

# **Heat resisting steels and nickel alloys**

## **耐热钢和镍基合金**

This British Standard, having been prepared under the direction of the Sector Committee for Engineering, was published under the authority of the Standards Committee and comes into effect on 15 July 1999

本英国标准已在工程设计分委员会指导下编制完成,并经标准委员会授权于1999年7月15日出版发行。

The European Standard EN 10095:1999 has the status of a British Standard ICS 77.140.10

本EN 10095:1999欧洲标准与ICS 77.140.10英国标准等效。

**NO COPYING WITHOUT BSI PERMISSION EXCEPT AS PERMITTED BY COPYRIGHT LAW 版权所有,翻印必究。**

Licensed Copy: Institute Of Technology Tallaght, Institute of Technology, Sat Jun 30 03:32:18 GMT+00:00 2007, Uncontrolled Copy, (c) BSI

## National foreword (英国) 国家标准前言

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 It supersedes BS 1449-2:1983, which is withdrawn, and the requirements for heat resisting steel 310S S31 detailed in BS 970-1 (Section 5):1996

本英国标准系EN10095: 1999英文版。它替代了作废的BS 1449-2: 1983标准, 并替代了BS970-1: 1996标准(第5节)细述的310S31耐热钢的要求。

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

BS 1449-2标准中所列两个钢规格与BS EN 10095标准中等值的两个钢规格可以相互参照如下:

BS 1449-2标准中所列两个钢

Steels in BS 1449-2	Nearest equivalent steel in BS EN 10095
BS 1449-2标准中所列钢	BS EN 10095标准中等值的钢

309S24 Cr Ni 23/14	X12CrNi23-13 1.4833
--------------------	---------------------

310S24 Cr Ni 24/20	X8CrNi25-21 1.4845
--------------------	--------------------

(以下略译)

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.

A British Standard does not purport to include all the necessary provisions of a contract. Users of British Standards are responsible for their correct application.

**Compliance with a British Standard does not of itself confer immunity from legal obligations.**

### 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.

The BSI copyright notice displayed throughout this document indicates when this document was last issued.

English version (英文版)

## Heat resisting steels and nickel alloys 耐热钢和镍基合金

This European Standard was approved by CEN on 1 March 1999.  
本欧洲标准由欧洲标准化委员会 (CEN) 于1999年3月批准。

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.

CEN成员共同遵守CEN/CENELEC 内部规程, 本标准规定给予本欧洲标准以国家标准的地位, 且不作任何变更。有关这些国家标准的最新列表和目录可从中央秘书处或任何CEN成员处获得。

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.

本欧洲标准现有英文版、法文版和德文版3个正式版本。任何一个由CEN成员负责翻译的本国语言版本, 在通报中央秘书处后均具有正式版本的同等地位。

CEN members are the national standards bodies of Austria, Belgium, Czech Republic, Denmark, Finland, France, Germany, Greece, Iceland, Ireland, Italy, Luxembourg, Netherlands, Norway, Portugal, Spain, Sweden, Switzerland and United Kingdom.

CEN成员包括奥地利、比利时、丹麦、芬兰、法国、德国、希腊、冰岛、爱尔兰、意大利、卢森堡、荷兰、挪威、葡萄牙、西班牙、瑞典、瑞士和英国的国家标准化组织。

## Foreword 前言

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 目录

Foreword 前言

1 Scope 适用范围

2 Normative references 引用标准

3 Definitions 定义

4 Classification and designation 分类及名称

4.1 Classification 分类

4.2 Designation 名称

5 Information to be supplied by the Purchaser 采购商提供的信息

5.1 Mandatory information 随机信息

5.2 Options 任选信息

6 Manufacturing process 制造 工艺

6.1 General 概述

6.2 Delivery condition 交货条件

7 Requirements 技术要求

7.1 General 概述

7.2 Chemical composition 化学成分

7.3 Mechanical properties 机械性能

7.4 Surface quality 表面质量

7.5 Dimensions and tolerances on Dimensions 尺寸和尺寸允差

7.6 Calculation of mass and tolerances on Mass 质量计算和质量允差

8 Inspection and testing 检验和试验

8.1 General 概述

8.2 Types and contents of inspection Documents 检验文件形式和目录

8.3 Specific inspection and testing 特殊检验和试验

8.4 Test methods 试验方法

8.5 Retest 重试

9 Marking 标识

Annex A (informative) Applicable dimensional standards 参考附录A 适用尺寸标准

Annex B (informative) Technical information on heat resisting steels and nickel alloys 参考附录B 耐热钢和镍基合金技术信息

Annex C (informative) Bibliography 参考附录C 参考文献

Annex D (informative) Grades from EN 10088-1 and prEN 10028-7 used as heat resisting steels 参考附录D 耐热钢和镍基合金用EN 10088-1 and prEN 10028-7标准等级

## 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 8C.

**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.

---

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.

