisting steel																				
X15CrNiSi25-4	1.4821	+AT	160	55	17	7,5	3,6		100	35	9,5	4,3	1,9							
Heat resisting nickel alloys																				
NiCr15Fe	2.4816	+A		160	96	38	22	11	297	138	63	29	13	7	215	97	42	17	7	
NiCr20Ti	2.4951	+AT				37	20	11		100	36	17	10	6		68	23	11,5	7	5
NiCr22Mo9Nb	2.4856	+A			260	107	34				190	63	20							
NiCr23Fe	2.4851	+AT		264	153	60	20			205	101	31	10	5		156	55	17	4	2
NiCr28FeSiCe	2.4889	+AT									40	19	9,5	5,9			28	13	5,9	3

[1)] Values in parentheses involve time and/or stress extrapolation.

Table B.5 — Physical properties for the steels and nickel alloys (for guidance only)

Designation		Density	Linear expansion coefficient $10^{-6}k^{-1}$ between 20 °C and					Thermal conductivity W/(m.K)		Specific heat capacity kJ(kg.k)	Electrical resistivity Ω.mm²/m	Magnetizability
Name	Number	kg/dm²	200 °C	400 °C	600 °C	800 °C	1 000 °C	at 20 °C	at 500 °C	at 20 °C	at 20 °C	
Ferritic heat resisting steels												
X8CrAlSi7	1.4713	7,7	11,5	12,0	12,5	13,0	—	23	25	0,45	0,70	yes
X10CrAlSi13	1.4724	7,7	10,5	11,5	12,0	12,5	—	21	23	0,50	0,75	yes
X10CrAlSi18	1.4742	7,7	10,5	11,5	12,0	12,5	13,5	19	25	0,50	0,93	yes
X10CrAlSi25	1.4762	7,7	10,5	11,5	12,0	12,0	13,5	17	23	0,50	1,1	yes
X18CrN28	1.4749	7,7	10,0	11,0	11,5	12,0	13,0	17	23	0,50	0,70	yes
X3CrAlTi18-2	1.4736	7,7	10,5	10,8	12,0	12,5	13,0	21	23	0,50	0,60	yes
Austenitic heat resisting steels												
X8CrNiTi18-10	1.4878	7,9	17,0	18,0	18,5	19,0	—	15	—	0,50	0,73	no[1)]
X15CrNiSi20-12	1.4828	7,9	16,5	17,5	18,0	18,5	19,5	15	21	0,50	0,85	no[1)]
X9CrNiSiNCe21-11-2	1.4835	7,8	17,0	18,0	18,5	19,0	19,5	15	21	0,50	0,85	no[1)]
X12CrNi23-13	1.4833	7,9	16,0	17,5	18,0	18,5	19,5	15	19	0,50	0,78	no[1)]
X8CrNi25-21	1.4845	7,9	15,5	17,0	17,5	18,5	19,0	15	19	0,50	0,85	no[1)]
X15CrNiSi25-21	1.4841	7,9	15,5	17,0	17,5	18,0	19,0	15	19	0,50	0,90	no[1)]
X12NiCrSi35-16	1.4864	8,0	15,0	16,0	17,0	17,5	18,5	12,5	17	0,55	1,0	no[1)]
X10NiCrAlTi32-21	1.4876	8,0	15,0	16,0	17,0	17,5	18,5	12	17	0,55	1,0	no[1)]
X6NiCrNbCe32-27	1.4877	8,0	15,5	16,5	16,5	17,7	18,4	12	20	0,45	0,96	no[1)]
X25CrMnNiN25-9-7	1.4872	7,8	16,5	18,0	18,5	19,0	19,5	14,5	20	0,50	0,75	no[1)]
X6CrNiSiNCe19-10	1.4818	7,8	16,5	18,0	18,5	19,0	20,0	15	21	0,50	0,85	no[1)]
X6NiCrSiNCe35-25	1.4854	7,9	15,5	16,5	17,0	17,5	18,0	11	18,5	0,45	1,0	no[1)]
X10NiCrSi35-19	1.4886	8,0	15,5	16,0	17,0	17,7	18,0	12	19,5	0,46	1,0	no[1)]
X10NiCrSiNb35-22	1.4887	8,0	15,5	16,0	17,0	17,7	18,0	12	19,5	0,46	1,0	no[1)]
Austenitic-ferritic heat resisting steel												
X15CrNiSi25-4	1.4821	7,7	13,0	13,5	14,0	14,5	15,0	17	23	0,50	0,90	yes
Heat resisting nickel alloys												
NiCr15Fe	2.4816	8,4	13,9	14,5	15,3	16,2	16,8	15	22	0,46	1,03	[2)]
NiCr20Ti	2.4951	8,4	12,7	13,9	15,0	16,5	18,2	12	20	0,46	1,09	[2)]
NiCr22Mo9Nb	2.4856	8,4	11,1	12,6	13,8	14,9	15,8	10	17	0,41	1,29	[2)]
NiCr23Fe	2.4851	8,1	14,4	14,8	15,7	16,7	17,7	11,3	19,2	0,45	1,19	[2)]
NiCr28FeSiCe	2.4889	8,0	14,5	15,4	16,2	17,0	17,8	13	21	0,50	1,18	[2)]

[1)] Slightly magnetic when cold worked.

[2)] Paramagnetic.

Annex C (informative)
Bibliography

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EN 10088-2, *Stainless steels — Part 2: Technical delivery conditions for sheet/plate and strip for general purposes.*

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prEN 10272[1)], *Stainless steel bars for pressure purposes.*

Annex D (informative)
Grades from EN 10088-1 and prEN 10028-7 used as heat resisting steels

Steels from EN 10088-1		Steels from prEN 10028-7	
Name	**Number**	**Name**	**Number**
X2CrTi12	1.4512		
X6Cr13	1.4000		
X6Cr17	1.4016		
X3CrTi17	1.4510	X3CrTi17	1.4510
X2CrNbZr17[*)]	1.4590[*)]		
X2CrTiNb18	1.4509	X2CrTiNb18	1.4509
X12Cr13	1.4006		
X5CrNi18-10	1.4301	X5CrNi18-10	1.4301
		X6CrNi18-10	1.4948
X6CrNiTi18-10	1.4541	X6CrNiTi18-10	1.4541
		X7CrNiTiB18-10	1.4941
		X6CrNi23-13	1.4950
		X6CrNi25-20	1.4951
X2CrNiN23-4[*)]	1.4362[*)]	X2CrNiN23-4[*)]	1.4362[*)]

[*)] Patented steel grade.

[1)] At present at the stage of draft.

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