EUROPEAN STANDARD **EN 10088-3**

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Descriptors: iron- and steel products, hot rolled products, drawing : forming process, semi-finished products, metal bars, wire rod, metal sections, stainless steels, delivery, designation, dimensions, dimensional tolerances, chemical composition, grades : quality, classifications, mechanical properties, tests, marking

English version

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

Aciers inoxydables - Partie 3: Conditions techniques de livraison pour les demi-produits, barres, fils machine et profils pour usage général

Nichtrostende Stähle - Teil 3: Technische Lieferbedingungen für Halbzeug, Stäbe, Walzdraht und Profile für allgemeine Verwendung

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

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## Vorwort

Diese Europäische Norm wurde vom SC 1 "Stainless steels" vom Technischen Komitee ECISS/TC 23 "Für eine Wärmebehandlung bestimmte Stähle, legierte Stähle und Automatenstähle - Gütenormen" erarbeitet, dessen Sekretariat vom DIN betreut wird.

Diese Europäische Norm ersetzt:

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|---|---|
| EU 88-2:1986 | Nichtrostende Stähle - Teil 2: Technische Lieferbedingungen für Blech und Band für allgemeine Verwendung |

Diese Europäische Norm muß den Status einer nationalen Norm erhalten, entweder durch Veröffentlichung eines identischen Textes oder durch Anerkennung bis Oktober 1995, und etwaige entgegenstehende nationale Normen müssen bis Oktober 1995 zurückgezogen werden.

Entsprechend der CEN/CENELEC-Geschäftsordnung sind folgende Länder gehalten, diese Europäische Norm zu übernehmen: Belgien, Dänemark, Deutschland, Finnland, Frankreich, Griechenland, Irland, Island, Italien, Luxemburg, Niederlande, Norwegen, Österreich, Portugal, Schweden, Schweiz, Spanien und das Vereinigte Königreich.

## 1 Scope

**1.1** This part of EN 10088 specifies the technical delivery conditions for semi-finished products, hot or cold formed bars, rods and sections of standard grades and special grades of stainless steels for general purposes.

NOTE:
Here and in the following are understood
- under the term "general purposes" purposes other than the special purposes mentioned in Annex C;
- under the term "standard grades" grades with a relative good availability and a wider range of application;
- under the term "special grades" grades for special use and/or with limited availability.

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

**1.3** This European Standard does not apply to components manufactured by further processing the product forms listed in 1.1 with quality characteristics altered as a result of such further processing.

## 2 Normative references

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

| | |
|---|---|
| EN 10002-1 | Metallic materials - Tensile testing - Part 1: Method of test (at ambient temperature) |
| EN 10002-5 | Metallic materials - Tensile testing - Part 5: Method of test at elevated temperature |
| EN 10003-1[1)] | Metallic materials - Hardness test - Brinell - Part 1: Test method |

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

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|---|---|
| EURONORM 18[2)] | Selection and preparation of samples and test pieces for steel and iron and steel products |
| EN 10021 | General technical delivery requirements for steel and steel 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 10 045-1 | Metallic materials - Charpy impact test - Part 1: Method of test |
| EN 10052 | Vocabulary of heat treatment terms for ferrous products |
| EN 10079 | Definition of steel products |
| EN 10088-1 | Stainless steels - Part 1: List of stainless steels |
| EURONORM 114[2)] | Determination of the resistance to intergranular corrosion of austenitic stainless steels: corrosion test in a sulphuric acid-copper sulphate medium (Monypenny-Strauss test) |
| EURONORM 168[2)] | Iron and steel products - Inspection documents - Contents |
| EN 10204 | Metallic products - Types of inspection documents |
| EN 10221 | Surface quality classes for hot-rolled bars and rods - Technical delivery conditions |

See also Annex B.

## 3 Definitions

### 3.1 Stainless steels

The definition in EN 10088-1 applies.

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2) 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.

### 3.2 Product forms

The definitions in EN 10079 apply.

### 3.3 Types of heat treatment

The definitions in EN 10052 apply.

## 4 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 B (see also Table 6).

## 5 Calculation of mass and tolerances on mass

**5.1** When calculating the nominal mass from the nominal dimensions the values given in EN 10088-1 shall be used as a basis for the density of the steel concerned.

**5.2** If the tolerances on mass are not specified in the dimensional standard listed in Annex B, they may be agreed at the time of enquiry and order.

## 6 Designation and ordering

### 6.1 Designation of steel grades

The steel names and steel numbers (see Tables 1 to 4) were formed in accordance with EN 10027-1 and EN 10027-2 respectively.

### 6.2 Designation to be used on ordering

The complete designation for ordering a product according to this European Standard shall contain the following information:

- the desired quantity;
- the product form (e. g. bar or rod);
- where an appropriate dimensional standard is available (see Annex B) the number of the standard plus any choice of requirements;
  if there is no dimensional standard, the nominal dimensions and tolerances required;
- the type of material (steel);
- the number of this European Standard;
- the steel name or steel number;

- if for the relevant steel in the table for the mechanical properties more than one treatment condition is covered, the symbol for the desired heat treatment or cold worked condition;
- the desired process route (see symbols in Table 6);
- if an inspection document is required, its designation in accordance with EN 10204.

**Example:**

10 t rounds of a steel grade with the name X5CrNi18-10 and the number 1.4301 as specified in EN 10088-3 of 50 mm diameter, dimensional tolerances as specified in EURONORM 60, in process route 1D (see Table 6), inspection document 3.1.B as specified in EN 10204:

10 t rounds EURONORM 60 - 50
Steel EN 10088-3-X5CrNi18-10+1D
Inspection document 3.1.B
or
10 t rounds EURONORM 60 - 50
Steel EN 10088-3-1.4301+1D
Inspection document 3.1.B

## 7 Classification of grades

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

- ferritic steels,
- martensitic steels,
- precipitation hardening steels,
- austenitic steels,
- austenitic-ferritic steels.

See also NOTE in 1.1 and Annex B to EN 10088-1.

## 8 Requirements

### 8.1 Production process

Unless a special steel-making process is agreed when ordering, the steel-making process for steels conforming to this European Standard shall be at the discretion of the manufacturer.

### 8.2 Delivery condition

The products shall be supplied in the delivery condition agreed in the order by reference to the process route given in Table 6 and, where different alternatives exist, to the treatment conditions

given in Tables 7 to 11 and 17 (see also Annex A).

**8.3 Chemical composition**

**8.3.1** The chemical composition requirements given in Tables 1 to 4 apply in respect of the chemical composition according to the cast analysis.
**8.3.2** The product analysis may deviate from the limiting values for the cast analysis given in Tables 1 to 4 by the values listed in Table 5.

**8.4 Chemical corrosion properties**

Referring to resistance to intergranular corrosion as defined in EURONORM 114, for ferritic, austenitic and austenitic-ferritic stainless steels the specifications in Tables 7, 10 and 11 apply.

NOTE 1: EURONORM 114 is not applicable for testing martensitic and precipitation hardening steels.

NOTE 2: The corrosion resistance of stainless steels is very dependant on the type of environment and can therefore not always be clearly ascertained through laboratory tests. It is therefore advisable to draw on the available experience of the use of the steels.

**8.5 Mechanical properties**

**8.5.1** The mechanical properties at room temperature as specified in Tables 7 to 11 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 Tables 7, 8, 9, 10 and 11 shall be obtainable from reference test pieces which have received the appropriate heat treatment (simulated heat treatment).

For cold worked products, the mechanical properties at room temperature as specified in Table 17 apply.

NOTE: Austenitic steels are insensitive to brittle fracture in the solution annealed condition. Because they do not have a pronounced transition temperature, which is characteristic of other steels, they are also useful for application at cryogenic temperatures.

8.5.2 The values in Tables 12 to 16 apply for the 0,2 % and 1 % proof strength at elevated temperatures.

## 8.6 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, where appropriate, on the basis of EN 10221.

## 8.7 Internal soundness

For the internal soundness, where appropriate, requirements together with the conditions for their verification may be agreed at the time of enquiry and order.

# 9 Testing

## 9.1 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 of steel 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.

## 9.2 Agreement on tests and inspection documents

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

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

9.2.3 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 9.3 are to be carried out and the following informations shall be given in the inspection document with the code numbers and details required by EURONORM 168:

a)
b) } As under 9.2.2 a) and b).
c) The results of the mandatory tests marked in Table 18, second column, by a m.
d) The results of any optional test or inspections agreed when ordering.