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 168-861), *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

### **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 90022).

### **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.

---

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

## **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.

### **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 Tensile	<b>Round cross-section products</b>	<b>Rectangular cross-section products</b>	
	$d \leq 25$ $25 < d \leq 160$	$b \leq 25$ $25 < b \leq 160$	$a \geq b$ $a \geq b$

Figure 1-- Position of test pieces for steel bars and rods # 160 mm diameter or thickness (longitudinal test pieces) 图1 - 直径或厚度 (矩形试样) ≤160 mm 钢条和钢棒试样取样位置

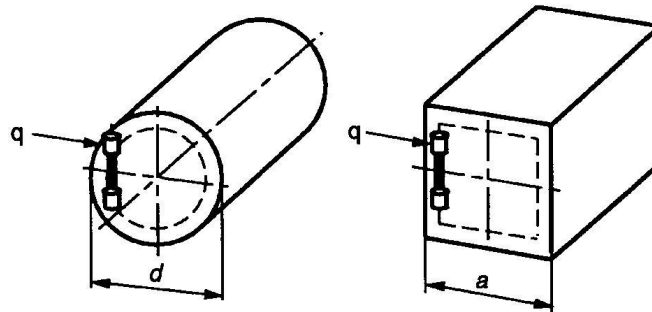
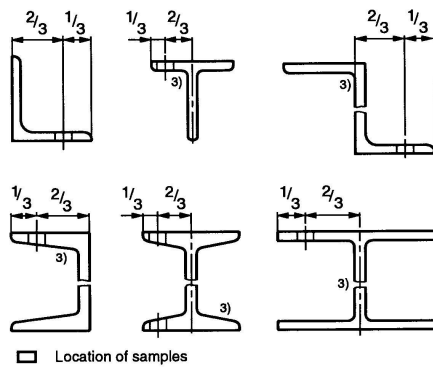
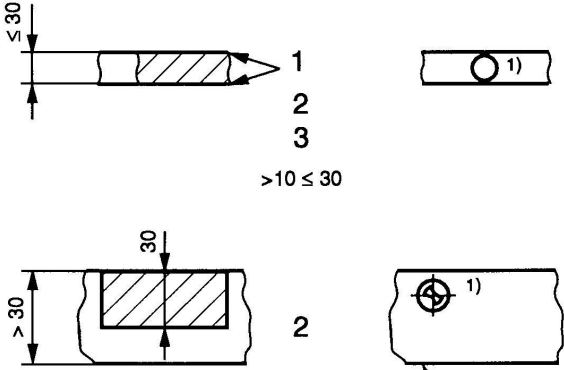


Figure 2 -- Position of test pieces for steel bars > 160 mm diameter or thickness [transverse test pieces (q)] 图1 - 直径或厚度 [绕曲试样(q)] >160 mm 钢条试样取样位置



3) By agreement, the sample can be taken from the web, at a quarter of the total height.  
根据协议, 在总高度1/4处, 可以从腹板取样

Figure 3D Position of test pieces for beams, channels, angles, T sections and Z sections  
图3 - T-形剖面 and Z-形剖面型钢、槽钢和角钢试样取样位置

Type of test piece 试件形式	Thickness Products 厚轧材  mm	Direction of the longitudinal axis of the test pieces in relation to the principal direction of rolling at a product width of在轧材上轧制试样时轧制主方向有关的纵轴向方向  < 300 mm    ≥300 mm		Distance of test piece from the rolled surface  mm
Tensile1)	≤30 — > 30	Longitudinal 矩形	Transverse 绕曲形	 <p>1. Rolled surface 轧制面 2. Or 或 3. For 用于</p>

1) In cases of doubt or dispute the gauge length shall be  $L_0 = 5,65 \sqrt{S_0}$  for test piece from products  $S \leq 3$  mm. 如有疑问或争议，对于从厚度  $\leq 3$  mm 轧材上所取试样的长度  $L_0 = 5,65 \sqrt{S_0}$ 。

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:

对于从厚度  $< 3$  mm 轧材上取样，应使用长度为 80 mm，宽度为 20 mm

-- 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  $\leq 5$  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**

扁平轧材抗拉试样取样位置

**Table 1 -- Chemical composition (cast analysis)1) of ferritic heat-resisting steels**  
**表1 --铁素体耐热钢化学成分（熔炼分析）**

Steel designation		% by mass							
Name	Number	C	Si	Mn最高	P最高	S最高	Cr	Al	Others
X10CrAlSi7	1.4713	max. 0,12	0,50 ~ 1,00	1,00	0,040	0,015	6,00 ~ 8,00	0,5 ~ 1,0	
X10CrAlSi13	1.4724	max. 0,12	0,70~ 1,40	1,00	0,040	0,015	12,0 ~ 14,0	0,7 ~ 1,2	
X10CrAlSi18	1.4742	max. 0,12	0,70 ~ 1,40	1,00	0,040	0,015	17,0 ~ 19,0	0,7 ~ 1,2	
X10CrAlSi25	1.4762	max. 0,12	0,70 ~ 1,40	1,00	0,040	0,015	23,0 ~ 26,0	1,2 ~ 1,7	
X18CrN28	1.4749	0,15 ~ 0,20	max. 1,00	1,00	0,040	0,015	26,0 ~ 29,0	--	N: 0,15 to 0,25
X3CrAlTi18-2	1.4736	max. 0,04	max. 1,00	1,00	0,040	0,015	17,0 ~ 18,0	1,7 ~ 2,1	0,2 + 4(C + N) # Ti # 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**  
**表2 --奥氏体耐热钢和奥氏体-铁素体耐热钢化学成分（熔炼分析）**