## 9.3 Specific inspection and testing

### 9.3.1 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 in Table 18.

### 9.3.2 Selection and preparation of samples

9.3.2.1 The specifications of Euronorm 18 shall be observed in sampling and sample preparation. The stipulations in 9.3.2.2 apply additionally for the mechanical tests.

9.3.2.2 The samples for the tensile test shall be taken in accordance with Figures 1 to 3. If it has been agreed that impact tests shall be carried out, the samples shall be taken from the same location.

The samples shall be taken from products in the delivery condition. If agreed, samples from bars may be taken before straightening. For samples to be given a simulated heat treatment the conditions for annealing, hardening and tempering shall be agreed.

9.3.2.3 Samples for the hardness test and for the resistance to intergranular corrosion test, where requested, shall be taken from the same locations as those for the mechanical tests.

**9.4 Test methods**

**9.4.1** 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.

**9.4.2** The tensile test at room temperature shall be carried out in accordance with EN 10002-1, this generally being with 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 these test pieces shall be used.

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

**9.4.3** If a tensile test at elevated temperature has been ordered, this shall be carried out in accordance with EN 10002-5. If the proof strength is to be verified, the 0,2 %-proof strength shall be determined, for ferritic, martensitic, precipitation hardening and austenitic-ferritic steels. In the case of austenitic steels the 0,2 % and the 1 % proof strength shall be determined.

**9.4.4** If an impact test has been ordered, it shall be carried out in accordance with EN 10045-1 on test pieces with a V-notch. The average obtained from three test pieces is considered to be the test result (see also EN 10021).

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

**9.4.6** The resistance to intergranular corrosion shall be tested in accordance with Euronorm 114.

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

**9.5 Retests**

See EN 10021.

## 10 Marking

**10.1** Marking shall be durable.

**10.2** Unless otherwise agreed, the requirements listed in Table 19 apply.

**10.3** Unless otherwise agreed, the products shall be marked as follows:

- semi-finished products, bars and sections in thicknesses over 35 mm by inking, adhesive labels, electrolytic etching or stamping;

- bars and sections in thicknesses up to 35 mm by labels attached to the bundle or by means of the possibilities listed in the first hyphen;

- rods by means of a label attached to the coil.

NOTE:
If the marking is to be applied by inking or adhesive label, the inks or adhesives should be carefully selected to ensure that resistance to corrosion is not impaired.