Steel designation 钢号		% by mass 质量百分比								
Name 名称	Number 材料号	C	Si	Mn	P最高	S最高	Cr	Ni	N	Others其他
<b>Austenitic heat-resisting steels 奥氏体耐热钢</b>										
X8CrNiTi18-10	1.4878	最高0,10	最高1,00	最高2,00	0,045	0,015	17,00~ 19,00	9,00~ 12,00		Ti: 5×3 % C ≤ Ti ≤ 0,80
X15CrNiSi20-12	1.4828	最高0,20	1,50~2,50	最高 2,00	0,045	0,015	19,00~21,00	11,00~13,00	最高0,11	
X9CrNiSiNCe21-11-2	1.4835	0,05~0,12	1,40~2,50	最高 1,00	0,045	0,015	20,00~22,00	10,00~12,00	0,12~ 0,20	Ce: 0,03 ~ 0,08
X12CrNi23-13	1.4833	最高0,15	最高 1,00	最高 2,00	0,045	0,015	22,00~24,00	12,00~14,00	最高0,11	
X8CrNi25-21	1.4845	最高0,10	最高1,50	最高 2,00	0,045	0,015	24,00~26,00	19,00~22,00	最高0,11	
X15CrNiSi25-21	1.4841	最高0,20	1,50~2,50	最高 2,00	0,045	0,015	24,00~26,00	19,00~22,00	最高0,11	
X12NiCrSi35-16	1.4864	最高0,15	1,00~2,00	最高 2,00	0,045	0,015	15,00~17,00	33,00~37,00	最高0,11	
X10NiCrAlTi32-21	1.4876	最高0,12	最高1,00	最高 2,00	0,030	0,015	19,00~23,00	30,00~34,00		Al: 0,15 ~ 0,60 Ti: 0,15 ~ 0,60
X6NiCrNbCe32-27	1.4877	0,04~0,08	最高0,30	最高 1,00	0,020	0,010	26,00~28,00	31,00~33,00	最高0,11	Al: max. 0,025 Ce: 0,05 ~ 0,10 Nb: 0,60 ~ 1,00

X25CrMnNiN25-9-7	1.4872	0,20~0,30	最高1,00	8,00~10,00	0,045	0,015	24,00~26,00	6,00~8,00	0,20~0,40	
X6CrNiSiNCe19-10	1.4818	0,04~0,08~	1,00~2,00	最高1,00	0,045	0,015	18,00~20,00	9,00~11,00	0,12~0,20	Ce: 0,03 ~ 0,08
X6NiCrSiNCe35-25*)	1.4854	0,04~0,08~	1,20~2,00	最高2,00	0,040	0,015	24,00~26,00	34,00~36,00	0,12~0,20	Ce: 0,03 ~ 0,08
X10NiCrSi35-19	1.4886	最高0,15	1,00~2,00	最高2,00	0,030	0,015	17,00~20,00	33,00~37,00	最高0,11	
X10NiCrSiNb35-22	1.4887	最高0,15	1,00~2,00	最高2,00	0,030	0,015	20,00~23,00	33,00~37,00	最高0,11	Nb: 1,00 ~ 1,50
<b>Austenitic-ferritic heat-resisting steel 奥氏体-铁素体耐热钢</b>										
X15CrNiSi25-4	1.4821	0,10~0,20	0,8~1,50	最高2,00	0,040	0,015	24,50~26,50	3,50~5,50	最高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 奥氏体镍基合金化学成分（熔炼分析）**

Alloy designation 合金名称		% by mass 质量百分比															
Name名称	Number 材料号	C	Mn 最高	Si 最高	P 最高	S 最高	Ni	Cr	Co	Fe	Mo	Al	Ti	Cu 最高	Nb + Ta	B 最高	Ce
NiCr15Fe	2.4816	0,05~0,10	1,00	0,50	0,020	0,015	最低72,00	14,0~17,0	2)	6,00~ 10,00		最高 0,30	最高 0,30	0,50			
NiCr20Ti	2.4951	0,08~0,15	1,00	1,00	0,020	0,015	余量	18,0~21,0	最高5,0	最高 5,00		最高 0,30	0,20~ 0,60	0,50			
NiCr22Mo9Nb	2,4856	0,03~0,10	0,50	0,50	0,020	0,015	最低58,00	20,0~23,0	最高1,0	最高 5,00	8,0~ 10,0	最高 0,40	最高 0,40	0,50	3,15~4,15		
NiCr23Fe	2,4851	0,03~0,10	1,00	0,50	0,020	0,015	58,00~63,0	21,0~25,0	2)	最高 18,0		1,00~ 1,70	最高 0,50	0,50		0,005	
NiCr28FeSiCe	2,4889	0,08~0,12	1,00	2,5~3,0	0,020	0,015	最低45,00	26,0~29,0	2)	21,0~ 25,00				0,30			0,03~0 ,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)

表4 – 钢材规定分析和产品分析之间允许偏差（见表1和表2）

Element	Cast analysis (Specified limits) 规定范围铸造分析%	Permissible deviations 1) from the specified composition 规定分析允许偏差1) %
C	$\leq 0,030$	$\pm 0,005$
	$> 0,030 \leq 0,20$	$\pm 0,01$
	$> 0,20 \leq 0,30$	$\pm 0,02$
Si	$\leq 1,00$	$\pm 0,05$
	$> 1,00 \leq 2,50$	$\pm 0,10$
Mn	$\leq 1,00$	$+0,03$
	$> 1,00 \leq 2,00$	$+0,04$
	$> 2,00 \leq 10,00$	$\pm 0,10$
P	$\leq 0,045$	$+0,005$
S	$\leq 0,015$	$+0,003$
	$> 0,015 \leq 0,030$	$+0,005$
N	$\geq 0,05 \leq 0,40$	$\pm 0,02$
Al	$\leq 0,15$	$\pm 0,05$
	$> 0,15 \leq 2,10$	$\pm 0,10$
Cr	$\leq 10,00$	$\pm 0,10$
	$> 10,00 \leq 15,00$	$\pm 0,15$
	$> 15,00 \leq 20,00$	$\pm 0,20$
	$> 20,00 \leq 29,00$	$\pm 0,25$
Ni	$\leq 1,00$	$\pm 0,03$
	$> 1,00 \leq 5,00$	$\pm 0,07$
	$> 5,00 \leq 10,00$	$\pm 0,10$
	$> 10,00 \leq 20,00$	$\pm 0,15$
	$> 20,00 \leq 32,00$	$\pm 0,20$
	$> 32,00 \leq 37,00$	$\pm 0,25$
Nb	$\leq 1,00$	$\pm 0,05$
Ti	$\leq 0,80$	$\pm 0,05$
Ce	$\leq 0,10$	$\pm 0,01$
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)**

**表5 – 镍基合金规定分析和产品分析之间允许偏差（见表3）**

<b>Element</b>	<b>Cast analysis (Specified limits) 规定范围铸造分析质量%</b>	<b>Permissible deviations 1) from the specified composition 规定分析允许偏差 1) 质量 %</b>
C	≤0,15	±0,01
Si	≤0,50 >0,50≤1,00	±0,03 ±0,05
Mn	≤1,00	+0,03
P	≤0,020	+0,005
S	≤0,015	+0,005
Al	≤0,40 >0,40≤1,70	+0,05 ±0,10
B	≤0,006	+0,0005
Ce	≤0,09	±0,005
Co	≤1,00 >1,00≤5,00	±0,03 ±0,05
Cr	≤15,00 >15,00≤20,00 >20,00≤29,00	±0,15 ±0,20 ±0,25
Cu	≤0,50	±0,03
Fe	≤5,00 >5,00≤10,00	±0,07 ±0,10
Mo	≤10,00	±0,15
Nb + Ta	≤4,15	±0,15
Ni	>40,00≤60,00 >60,00≤80,00	±0,35 ±0,45
Ti	≤0,30 >0,30≤0,60	±0,03 ±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 牌号		Product		Heat treatment condition	HB max. 1) 2) 3)	Proof strength		Tensile strength Rm N/mm <sup>2</sup> 1)	A % min.			
Name 钢号	Number 材料号	Form	Thickness <i>a</i> or diameter <i>d</i> mm			Rp0,2 N/mm <sup>2</sup> min. 3)	Rp1,0 N/mm <sup>2</sup> min.3)		Long products	Flat products		0,5 # <i>a</i> < 3
<b>ferritic heat-resisting steels 铁素体耐热钢</b>												
X10CrAlSi7	1.4713	Flat products	a≤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≤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≤25	+A	212	280		500 to 700	15	13	15	15
X3CrAlTi18-2	1.4736			+A	200	280		500 to 650	—	25	25	25
<b>Austenitic heat-resisting steels 奥氏体耐热钢</b>												
X8CrNiTi18-10	1.4878	Flat products	a≤75	+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	
X9CrNiSiN21-11-2	1.4835			+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	Bars	d≤160	+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			+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			Rods and sections	d≤25	+AT	311	500	540	850 to 1050	25 1)	—
X6CrNiSiN21-11-2	1.4818	+AT	210			290	330	600 to 800	40 1)	30	40	
X6NiCrSiN21-11-2	1.4854	+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<sup>2</sup> 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 牌号		Product		Heat treatment condition	HB max. 1) 2) 3)	Proof strength $R_{p0.2}$ N/mm <sup>2</sup> min. 3)	Tensile strength $R_m$ N/mm <sup>2</sup> 1)	A % min.										
Name 钢号	Number 材料号	Form	Thickness $a$ or diameter $d$ mm					Long products	Flat products									
									0,5 # $a < 3$		3 < $a$							
<b>Austenitic-ferritic heat resisting steel 奥氏体 -- 铁素体耐热钢</b>																		
X15CrNiSi25-4	1,4821	Flat rodcts	$a \leq 12$	+AT	235	400	600 to 850	16	—	16	12							
		bars	$d \leq 60$															
		rods	$d \leq 25$															
<b>Heat resisting nickel alloys 耐热镍基合金</b>																		
NiCr15Fe	2,4816	Flat rodcts	$a \leq 75$	+A	200	240	550~850	30	30									
		bars	$d \leq 160$															
		rods	$d \leq 25$															
NiCr20Ti	2,4951	Flat rodcts	$a \leq 75$	+AT	230	240	650~850	30	—									
		bars	$d \leq 160$															
		rods	$d \leq 25$															
NiCr22Mo9Nb	2,4856	Flat rodcts	$S \leq a < 75$	+A	240	380	760~1000	—	—	30	30							
			$a < 3$									bars	$100 < d \leq 250$	415	820~1050	—	30	—
		$d \leq 100$	345										760~1000	25	—	—	—	
		$d \leq 25$	415										820~1050	30	—	—	—	
		rods	$d \leq 25$									415	820~1050	30	—	—	—	
NiCr23Fe	2,4851	Flat rodcts	$a \leq 12$	+AT	220	205	550~750	30	—	30	30							
		bars	$d \leq 60$															
		rods	$d \leq 25$															
NiCr28FeSiCe	2,4889	Flat rodcts	$a \leq 12$	+AT	220	240	620~820	35	35	35	35							
		bars	$d \leq 60$															
1) The maximum HB values may be raised by 100 units or the maximum tensile strength value may be raised by 200 N/mm <sup>2</sup> 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 7 — Type of process route and surface finish of sheet, plate and strip<sup>1)</sup>**