*(dimensions in mm)*

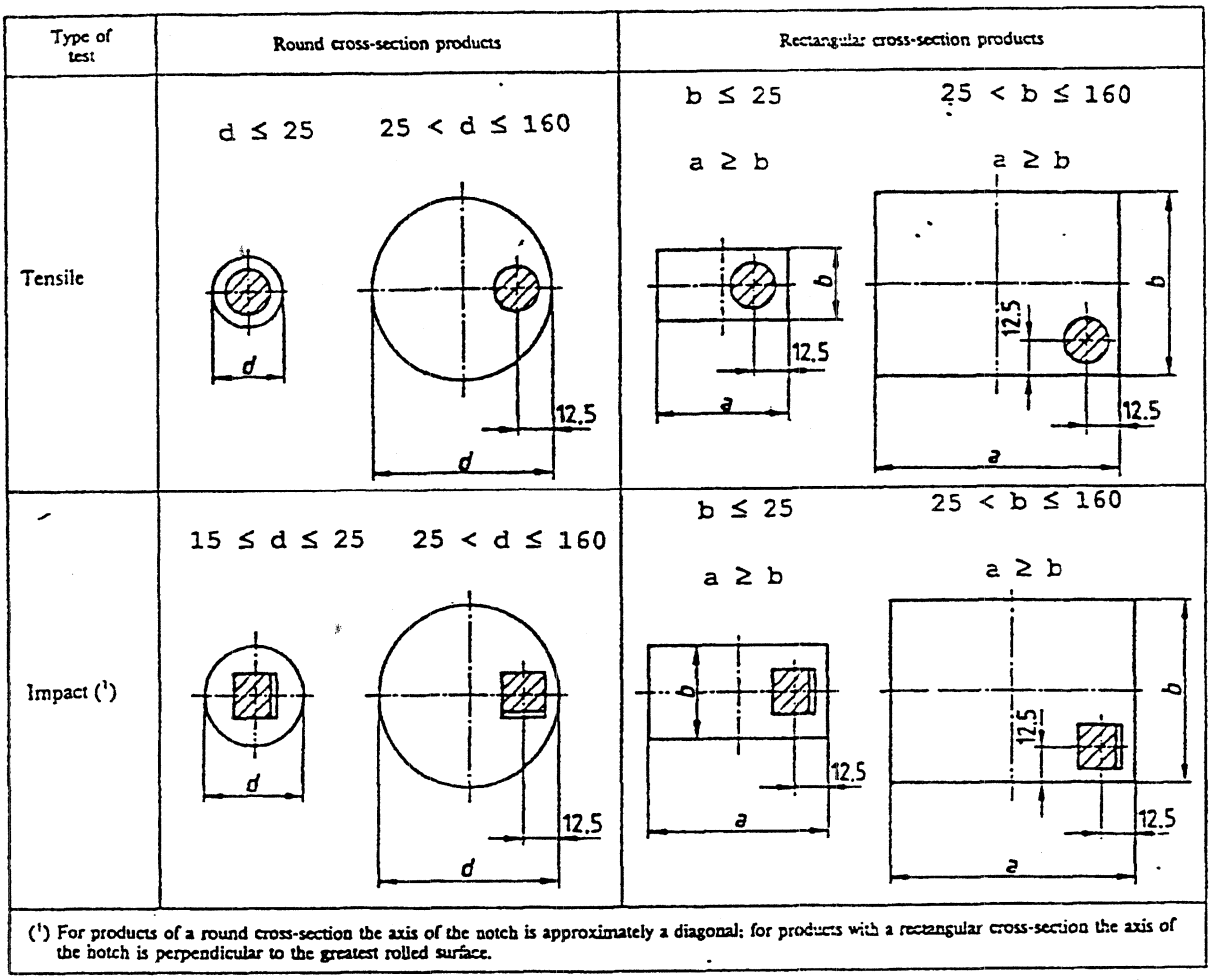


**Figure 1:** Position of test pieces for steel bars and rods ≤160 mm diameter or thickness (longitudinal test pieces)

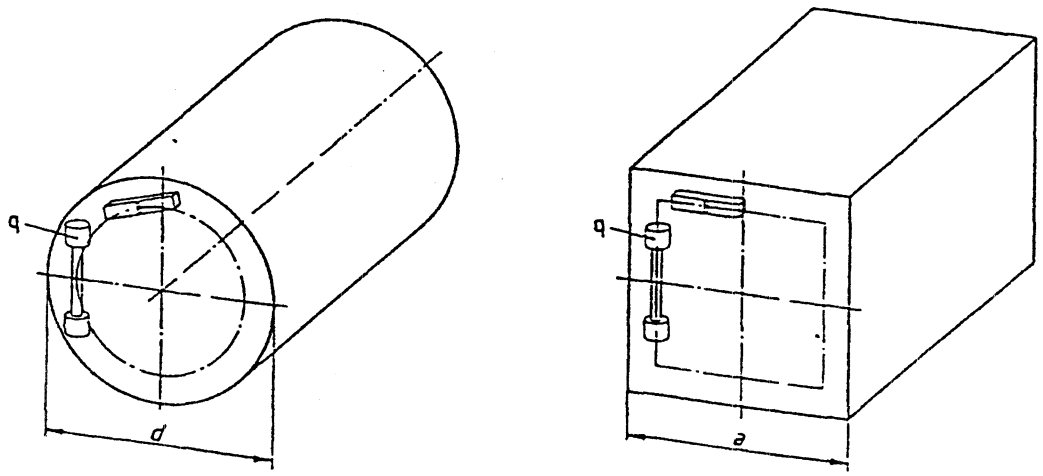


**Figure 2:** Position of test pieces for steel bars > 160 mm diameter or thickness (transverse test pieces)

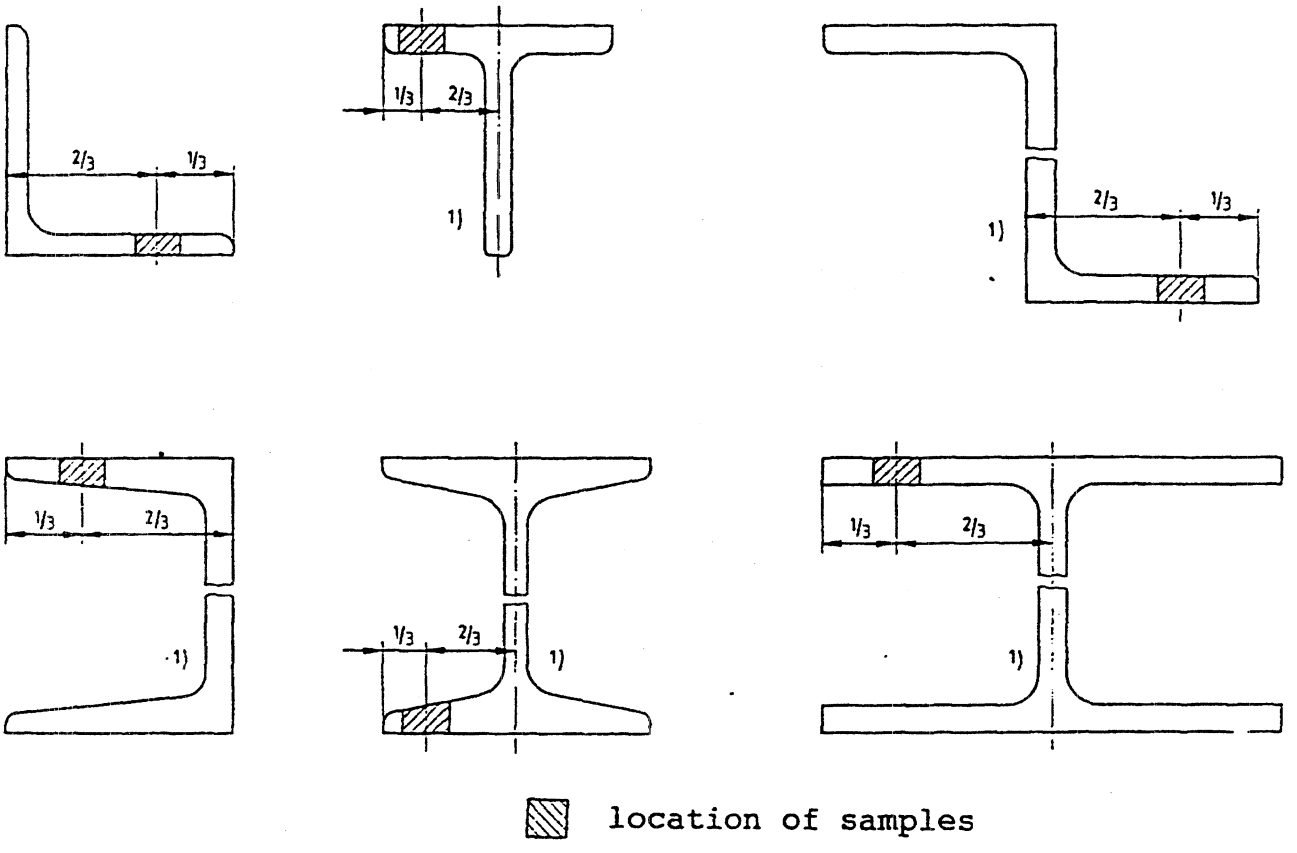


**Figure 3**: Position of test pieces for beams, channels, angles, T sections and Z sections

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

**Table 1:** Chemical composition (cast analysis) [1] of ferritic stainless steels

| Steel designation | | % by mass | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| name | number | C max. | Si max. | Mn max. | P max. | S | N max. | Cr | Mo | Ni | Ti | Others |
| **Standard grades** | | | | | | | | | | | | |
| X2CrNi12 | 1.4003 | 0,030 | 1,00 | 1,50 | 0,040 | ≤ 0,015 | 0,030 | 10,50 to 12,50 | | 0,30 to 1,00 | | |
| X6Cr13 | 1.4000 | 0,08 | 1,00 | 1,00 | 0,040 | ≤ 0,030[2] | | 12,00 to 14,00 | | | | |
| X6Cr17 | 1.4016 | 0,08 | 1,00 | 1,00 | 0,040 | ≤ 0,030[2] | | 16,00 to 18,00 | | | | |
| X6CrMoS17 | 1.4105 | 0,08 | 1,50 | 1,50 | 0,040 | 0,15 to 0,35 | | 16,00 to 18,00 | 0,20 to 0,60 | | | |
| X6CrMo17-1 | 1.4113 | 0,08 | 1,00 | 1,00 | 0,040 | ≤ 0,030[2] | | 16,00 to 18,00 | 0,90 to 1,40 | | | |
| **Special grade** | | | | | | | | | | | | |
| X2CrMoTiS18-2[3] | 1.4523[3] | 0,030 | 1,00 | 0,50 | 0,040 | 0,15 to 0,35 | | 17,50 to 19,00 | 2,00 to 2,50 | | 0,30 to 0,80 | (C + N) ≤ 0,040 |

[1] Elements not quoted in this 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 the addition of such elements from scrap and other materials used in production which would impair mechanical properties and the suitability of the steel.

[2] For products to be machined a controlled sulfur content of 0,015 to 0,030 % is recommended.

[3] Patented steel grade.

**Table 2:** Chemical composition (cast analysis)[1] of martensitic and precipitation hardening stainless steels

| Steel designation | | % by mass | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| name | number | C | Si max. | Mn max. | P max. | S | Cr | Cu | Mo | Nb | Ni | Others |
| **Standard grades (Martensitic steels[2])** | | | | | | | | | | | | |
| X12 Cr13 | 1.4006 | 0,08 to 0,15 | 1,00 | 1,50 | 0,040 | ≤ 0,030[3] | 11,50 to 13,50 | | | | ≤ 0,75 | |
| X12CrS13 | 1.4005 | 0,08 to 0,15 | 1,00 | 1,50 | 0,040 | 0,15 to 0,35 | 12,00 to 14,00 | | ≤ 0,60 | | | |
| X20Cr13 | 1.4021 | 0,16 to 0,25 | 1,00 | 1,50 | 0,040 | ≤ 0,030[3] | 12,00 to 14,00 | | | | | |
| X30Cr13 | 1.4028 | 0,26 to 0,35 | 1,00 | 1,50 | 0,040 | ≤ 0,030[3] | 12,00 to 14,00 | | | | | |
| X39Cr13 | 1.4031 | 0,36 to 0,42 | 1,00 | 1,00 | 0,040 | ≤ 0,030[3] | 12,50 to 14,50 | | | | | |
| X46Cr13 | 1.4034 | 0,43 to 0,50 | 1,00 | 1,00 | 0,040 | ≤ 0,030[3] | 12,50 to 14,50 | | | | | |
| X50CrMoV15 | 1.4116 | 0,45 to 0,55 | 1,00 | 1,00 | 0,040 | ≤ 0,030[3] | 14,00 to 15,00 | | 0,50 to 0,80 | | | V : 0,10 to 0,20 |
| X14CrMoS17 | 1.4104 | 0,10 to 0,17 | 1,00 | 1,50 | 0,040 | 0,15 to 0,35 | 15,50 to 17,50 | | 0,20 to 0,60 | | | |
| X39CrMo17-1 | 1.4122 | 0,33 to 0,45 | 1,00 | 1,50 | 0,040 | ≤ 0,030[3] | 15,50 to 17,50 | | 0,80 to 1,30 | | ≤ 1,00 | |
| X17CrNi16-2 | 1.4057 | 0,12 to 0,22 | 1,00 | 1,50 | 0,040 | ≤ 0,030[3] | 15,00 to 17,00 | | | | 1,50 to 2,50 | |
| X3CrNiMo13-4 | 1.4313 | ≤ 0,05 | 0,70 | 1,50 | 0,040 | ≤ 0,015 | 12,00 to 14,00 | | 0,30 to 0,70 | | 3,50 to 4,50 | N: ≥ 0,020 |
| X4CrNiMo16-5-1 | 1.4418 | ≤ 0,06 | 0,70 | 1,50 | 0,040 | ≤ 0,030[3] | 15,00 to 17,00 | | 0,80 to 1,50 | | 4,00 to 6,00 | N: ≥ 0,020 |
| **Standard grades (Precipitation hardening steels)** | | | | | | | | | | | | |
| X5CrNiCuNb16-4 | 1.4542 | ≤ 0,07 | 0,70 | 1,50 | 0,040 | ≤ 0,030[3] | 15,00 to 17,00 | 3,00 to 5,00 | ≤ 0,60 | 5 x C to 0,45 | 3,00 to 5,00 | |
| X7CrNiAl17-7 | 1.4568 | ≤ 0,09 | 0,70 | 1,00 | 0,040 | ≤ 0,015 | 16,00 to 18,00 | | | | 6,50 to 7,80[4] | Al : 0,70 to 1,50 |
| X5CrNiMoCuNb14-5 | 1.4594 | ≤ 0,07 | 0,70 | 1,00 | 0,040 | ≤ 0,015 | 13,00 to 15,00 | 1,20 to 2,00 | 1,20 to 2,00 | 0,15 to 0,60 | 5,00 to 6,00 | |
| **Special grades (Martensitic steels[2])** | | | | | | | | | | | | |
| X29CrS13 | 1.4029 | 0,25 to 0,32 | 1,00 | 1,50 | 0,040 | 0,15 to 0,25 | 12,00 to 13,50 | | ≤ 0,60 | | | |
| X70CrMo15 | 1.4109 | 0,65 to 0,75 | 0,70 | 1,00 | 0,040 | ≤ 0,030[3] | 14,00 to 16,00 | | 0,40 to 0,60 | | | |
| X105CrMo17 | 1.4125 | 0,95 to 1,20 | 1,00 | 1,00 | 0,040 | ≤ 0,030[3] | 16,00 to 18,00 | | 0,40 to 0,60 | | | |
| X90CrMoV18 | 1.4112 | 0,85 to 0,95 | 1,00 | 1,00 | 0,040 | ≤ 0,030[3] | 17,00 to 19,00 | | 0,90 to 1,30 | | | V : 0,07 to 0,12 |

[1] Elements not quoted in this 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 the addition of such elements from scrap and other materials used in production which would impair mechanical properties and the suitability of the steel.

[2] Tighter carbon ranges may be agreed at the time of enquiry and order.

[3] For products to be machined a controlled sulfur content of 0,015 to 0,030 % is recommended.

[4] For better cold deformability, the upper limit may be increased to 6,30 %.

## Table 3: Chemical composition (cast analysis)[1] of austenitic stainless steels

| Steel designation | | % by mass | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| name | number | C | Si | Mn | P max. | S | N | Cr | Cu | Mo | Nb | Ni | Ti |
| **Standard grades** | | | | | | | | | | | | | |
| X10CrNi18-8 | 1.4310 | 0,05 to 0,15 | ≤ 2,00 | ≤ 2,00 | 0,045 | ≤ 0,015 | ≤ 0,11 | 16,00 to 19,00 | | ≤ 0,80 | | 6,00 to 9,50 | |
| X2CrNi18-9 | 1.4307 | ≤ 0,030 | ≤ 1,00 | ≤ 2,00 | 0,045 | ≤ 0,030[2] | ≤ 0,11 | 17,50 to 19,50 | | | | 8,00 to 10,00 | |
| X2CrNi19-11 | 1.4306 | ≤ 0,030 | ≤ 1,00 | ≤ 2,00 | 0,045 | ≤ 0,030[2] | ≤ 0,11 | 18,00 to 20,00 | | | | 10,00 to 12,00[3] | |
| X2CrNiN18-10 | 1.4311 | ≤ 0,030 | ≤ 1,00 | ≤ 2,00 | 0,045 | ≤ 0,030[2] | 0,12 to 0,22 | 17,00 to 19,50 | | | | 8,50 to 11,50 | |
| X5CrNi18-10 | 1.4301 | ≤ 0,07 | ≤ 1,00 | ≤ 2,00 | 0,045 | ≤ 0,030[2] | ≤ 0,11 | 17,00 to 19,50 | | | | 8,00 to 10,50 | |
| X8CrNiS18-9 | 1.4305 | ≤ 0,10 | ≤ 1,00 | ≤ 2,00 | 0,045 | 0,15 to 0,35 | ≤ 0,11 | 17,00 to 19,00 | ≤ 1,00 | | | 8,00 to 10,00 | |
| X6CrNiTi18-10 | 1.4541 | ≤ 0,08 | ≤ 1,00 | ≤ 2,00 | 0,045 | ≤ 0,030[2] | | 17,00 to 19,00 | | | | 9,00 to 12,00[3] | 5 x C to 0,70 |
| X4CrNi18-12 | 1.4303 | ≤ 0,06 | ≤ 1,00 | ≤ 2,00 | 0,045 | ≤ 0,030[2] | ≤ 0,11 | 17,00 to 19,00 | | | | 11,00 to 13,00 | |
| X2CrNiMo17-12-2 | 1.4404 | ≤ 0,030 | ≤ 1,00 | ≤ 2,00 | 0,045 | ≤ 0,030[2] | ≤ 0,11 | 16,50 to 18,50 | | 2,00 to 2,50 | | 10,00 to 13,00[3] | |
| X2CrNiMoN17-11-2 | 1.4406 | ≤ 0,030 | ≤ 1,00 | ≤ 2,00 | 0,045 | ≤ 0,030[2] | 0,12 to 0,22 | 16,50 to 18,50 | | 2,00 to 2,50 | | 10,00 to 12,00[3] | |
| X5CrNiMo17-12-2 | 1.4401 | ≤ 0,07 | ≤ 1,00 | ≤ 2,00 | 0,045 | ≤ 0,030[2] | ≤ 0,11 | 16,50 to 18,50 | | 2,00 to 2,50 | | 10,00 to 13,00 | |
| X6CrNiMoTi17-12-2 | 1.4571 | ≤ 0,08 | ≤ 1,00 | ≤ 2,00 | 0,045 | ≤ 0,030[2] | | 16,50 to 18,50 | | 2,00 to 2,50 | | 10,50 to 13,50[3] | 5 x C to 0,70 |
| X2CrNiMo17-12-3 | 1.4432 | ≤ 0,030 | ≤ 1,00 | ≤ 2,00 | 0,045 | ≤ 0,030[2] | ≤ 0,11 | 16,50 to 18,50 | | 2,50 to 3,00 | | 10,50 to 13,00 | |
| X2CrNiMoN17-13-3 | 1.4429 | ≤ 0,030 | ≤ 1,00 | ≤ 2,00 | 0,045 | ≤ 0,015 | 0,12 to 0,22 | 16,50 to 18,50 | | 2,50 to 3,00 | | 11,00 to 14,00[3] | |
| X3CrNiMo17-13-3 | 1.4436 | ≤ 0,05 | ≤ 1,00 | ≤ 2,00 | 0,045 | ≤ 0,030[2] | ≤ 0,11 | 16,50 to 18,50 | | 2,50 to 3,00 | | 10,50 to 13,00 | |
| X2CrNiMo18-14-3 | 1.4435 | ≤ 0,030 | ≤ 1,00 | ≤ 2,00 | 0,045 | ≤ 0,030[2] | ≤ 0,11 | 17,00 to 19,00 | | 2,50 to 3,00 | | 12,50 to 15,00 | |
| X2CrNiMoN17-13-5 | 1.4439 | ≤ 0,030 | ≤ 1,00 | ≤ 2,00 | 0,045 | ≤ 0,015 | 0,12 to 0,22 | 16,50 to 18,50 | | 4,00 to 5,00 | | 12,50 to 14,50 | |
| X3CrNiCu18-9-4 | 1.4567 | ≤ 0,04 | ≤ 1,00 | ≤ 2,00 | 0,045 | ≤ 0,030[2] | ≤ 0,11 | 17,00 to 19,00 | 3,00 to 4,00 | | | 8,50 to 10,50 | |
| X1NiCrMoCu25-20-5 | 1.4539 | ≤ 0,020 | ≤ 0,70 | ≤ 2,00 | 0,030 | ≤ 0,010 | ≤ 0,15 | 19,00 to 21,00 | 1,20 to 2,00 | 4,00 to 5,00 | | 24,00 to 26,00 | |
| **Special grades** | | | | | | | | | | | | | |
| X6CrNiNb18-10 | 1.4550 | ≤ 0,08 | ≤ 1,00 | ≤ 2,00 | 0,045 | ≤ 0,015 | | 17,00 to 19,00 | | | 10 x C to 1,00 | 9,00 to 12,00[3] | |
| X6CrNiMoNb17-12-2 | 1.4580 | ≤ 0,08 | ≤ 1,00 | ≤ 2,00 | 0,045 | ≤ 0,015 | | 16,50 to 18,50 | | 2,00 to 2,50 | 10 x C to 1,00 | 10,50 to 13,50 | |
| X2CrNiMo18-15-4 | 1.4438 | ≤ 0,030 | ≤ 1,00 | ≤ 2,00 | 0,045 | ≤ 0,030[2] | ≤ 0,11 | 17,50 to 19,50 | | 3,00 to 4,00 | | 13,00 to 16,00[3] | |
| X1CrNiSi18-15-4 | 1.4361 | ≤ 0,015 | 3,70 to 4,50 | ≤ 2,00 | 0,025 | ≤ 0,010 | ≤ 0,11 | 16,50 to 18,50 | | ≤ 0,20 | | 14,00 to 16,00 | |
| X3CrNiCu19-9-2 | 1.4560 | ≤ 0,035 | ≤ 1,00 | 1,50 to 2,00 | 0,045 | ≤ 0,015 | ≤ 0,11 | 18,00 to 19,00 | 1,50 to 2,00 | | | 8,00 to 9,00 | |
| X6CrNiCuS18-9-2 | 1.4570 | ≤ 0,08 | ≤ 1,00 | ≤ 2,00 | 0,045 | 0,15 to 0,35 | ≤ 0,11 | 17,00 to 19,00 | 1,40 to 1,80 | ≤ 0,60 | | 8,00 to 10,00 | |
| X3CrNiCuMo17-11-3-2 | 1.4578 | ≤ 0,04 | ≤ 1,00 | ≤ 1,00 | 0,045 | ≤ 0,015 | ≤ 0,11 | 16,50 to 17,50 | 3,00 to 3,50 | 2,00 to 2,50 | | 10,00 to 11,00 | |
| X1NiCrMoCu31-27-4 | 1.4563 | ≤ 0,020 | ≤ 0,70 | ≤ 2,00 | 0,030 | ≤ 0,010 | ≤ 0,11 | 26,00 to 28,00 | 0,70 to 1,50 | 3,00 to 4,00 | | 30,00 to 32,00 | |
| X1CrNiMoCuN25-25-5 | 1.4537 | ≤ 0,020 | ≤ 0,70 | ≤ 2,00 | 0,030 | ≤ 0,010 | 0,17 to 0,25 | 24,00 to 26,00 | 1,00 to 2,00 | 4,70 to 5,70 | | 24,00 to 27,00 | |
| X1CrNiMoCuN20-18-7[4] | 1.4547[4] | ≤ 0,020 | ≤ 0,70 | ≤ 1,00 | 0,030 | ≤ 0,010 | 0,18 to 0,25 | 19,50 to 20,50 | 0,50 to 1,00 | 6,00 to 7,00 | | 17,50 to 18,50 | |
| X1NiCrMoCuN25-20-7 | 1.4529 | ≤ 0,020 | ≤ 0,50 | ≤ 1,00 | 0,030 | ≤ 0,010 | 0,15 to 0,25 | 19,00 to 21,00 | 0,50 to 1,50 | 6,00 to 7,00 | | 24,00 to 26,00 | |