	<b>Abb.2)</b>	<b>Type of treatment</b>	<b>Surface finish</b>	<b>Notes</b>
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	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
Cold rolled	2B	Cold rolled, heat treated, pickled, skin passed	Smother 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 <sup>3)</sup>	Smooth, bright, reflective	Smother and brighter than 2B. Also common finish for further processing
Special finishes	1G or 2G	Ground <sup>4)</sup>	5)	Grade of grit or surface roughness can be specified. Unidirectional texture, not very reflective
	1J or 2J	Brushed <sup>4)</sup> or dull polished <sup>4)</sup>	Smother than ground <sup>5)</sup>	Grade of brush or polishing belt or surface roughness can be specified. Unidirectional texture, not very reflective
	1P or 2P	Bright polished <sup>4)</sup>	5)	Mechanical polishing. Process or surface roughness can be specified. Non-directional finish, reflective with high degree of image clarity
	2F	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 products1)**

	Abbreviation2)	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 treated3), 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 treated3), 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 treated3), pickled	Free of scale	X	X	∅	Tolerance $\geq$ IT 145)6)
	1X	Hot formed, heat treated3), rough machined (peeled or rough turned)	Metallically clean	∅	X	∅	Tolerance $\geq$ IT 125)6)
Cold processed	2H	Heat treated3), mechanically or chemically descaled,	Smooth and bright. Substantially	∅	X	∅	On products formed by cold drawing without subsequent heat

		cold processed <sup>4)</sup>	smoother than finishes 1E, 1D or 1X				treatment, the tensile strength is substantially increased, particularly on austenitic structure, depending on the degree of forming. Tolerance IT 9 to IT 115) <sup>6)</sup>
	2D	Cold processed <sup>4)</sup> , heat treated <sup>3)</sup> , pickled, (skin passed)	Smoother than finishes 1E or 1D	Đ	X	Đ	Finish for good ductility (cold heading)
	2B	Heat treated <sup>3)</sup> , machined (peeled), mechanically smoothed	Smoother and brighter than finishes 1E, 1D, 1X	Đ	X	Đ	Pre-finish for close ISO-tolerances. Tolerance IT 9 to IT 115) <sup>6)</sup>

- 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 <sup>2)</sup>	2)
Tensile test at room temperature	m	batch <sup>3)</sup>	1 sample per 30 t; maximum of 2 per test unit	1

- 1) Tests marked with an <sup>a</sup>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 D · Marking of the products**


**Marking of Products**

**with specific testing1) without specific testing1)**

Manufacturer's name, trade mark or logo + +

Number or name of the grade + +

Cast number + +

Identification number2) + (+)

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.