[1] Elements not quoted in this 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 the addition of such elements from scrap and other materials used in production which would impair mechanical properties and the suitability of the steel.

[2] For products to be machined a controlled sulfur content of 0,015 to 0,030 % is recommended.

[3] Where for special reasons , e. g. hot workability for the fabrication of seamless tubes where it is necessary to minimize the deltaferrite content, or with the aim of low permeability, the maximum Ni content may be increased by the following amounts:
0,50 % (m/m): 1.4571
1,00 % (m/m): 1.4306, 1.4406, 1.4429, 1.4436, 1.4438, 1.4541, 1.4550.
1,50 % (m/m): 1.4404

[4] Patented steel grades.

## Table 4.Chemical composition (cast analysis)[1] of austenitic-ferritic stainless steels

| Steel designation | | % by mass | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| name | number | C max. | Si max. | Mn max. | P max. | S max. | N | Cr | Cu | Mo | Ni | Others |
| **Standard grades** | | | | | | | | | | | | |
| X3CrNiMoN27-5-2 | 1.4460 | 0,05 | 1,00 | 2,00 | 0,035 | 0,030[2] | 0,05 to 0,20 | 25,00 to 28,00 | | 1,30 to 2,00 | 4,50 to 6,50 | |
| X2CrNiMoN22-5-3 | 1.4462 | 0,030 | 1,00 | 2,00 | 0,035 | 0,015 | 0,10 to 0,22 | 21,00 to 23,00 | | 2,50 to 3,50 | 4,50 to 6,50 | |
| **Special grades** | | | | | | | | | | | | |
| X2CrNiN23-4*) | 1.4362*) | 0,030 | 1,00 | 2,00 | 0,035 | 0,015 | 0,05 to 0,20 | 22,00 to 24,00 | 0,10 to 0,60 | 0,10 to 0,60 | 3,50 to 5,50 | |
| X2CrNiMoCuN25-6-3 | 1.4507 | 0,030 | 0,70 | 2,00 | 0,035 | 0,015 | 0,15 to 0,30 | 24,00 to 26,00 | 1,00 to 2,50 | 2,70 to 4,00 | 5,50 to 7,50 | |
| X2CrNiMoN25-7-4*) | 1.4410*) | 0,030 | 1,00 | 2,00 | 0,035 | 0,015 | 0,20 to 0,35 | 24,00 to 26,00 | | 3,00 to 4,50 | 6,00 to 8,00 | |
| X2CrNiMoCuWN25-7-4 | 1.4501 | 0,030 | 1,00 | 1,00 | 0,035 | 0,015 | 0,20 to 0,30 | 24,00 to 26,00 | 0,50 to 1,00 | 3,00 to 4,00 | 6,00 to 8,00 | W : 0,50 to 1,00 |

1) Elements not quoted in this 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 the addition of such elements from scrap and other materials used in production which would impair mechanical properties and the suitability of the steel.

2) For products to be machined a controlled sulfur content of 0,015 to 0,030 % is recommended.

*) Patented steel grade.

**Table 5**: Permissible product analysis tolerances on the limiting values given in Tables 1 to 4 for the cast analysis

| Element | Specified limits, cast analysis % by mass | | Permissible tolerance[1] % by mass |
|---|---|---|---|
| Carbon | | ≤ 0,030 | + 0,005 |
| | ≥ 0,030 | ≤ 0,20 | ± 0,01 |
| | > 0,20 | ≤ 0,50 | ± 0,02 |
| | > 0,50 | ≤ 1,20 | ± 0,03 |
| Silicon | | ≤ 1,00 | + 0,05 |
| | > 1,00 | ≤ 4,50 | ± 0,10 |
| Manganese | | ≤ 1,00 | + 0,03 |
| | > 1,00 | ≤ 2,00 | ± 0,04 |
| Phosphorus | | ≤ 0,045 | + 0,005 |
| Sulphur | | ≤ 0,015 | + 0,003 |
| | > 0,015 | ≤ 0,030 | + 0,005 |
| | ≥ 0,15 | ≤ 0,35 | ± 0,02 |
| Nitrogen | ≥ 0,05 | ≤ 0,35 | ± 0,01 |
| Aluminium | ≥ 0,70 | ≤ 1,50 | ± 0,10 |
| Chromium | ≥ 10,50 | < 15,00 | ± 0,15 |
| | ≥ 15,00 | ≤ 20,00 | ± 0,20 |
| | > 20,00 | ≤ 28,00 | ± 0,25 |
| Copper | | ≤ 1,00 | ± 0,07 |
| | > 1,00 | ≤ 5,00 | ± 0,10 |
| Molybdenum | | ≤ 0,60 | ± 0,03 |
| | > 0,60 | < 1,75 | ± 0,05 |
| | ≥ 1,75 | ≤ 7,00 | ± 0,10 |
| Niobium | | ≤ 1,00 | ± 0,05 |
| Nickel | | ≤ 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 |
| Titan | | ≤ 0,80 | ± 0,05 |
| Tungsten | | ≤ 1,00 | ± 0,05 |
| Vanadium | | ≤ 0,20 | ± 0,03 |

[1] If several product analyses are carried out on one cast, and the contents of an individual element determined lie 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 minimum value, but not both for one cast.

## Table 6: Type of process route and surface finish[1)]

| | Abbreviation[2)] | Type of process route | Surface finish | Product form | | | Notes |
|---|---|---|---|---|---|---|---|
| | | | | Rods | Bars, sections | Semi-finished 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 1E, 1D, 1X | - | X | - | Pre-finish for close ISO-tolerances Tolerance IT 9 to IT 11[5) 6)] |
| Special finishing processes | 1G or 2G | Centerless ground | Uniform finish. Type and degree of grinding to be agreed | - | X | - | Surface roughness can be specified. Finish for close ISO-tolerances. Normally obtained from material in finishes 1E, 1D, 2H or 2B Tolerance ≤ IT 8[5) 6)] |
| | 1P or 2P | Polished | Smoother and brighter than finish 1G or 2G. Type and degree of polishing to be agreed | - | X | - | Surface roughness can be specified. Finish for close ISO-tolerances. Normally obtained from material in finishes 1E, 1D, 2B, 1G, 2G, 2H Tolerance ≤ IT 11[5) 6)] |

1) Not all process routes and surface finishes are available for all steels.
2) First digit, 1 = hot formed, 2 = cold processed.
31) 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 and the resistance to intergranular corrosion are obtained.
4) The type of cold processing, e. g. cold drawing, turning, or centerless grinding, is left to the manufacturer's discretion, provided that the rerquirements concerning tolerances on dimensions and surface roughness are respected.
5) For information.
6) Specific tolerance within the ranges shall be agreed upon at the time of enquiry and order.

**Table 7**: Mechanical properties at room temperature for ferritic steels in the annealed[*)] condition (see Table A.1) and resistance to intergranular corrosion

| Steel designation | | Thickness | Hardness | 0,2 %-proof strength | Tensile strength | Elongation after fracture[2), 3)] | Resistance to intergranular corrosion 4) | |
|---|---|---|---|---|---|---|---|---|
| name | number | mm max. | HB[1)2)] max. | $R_{p0,2}$[3)] N/mm² min. | $R_m$[2) 3)] N/mm² | A % min. (long.) | in the delivery condition | in the welded condition |
| *Standard grades* | | | | | | | | |
| X2CrNi12 | 1.4003 | 100 | 200 | 260 | 450 to 600 | 20 | no | no |
| X6Cr13 | 1.4000 | 25 | 200 | 230 | 400 to 630 | 20 | no | no |
| X6Cr17 | 1.4016 | 100 | 200 | 240 | 400 to 630 | 20 | yes | no |
| X6CrMoS17 | 1.4105 | 100 | 200 | 250 | 430 to 630 | 20 | no | no |
| X6CrMo17-1 | 1.4113 | 100 | 200 | 280 | 440 to 660 | 18 | yes | no |
| *Special grade* | | | | | | | | |
| X2CrMoTiS18-2 | 1.4523 | 100 | 200 | 280 | 430 to 600 | 15 | yes | no |

1) Only for guidance
2) The maximum HB-values may be raised by 60 units or the maximum tensile strength value may be raised by 150 N/mm² and the minimum elongation value be lowered to 10 % for sections and bars of ≤ 35 mm thickness having a final cold deformation.
3) For rods, only the tensile strength values apply.
4) When tested according to EURONORM 114.
*) The annealing treatment may be omitted, if the conditions for hot working and subsequent cooling are such that the requirements for the mechanical properties of the product and the resistance to intergranular corrosion as defined in EU 114 are obtained.

**Table 8:** Mechanical properties at room temperature for martensitic steels in the heat-treated condition (see Table A 2)

| Steel designation | | Thickness (d) | Heat-treatment condition[1] | Hardness | 0,2 %-proof strength | Tensile strength | Elongation after fracture | | Impact energy (ISO-V) | |
|---|---|---|---|---|---|---|---|---|---|---|
| name | number | mm | | HB[2] max. | $R_{p0,2}$[3] N/mm² min. | $R_m$[3] N/mm² | A[3] % min (long) | A[3] % min (tr) | KV J min (long) | KV J min (tr) |
| **Standard grades** | | | | | | | | | | |
| X12Cr13 | 1 4006 | | A | 220[4] | - | max. 730[4] | - | - | - | - |
| | | ≤ 160 | QT650 | | 450 | 650 to 850 | 15 | - | 25 | - |
| X12CrS13 | 1 4005 | | A | 220[4] | - | max. 730[4] | - | - | - | - |
| | | ≤ 160 | QT650 | - | 450 | 650 to 850 | 12 | - | - | - |
| X20Cr13 | 1 4021 | | A | 230[4] | - | max 760[4] | - | - | - | - |
| | | ≤ 160 | QT700 | - | 500 | 700 to 850 | 13 | - | 25 | - |
| | | | QT800 | - | 600 | 800 to 950 | 12 | - | 20 | - |
| X30Cr13 | 1.4028 | | A | 245[4] | - | max. 800[4] | - | - | - | - |
| | | ≤ 160 | QT850 | - | 650 | 850 to 1000 | 10 | - | - | - |
| X39Cr13 | 1.4031 | | A | 245[4] | - | max 800[4] | - | - | - | - |
| X46Cr13 | 1 4034 | | A | 245[4] | - | max. 800[4] | - | - | - | - |
| X50CrMoV15 | 1 4116 | | A | 280[4] | - | max 900[4] | - | - | - | - |
| X14CrMoS17 | 1.4104 | | A | 220[4] | - | max 730[4] | - | - | - | - |
| | | ≤ 60 | QT650 | - | 500 | 650 to 850 | 12 | - | - | - |
| | | 60 < d ≤ 160 | | | | | 10 | - | - | - |
| X39CrMo17-1 | 1 4122 | | A | 280[4] | - | max 900[4] | - | - | - | - |
| | | ≤ 60 | QT750 | - | 550 | 750 to 950 | 12 | - | 20 | - |
| | | 60 < d ≤ 160 | | | | | | | 14 | |
| X17CrNi16-2 | 1 4057 | | A | 295[4] | - | max. 950[4] | | | | |
| | | ≤ 60 | QT800 | - | 600 | 800 to 950 | 14 | - | 25 | - |
| | | 60 < d ≤ 160 | | | | | 12 | | 20 | |
| | | ≤ 60 | QT900 | - | 700 | 900 to 1050 | 12 | - | 20 | - |
| | | ≤ 60 < d ≤ 160 | | | | | 10 | | 15 | |
| X3CrNiMo13-4 | 1 4313 | | A | 320 | - | max 1100 | - | - | - | - |
| | | ≤ 160 | QT650 | - | 520 | 650 to 830 | 15 | - | 70 | - |
| | | 160 < d ≤ 250 | | | | | - | 12 | - | 50 |
| | | ≤ 160 | QT780 | - | 620 | 780 to 980 | 15 | - | 70 | - |
| | | 160 < d ≤ 250 | | | | | - | 12 | - | 50 |
| | | ≤ 160 | QT900 | - | 800 | 900 to 1100 | 12 | - | 50 | - |
| | | 160 < d ≤ 250 | | | | | - | 10 | - | 40 |
| X4CrNiMo16-5-1 | 1.4418 | | A | 320 | - | max. 1100 | - | - | - | - |
| | | ≤ 160 | QT760 | - | 550 | 760 to 960 | 16 | - | 90 | - |
| | | 160 < d ≤ 250 | | | | | - | 14 | - | 70 |
| | | ≤ 160 | QT900 | - | 700 | 900 to 1100 | 16 | - | 80 | - |
| | | 160 < d ≤ 250 | | | | | - | 14 | - | 60 |
| **Special grades** | | | | | | | | | | |
| X29CrS13 | 1 4029 | ≤ 160 | A | 245[4] | - | max. 800[4] | - | - | - | - |
| | | | QT850 | - | 650 | 850 to 1000 | 9 | - | - | - |
| X70CrMo15 | 1 4109 | ≤ 100 | A | 280[4] | - | max 900[4] | - | - | - | - |
| X105CrMo17 | 1 4125 | ≤ 100 | A | 285[4] | - | - | - | - | - | - |
| X90CrMoV18 | 1.4112 | ≤ 100 | A | 265[4] | - | - | - | - | - | - |

[1] A = annealed; QT = quenched and tempered
[2] Only for guidance
[3] For rods, only the tensile strength values apply
[4] $HB_{max}$-values may be raised by 60 units or $R_{m\,max}$-values may be raised by 150 N/mm² for sections and bars of ≤ 35 mm thickness having a final cold deformation