Licensed Copy: Institute Of Technology Tallaght, Institute of Technology, Sat Jun 30 03:32:18 GMT+00:00 2007, Uncontrolled Copy, (c) BSI

**Page 20**

**EN 10095:1999**

BSI 07-1999

**Annex A (informative)**

**Applicable dimensional standards**

EU 17-70, *Wire rod in general purpose non-alloy steel for cold drawing or forming*  $\bar{D}$  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*  $\Delta$  *Tolerances on dimensions and shape.*

EN 10259, *Cold rolled stainless steel wide strip and plate/sheet*  $\Delta$  *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 sigma phase- 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.

Licensed Copy: Institute Of Technology Tallaght, Institute of Technology, Sat Jun 30 03:32:18 GMT+00:00 2007, Uncontrolled Copy, (c) BSI

**Page 21**

**EN 10095:1999**

BSI 07-1999

**Table B.1 D Heat treatment (for guidance only)**

**Designation Heat treatment**

**Name Number Symbol<sup>1)</sup> Temperature<sup>2)</sup> Type of cooling<sup>3)</sup>**

**8C**

**Ferritic heat resisting steels**

X10CrAlSi7 1.4713 +A 780 to 840 a, w<sup>4)</sup>

X10CrAlSi13 1.4724 +A 800 to 860 a, w<sup>4)</sup>

X10CrAlSi18 1.4742 +A 800 to 860 a, w<sup>4)</sup>

X10CrAlSi25 1.4762 +A 800 to 860 a, w<sup>4)</sup>

X18CrN28 1.4749 +A 800 to 860 a, w<sup>4)</sup>

X3CrAlTi18-2 1.4736 +A 870 to 930 a

**Austenitic heat resisting steels<sup>6)</sup>**

X8CrNiTi18-10 1.4878 +AT 1 020 to 1 120 w, a<sup>5)</sup>

X15CrNiSi20-12 1.4828 +AT 1 050 to 1 150 w, a<sup>5)</sup>

X9CrNiSiNCe21-11-2 1.4835 +AT 1 020 to 1 120 w, a<sup>5)</sup>

X12CrNi23-13 1.4833 +AT 1 050 to 1 150 w, a<sup>5)</sup>

X8CrNi25-21 1.4845 +AT 1 050 to 1 150 w, a<sup>5)</sup>

X15CrNiSi25-21 1.4841 +AT 1 050 to 1 150 w, a<sup>5)</sup>

X12NiCrSi35-16 1.4864 +AT 1 020 to 1 120 w, a5)  
X10NiCrAlTi32-21 1.4876 +AT 1 050 to 1 150 w, a5)  
X6NiCrNbCe32-27 1.4877 +AT 1 050 to 1 150 w, a5)  
X25CrMnNiN25-9-7 1.4872 +AT 1 050 to 1 150 w, a5)  
X6CrNiSiNcCe19-10 1.4818 +AT 1 020 to 1 120 w, a5)  
X6NiCrSiNcCe35-25 1.4854 +AT 1 100 to 1 150 w, a5)  
X10NiCrSi35-19 1.4886 +AT 1 050 to 1 150 w, a5)  
X10NiCrSiNb35-22 1.4887 +AT 1 050 to 1 150 w, a5)

**Austenitic-ferritic heat resisting steel**

X15CrNiSi25-4 1.4821 +AT 1 000 to 1 100 w, a5)

**Heat resisting nickel alloys**

NiCr15Fe 2.4816 +A 950 to 1 000 w, a5)

NiCr20Ti 2.4951 +AT 1 000 to 1 050 w, a5)

NiCr22Mo9Nb 2.4856 +A 950 to 1 000 w, a5)

NiCr23Fe 2.4851 +AT 1 100 to 1 200 w, a5)

NiCr28FeSiCe 2.4889 +AT 1 150 to 1 200 w, a5)

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.

Licensed Copy: Institute Of Technology Tallaght, Institute of Technology, Sat Jun 30 03:32:18 GMT+00:00 2007, Uncontrolled Copy, (c) BSI

**Page 22**

**EN 10095:1999**

BSI 07-1999

**Table B.2 D Maximum application temperature  $T_a$  for air (for guidance only)<sup>1)</sup>**

**Designation**  $T_a$  max.

**Name Number** 8C

**Ferritic heat resisting steels**

X10CrAlSi7 1.4713 8002)

X10CrAlSi13 1.4724 8502)

X10CrAlSi18 1.4742 1 0002)

X10CrAlSi25 1.4762 1 1502)

X18CrN28 1.4749 1 100

X3CrAlTi18-2 1.4736 1 000

### **Austenitic heat resisting steels**

X8CrNiTi18-10 1.4878 8502)  
X15CrNiSi20-12 1.4828 1 0002)  
X9CrNiSiNcCe21-11-2 1.4835 1 150  
X12CrNi23-13 1.4833 1 0002)  
X8CrNi25-21 1.4845 1 0502)  
X15CrNiSi25-21 1.4841 1 1502)  
X12NiCrSi35-16 1.4864 1 1002)  
X10NiCrAlTi32-21 1.4876 1 1002)  
X6NiCrNbCe32-27 1.4877 1 1502)  
X25CrMnNiN25-9-7 1.4872 1 1502)  
X6CrNiSiNcCe19-10 1.4818 1 050  
X6NiCrSiNcCe35-25 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 1002)

### **Heat resisting nickel alloys**

NiCr15Fe 2.4816 1 1502)  
NiCr20Ti 2.4951 1 150  
NiCr22Mo9Nb 2.4856 1 000  
NiCr23Fe 2.4851 1 2002)  
NiCr28FeSiCe 2.4889 1 200

1) See **B.3**.

2) The loss of metal caused by scaling does not exceed 1 g/m<sup>2</sup> h at  $T_a$ , and does not exceed 2 g/m<sup>2</sup> at  $T_a + 50$  8C on average for a period of 120 h with four intermediate coolings.

Licensed Copy: Institute Of Technology Tallaght, Institute of Technology, Sat Jun 30 03:32:18 GMT+00:00 2007, Uncontrolled Copy, (c) BSI

**Page 23**

**EN 10095:1999**

BSI 07-1999

**Table B.3D Creep properties (for guidance only)**

**Estimated average value of the strength for 1% elongation at elevated temperature<sup>1)</sup>**

Strength in N/mm<sup>2</sup>

**Designation Heat**

**treatment**

**Elongation 1 % in 1 000 h Elongation 1 % in 10 000 h Elongation 1 % in 100 000 h**

Name Number 500 8C 600 8C 700 8C 800 8C 900 8C 1000 8C 500 8C 600 8C 700 8C 800 8C 900 8C 1000 8C 500 8C 600 8C 700 8C 800 8C 900 8C 1000 8C

**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  
X9CrNiSiNc21-11-2 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  
X6CrNiSiNc19-10 1.4818 +AT 147 61 25 9 (2,5) 126 42 15 5 (1,7) 80 26 9 3 (1,0)  
X6NiCrSiNc35-25 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.

Licensed Copy: Institute Of Technology Tallaght, Institute of Technology, Sat Jun 30 03:32:18 GMT+00:00 2007, Uncontrolled Copy, (c) BSI  
BSI 07-1999

Page 24

EN 10095:1999

Table B.4D Creep properties (for guidance only)

Estimated average value of the strength for rupture at elevated temperature<sup>1)</sup>

Strength in N/mm<sup>2</sup>

**Designation Heat treatment**

**Rupture in 1 000 h Rupture in 10 000 h Rupture in 100 000 h**

**Name Number 500 8C 600 8C 700 8C 800 8C 900 8C 1000 8C 500 8C 600 8C 700 8C 800 8C 900 8C 1000 8C 500 8C 600 8C 700 8C 800 8C 900 8C 1000 8C**

**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

X9CrNiSiN21-11-2 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

X6CrNiSiN21-11-2 1.4818 +AT 238 105 46 18 (7) 157 63 25 10 (4) 88 35 14 5 (1,5)

X6NiCrSiN21-11-2 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.

Licensed Copy: Institute Of Technology Tallaght, Institute of Technology, Sat Jun 30 03:32:18 GMT+00:00 2007, Uncontrolled Copy, (c) BSI

**Page 25**

**EN 10095:1999**

BSI 07-1999

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

**Designation Density Linear expansion coefficient**

1026k21

**between 20 °C and**

**Thermal conductivity**

W/(m.K)

**Specific heat**

**capacity**

kJ(kg.k)

**Electrical**

**resistivity**

V.mm<sup>2</sup>/m

**Magnetizability**

**Name Number kg/dm<sup>3</sup> 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 13,0 D 23 25 0,45 0,70 yes

X10CrAlSi13 1.4724 7,7 10,5 11,5 12,0 12,5 D 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 D 15 D 0,50 0,73 no1)

X15CrNiSi20-12 1.4828 7,9 16,5 17,5 18,0 18,5 19,5 15 21 0,50 0,85 no1)

X9CrNiSiNc21-11-2 1.4835 7,8 17,0 18,0 18,5 19,0 19,5 15 21 0,50 0,85 no1)

X12CrNi23-13 1.4833 7,9 16,0 17,5 18,0 18,5 19,5 15 19 0,50 0,78 no1)

X8CrNi25-21 1.4845 7,9 15,5 17,0 17,5 18,5 19,0 15 19 0,50 0,85 no1)

X15CrNiSi25-21 1.4841 7,9 15,5 17,0 17,5 18,0 19,0 15 19 0,50 0,90 no1)

X12NiCrSi35-16 1.4864 8,0 15,0 16,0 17,0 17,5 18,5 12,5 17 0,55 1,0 no1)

X10NiCrAlTi32-21 1.4876 8,0 15,0 16,0 17,0 17,5 18,5 12 17 0,55 1,0 no1)