**Table 9:** Mechanical properties at room temperature for precipitation hardening steels in the heat-treated condition (see Table A.3)

| Steel designation | | Thickness | Heat treatment condition[1] | Hardness[2] | 0,2 %- proof strength | Tensile strength | Elongation after fracture | Impact energy (ISO-V) |
|---|---|---|---|---|---|---|---|---|
| name | number | mm max. | | HB max. | $R_{p0,2}$ N/mm² min. | $R_m$ N/mm² | A % min. (long.) | KV J min. (long.) |
| Standard grades | | | | | | | | |
| X5CrNiCuNb16-4 | 1.4542 | 100 | AT | 360 | - | max. 1 200 | - | - |
| | | | P800 | - | 520 | 800 to 950 | 18 | 75 |
| | | | P930 | - | 720 | 930 to 1 100 | 16 | 40 |
| | | | P960 | - | 790 | 960 to 1 160 | 12 | - |
| | | | P1070 | - | 1 000 | 1 070 to 1 270 | 10 | - |
| X7CrNiAl17-7 | 1.4568 | 30 | AT[3] | 255 | - | max. 850 | - | - |
| X5CrNiMoCuNb14-5 | 1.4594 | 100 | AT | 360 | - | max. 1 200 | - | - |
| | | | P930 | - | 720 | 930 to 1 100 | 15 | 40 |
| | | | P1000 | - | 860 | 1 000 to 1 200 | 10 | - |
| | | | P1070 | - | 1 000 | 1 070 to 1 270 | 10 | - |

[1] AT = solution annealed; P = precipitation hardened .
[2] Only for guidance.
[3] For spring hard drawn condition see EURONORM 151-1.

Table 10: Mechanical properties at room temperature of austenitic steels in the solution annealed condition[7] (see Table A.4) and resistance to intergranular corrosion

| Steel designation | | Thickness d | Hardness [1] [2] | 0,2 %-proof strength $R_{p0,2}$ [3] | 1 %-proof strength $R_{p1,0}$ [3] | Tensile strength $R_m$ [2] [3] | Elongation after fracture A [2] [3] | | Impact energy (ISO-V) KV | | Resistance to intergranular corrosion [4] | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| name | number | mm | HB max. | N/mm² min. | | N/mm² | % min. (long) | % min. (tr.) | J min. (long) | J min. (tr.) | in the delivery condition | in the sensitized condition [5] |
| **Standard grades** | | | | | | | | | | | | |
| X10CrNi18-8 | 1.4310 | d ≤ 40 | 230 | 195 | 230 | 500 to 750 | 40 | - | - | - | no | no |
| X2CrNi18-9 | 1.4307 | d ≤ 160 | 215 | 175 | 210 | 450 to 680 | 45 | - | 100 | - | yes | yes |
| | | 160 < d ≤ 250 | | | | | - | 35 | - | 60 | | |
| X2CrNi19-11 | 1 4306 | d ≤ 160 | 215 | 180 | 215 | 460 to 680 | 45 | - | 100 | - | yes | yes |
| | | 160 < d ≤ 250 | | | | | - | 35 | - | 60 | | |
| X2CrNiN18-10 | 1 4311 | d ≤ 160 | 230 | 270 | 305 | 550 to 760 | 40 | - | 100 | - | yes | yes |
| | | 160 < d ≤ 250 | | | | | - | 30 | - | 60 | | |
| X5CrNi18-10 | 1 4301 | d ≤ 160 | 215 | 190 | 225 | 500 to 700 | 45 | - | 100 | - | yes | no [6] |
| | | 160 < d ≤ 250 | | | | | - | 35 | - | 60 | | |
| X8CrNiS18-9 | 1 4305 | d ≤ 160 | 230 | 190 | 225 | 500 to 750 | 35 | - | - | - | no | no |
| X6CrNiTi18-10 | 1.4541 | d ≤ 160 | 215 | 190 | 225 | 500 to 700 | 40 | - | 100 | - | yes | yes |
| | | 160 < d ≤ 250 | | | | | - | 30 | - | 60 | | |
| X4CrNi18-12 | 1.4303 | d ≤ 160 | 215 | 190 | 225 | 500 to 700 | 45 | - | 100 | - | yes | no [6] |
| | | 160 < d ≤ 250 | | | | | - | 35 | - | 60 | | |
| X2CrNiMo17-12-2 | 1 4404 | d ≤ 160 | 215 | 200 | 235 | 500 to 700 | 40 | - | 100 | - | yes | yes |
| | | 160 < d ≤ 250 | | | | | - | 30 | - | 60 | | |
| X2CrNiMoN17-11-2 | 1.4406 | d ≤ 160 | 250 | 280 | 315 | 580 to 800 | 40 | - | 100 | - | yes | yes |
| | | 160 < d ≤ 250 | | | | | - | 30 | - | 60 | | |
| X5CrNiMo17-12-2 | 1 4401 | d ≤ 160 | 215 | 200 | 235 | 500 to 700 | 40 | - | 100 | - | yes | no [6] |
| | | 160 < d ≤ 250 | | | | | - | 30 | - | 60 | | |
| X6CrNiMoTi17-12-2 | 1.4571 | d ≤ 160 | 215 | 200 | 235 | 500 to 700 | 40 | - | 100 | - | yes | yes |
| | | 160 < d ≤ 250 | | | | | - | 30 | - | 60 | | |
| X2CrNiMo17-12-3 | 1 4432 | d ≤ 160 | 215 | 200 | 235 | 500 to 700 | 40 | - | 100 | - | yes | yes |
| | | 160 < d ≤ 250 | | | | | - | 30 | - | 60 | | |
| X2CrNiMoN17-13-3 | 1.4429 | d ≤ 160 | 250 | 280 | 315 | 580 to 800 | 40 | - | 100 | - | yes | yes |
| | | 160 < d ≤ 250 | | | | | - | 30 | - | 60 | | |
| X3CrNiMo17-13-3 | 1 4436 | d ≤ 160 | 215 | 200 | 235 | 500 to 700 | 40 | - | 100 | - | yes | no [6] |
| | | 160 < d ≤ 250 | | | | | - | 30 | - | 60 | | |
| X2CrNiMo18-14-3 | 1.4435 | d ≤ 160 | 215 | 200 | 235 | 500 to 700 | 40 | - | 100 | - | yes | yes |
| | | 160 < d ≤ 250 | | | | | - | 30 | - | 60 | | |
| X2CrNiMoN17-13-5 | 1 4439 | d ≤ 160 | 250 | 280 | 315 | 580 to 800 | 35 | - | 100 | - | yes | yes |
| | | 160 < d ≤ 250 | | | | | - | 30 | - | 60 | | |
| X3CrNiCu18-9-4 | 1 4567 | d ≤ 160 | 215 | 175 | - | 450 to 650 | 45 | - | - | - | yes | yes |
| X1NiCrMoCu25-20-5 | 1.4539 | d ≤ 160 | 230 | 230 | 260 | 530 to 730 | 35 | - | 100 | - | yes | yes |
| | | 160 < d ≤ 250 | | | | | - | 30 | - | 60 | | |
| **Special grades** | | | | | | | | | | | | |
| X6CrNiNb18-10 | 1.4550 | d ≤ 160 | 230 | 205 | 240 | 510 to 740 | 40 | - | 100 | - | yes | yes |
| | | 160 < d ≤ 250 | | | | | - | 30 | - | 60 | | |
| X6CrNiMoNb17-12-2 | 1 4580 | d ≤ 160 | 230 | 215 | 250 | 510 to 740 | 35 | - | 100 | - | yes | yes |
| | | 160 < d ≤ 250 | | | | | - | 30 | - | 60 | | |
| X2CrNiMo18-15-4 | 1 4438 | d ≤ 160 | 215 | 200 | 235 | 500 to 700 | 40 | - | 100 | - | yes | yes |
| | | 160 < d ≤ 250 | | | | | - | 30 | - | 60 | | |
| X1CrNiSi18-5-4 | 1 4361 | d ≤ 160 | 230 | 210 | 240 | 530 to 730 | 40 | - | 100 | - | yes | yes |
| | | 160 < d ≤ 250 | | | | | - | 30 | - | 60 | | |
| X3CrNiCu19-9-2 | 1.4560 | d ≤ 160 | 215 | 175 | - | 450 to 650 | 45 | - | - | - | yes | yes |
| X6CrNiCuS18-9-2 | 1.4570 | d ≤ 160 | 215 | 185 | 220 | 500 to 710 | 35 | - | - | - | no | no |
| X3CrNiCuMo17-11-3-2 | 1 4578 | d ≤ 160 | 215 | 175 | - | 450 to 650 | 45 | - | - | - | yes | yes |
| X1NiCrMoCu31-27-4 | 1.4563 | d ≤ 160 | 230 | 220 | 250 | 500 to 750 | 35 | - | 100 | - | yes | yes |
| | | 160 < d ≤ 250 | | | | | - | 30 | - | 60 | | |
| X1CrNiMoCuN25-25-5 | 1 4537 | d ≤ 160 | 250 | 300 | 340 | 600 to 800 | 35 | - | 100 | - | yes | yes |
| | | 160 < d ≤ 250 | | | | | - | 30 | - | 60 | | |
| X1CrNiMoCuN20-18-7 | 1.4547 | d ≤ 160 | 260 | 300 | 340 | 650 to 850 | 35 | - | 100 | - | yes | yes |
| | | 160 < d ≤ 250 | | | | | - | 30 | - | 60 | | |
| X1NiCrMoCuN25-20-7 | 1 4529 | d ≤ 160 | 250 | 300 | 340 | 650 to 850 | 40 | - | 100 | - | yes | yes |
| | | 160 < d ≤ 250 | | | | | - | 35 | - | 60 | | |