X6NiCrNbCe32-27 1.4877 8,0 15,5 16,5 16,5 17,7 18,4 12 20 0,45 0,96 no1)  
X25CrMnNiN25-9-7 1.4872 7,8 16,5 18,0 18,5 19,0 19,5 14,5 20 0,50 0,75 no1)  
X6CrNiSiNcCe19-10 1.4818 7,8 16,5 18,0 18,5 19,0 20,0 15 21 0,50 0,85 no1)  
X6NiCrSiNcCe35-25 1.4854 7,9 15,5 16,5 17,0 17,5 18,0 11 18,5 0,45 1,0 no1)  
X10NiCrSi35-19 1.4886 8,0 15,5 16,0 17,0 17,7 18,0 12 19,5 0,46 1,0 no1)  
X10NiCrSiNb35-22 1.4887 8,0 15,5 16,0 17,0 17,7 18,0 12 19,5 0,46 1,0 no1)

#### **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.

Licensed Copy: Institute Of Technology Tallaght, Institute of Technology, Sat Jun 30 03:32:18 GMT+00:00 2007, Uncontrolled Copy, (c) BSI

#### **Page 26**

#### **EN 10095:1999**

BSI 07-1999

1) At present at the stage of draft.

#### **Annex C (informative)**

#### **Bibliography**

prEN 10028-71), *Flat products made of steels for pressure purposes* Part 7: *Stainless steels*.

EN 10088-1, *Stainless steels* Part 1: *List of stainless steels*.

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

EN 10088-3, *Stainless steels* Part 3: *Technical delivery conditions for semi-finished products, bars, rods and sections for general purposes*.

prEN 10151, *Stainless steel wire and strip for springs* Technical delivery conditions for strip.

EN 10213-4, *Technical delivery conditions for steel*

*castings for pressure purposes* Part 4: Austenitic and austenitic-ferritic steel grades.

prEN 10222-51), *Forgings for pressure purposes* Part 5: Austenitic, martensitic and austenitic-ferritic stainless steels.

prEN 10250-41), *Open die steel forgings for general engineering purposes* Part 4: Stainless steels.

prEN 10263-51), *Steel rod, bars and steel wire for cold heading and cold extrusion* Part 5: Technical delivery conditions for stainless steels.

prEN 10270-31), *Steel wire for mechanical springs* Part 3: Stainless spring wire.

prEN 102721), *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.

Licensed Copy: Institute Of Technology Tallaght, Institute of Technology, Sat Jun 30 03:32:18 GMT+00:00 2007, Uncontrolled Copy, (c) BSI  
*blank*

**BS EN**

**10095:1999**

BSI  
389 Chiswick High Road  
London  
W4 4AL



**BSI British Standards Institution**

BSI is the independent national body responsible for preparing British Standards. It presents the UK view on standards in Europe and at the international level. It is incorporated by Royal Charter.

**Revisions**

British Standards are updated by amendment or revision. Users of British Standards should make sure that they possess the latest amendments or editions.

It is the constant aim of BSI to improve the quality of our products and services. We would be grateful if anyone finding an inaccuracy or ambiguity while using this British Standard would inform the Secretary of the technical committee responsible, the identity of which can be found on the inside front cover. Tel: 020 8996 9000.

Fax: 020 8996 7400.

BSI offers members an individual updating service called PLUS which ensures that subscribers automatically receive the latest editions of standards.

**Buying standards**

Orders for all BSI, international and foreign standards publications should be addressed to Customer Services. Tel: 020 8996 9001. Fax: 020 8996 7001.

In response to orders for international standards, it is BSI policy to supply the BSI implementation of those that have been published as British Standards, unless otherwise requested.

**Information on standards**

BSI provides a wide range of information on national, European and international standards through its Library and its Technical Help to Exporters Service. Various BSI electronic information services are also available which give details on all its products and services. Contact the Information Centre. Tel: 020 8996 7111.

Fax: 020 8996 7048.

Subscribing members of BSI are kept up to date with standards developments and receive substantial discounts on the purchase price of standards. For details of these and other benefits contact Membership Administration. Tel: 020 8996 7002.

Fax: 020 8996 7001.

**Copyright**

Copyright subsists in all BSI publications. BSI also holds the copyright, in the UK, of the publications of the international standardization bodies. Except as permitted under the Copyright, Designs and Patents Act 1988 no extract may be reproduced, stored in a retrieval system or transmitted in any form or by any means ± electronic, photocopying, recording or otherwise ± without prior written permission from BSI. This does not preclude the free use, in the course of implementing the standard, of necessary details such as symbols, and size, type or grade designations. If these details are to be used for any other purpose than implementation then the prior written permission of BSI must be obtained.

If permission is granted, the terms may include royalty payments or a licensing agreement. Details and advice can be obtained from the Copyright Manager.

Tel: 020 8996 7070.

GMT+00:00 2007, Uncontrolled Copy, (c) BSI