[1] Only for guidance.
[2] The maximum HB-values may be raised by 100 HB or the tensile strength value may be raised by 200 N/mm² and the minimum elongation value be lowered to 20 % for sections and bars of ≤ 35 mm thickness having a final cold deformation
[3] For rods, only the tensile strength values apply.
[4] When tested according to EURONORM 114
[5] See NOTE 2 to 8 4
[6] Sensibilization treatment of 15 min at 700 °C followed by cooling in air.
[7] The solution treatment may be omitted if the conditions for hot working and subsequent cooling are such that the requirements for the mechanical properties of the product and the resistance to intergranular corrosion as defined in EU 114 are obtained.

**Table 11: Mechanical properties at room temperature of austenitic-ferritic steels in the solution annealed condition[7] (see Table A.5) and resistance to intergranular corrosion**

| Steel designation | | Thickness d | Hardness [1] | 0,2 %-proof strength | Tensile strength | Elongation after fracture | Impact energy (ISO-V) | Resistance to intergranular corrosion[3] | |
|---|---|---|---|---|---|---|---|---|---|
| name | number | mm | HB max. | $R_{p0,2}$ [2] N/mm² min. | $R_m$ [2] N/mm² | A [2] % min. (long.) | KV J min. (long.) | in the delivery condition | in the welded condition [4] |
| **Standard grades** | | | | | | | | | |
| X3CrNiMoN27-5-2 | 1.4460 | d ≤ 160 | 260 | 460 | 620 to 880 | 20 | 85 | yes | yes |
| X2CrNiMoN22-5-3 | 1.4462 | d ≤ 160 | 270 | 450 | 650 to 880 | 25 | 100 | yes | yes |
| **Special grades** | | | | | | | | | |
| X2CrNiN23-4 | 1.4362 | d ≤ 160 | 260 | 400 | 600 to 850 | 25 | 100 | yes | yes |
| X2CrNiMoCuN25-6-3 | 1.4507 | d ≤ 160 | 270 | 500 | 700 to 900 | 25 | 100 | yes | yes |
| X2CrNiMoN25-7-4 | 1.4410 | d ≤ 160 | 290 | 530 | 730 to 930 | 25 | 100 | yes | yes |
| X2CrNiMoCuWN25-7-4 | 1.4501 | d ≤ 160 | 290 | 530 | 730 to 930 | 25 | 100 | yes | yes |

[1] Only for guidance.
[2] For rods, only the tensile strength values apply.
[3] When tested according to EURONORM 114.
[4] See NOTE 2 to 8.4.
[7] The solution treatment may be omitted if the conditions for hot working and subsequent cooling are such that the requirements for the mechanical properties of the product and the resistance to intergranular corrosion as defined in EU 114 are obtained.

**Table 12: Minimum values for the 0,2 % proof strength of ferritic steels at elevated temperatures**

| Steel designation | | Heat treatment condition [1] | Minimum 0,2 % proof strength (N/mm²) at a temperature (in °C) of | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| name | number | | 100 | 150 | 200 | 250 | 300 | 350 | 400 |
| **Standard grades** | | | | | | | | | |
| X2CrNi12 | 1.4003 | A | 240 | 230 | 220 | 215 | 210 | - | - |
| X6Cr13 | 1.4000 | A | 220 | 215 | 210 | 205 | 200 | 195 | 190 |
| X6Cr17 | 1.4016 | A | 220 | 215 | 210 | 205 | 200 | 195 | 190 |
| X6CrMoS17 | 1.4105 | A | 230 | 220 | 215 | 210 | 205 | 200 | 195 |
| X6CrMo17-1 | 1.4113 | A | 250 | 240 | 230 | 220 | 210 | 205 | 200 |
| **Special grade** | | | | | | | | | |
| X2CrMoTiS18-2 | 1.4523 | A | 250 | 240 | 230 | 220 | 210 | 205 | 200 |

[1] A = annealed

**Table 13:** Minimum values for the 0,2 % proof strength of martensitic steels at elevated temperatures

| Steel designation | | Heat treatment condition [1] | Minimum 0,2 % proof strength (N/mm²) at a temperature (in °C) of | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| name | number | | 100 | 150 | 200 | 250 | 300 | 350 | 400 |
| Standard grades | | | | | | | | | |
| X12Cr13 | 1.4006 | QT 650 | 420 | 410 | 400 | 385 | 365 | 335 | 305 |
| X20Cr13 | 1.4021 | QT 700 | 460 | 445 | 430 | 415 | 395 | 365 | 330 |
| | | QT 800 | 515 | 495 | 475 | 460 | 440 | 405 | 355 |
| X39CrMo17-1 | 1.4122 | QT 750 | 540 | 535 | 530 | 520 | 510 | 490 | 470 |
| X17CrNi16-2 | 1.4057 | QT 800 | 515 | 495 | 475 | 460 | 440 | 405 | 355 |
| | | QT 900 | 585 | 525 | 505 | 490 | 470 | 430 | 375 |
| X3CrNiMo13-4 | 1.4313 | QT 650 | 500 | 490 | 480 | 470 | 460 | 450 | - |
| | | QT 780 | 590 | 575 | 560 | 545 | 530 | 515 | - |
| | | QT 900 | 720 | 690 | 665 | 640 | 620 | - | - |
| X4CrNiMo16-5-1 | 1.4418 | QT 780 | 520 | 510 | 500 | 490 | 480 | - | - |
| | | QT900 | 660 | 640 | 620 | 600 | 580 | - | - |
| [1] QT = quenched and tempered | | | | | | | | | |

**Table 14:** Minimum values for the 0,2 % proof strength of precipitation hardening steels at elevated temperatures

| Steel designation | | Heat treatment condition [1] | Minimum 0,2 % proof strength; (N/mm²) at a temperature (in °C) of | | | | |
|---|---|---|---|---|---|---|---|
| name | number | | 100 | 150 | 200 | 250 | 300 |
| Standard grades | | | | | | | |
| X5CrNiCuNb16-4 | 1.4542 | P800 | 500 | 490 | 480 | 470 | 460 |
| | | P930 | 680 | 660 | 640 | 620 | 600 |
| | | P960 | 730 | 710 | 690 | 670 | 650 |
| | | P1070 | 880 | 830 | 800 | 770 | 750 |
| X5CrNiMoCuNb14-5 | 1.4594 | P930 | 680 | 660 | 640 | 620 | 600 |
| | | P1000 | 785 | 755 | 730 | 710 | 690 |
| [1] P = precipitation hardened | | | | | | | |

## Table 15: Minimum values for the 0,2 % and 1 % proof strength of austenitic steels at elevated temperatures

| Steel designation | | Heat treatment condition [1] | Minimum 0,2 % proof strength (N/mm²) | | | | | | | | | | Minimum 1 % proof strength (N/mm²) | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| name | number | | at a temperature (in °C) of | | | | | | | | | | | | | | | | | | | |
| | | | 100 | 150 | 200 | 250 | 300 | 350 | 400 | 450 | 500 | 550 | 100 | 150 | 200 | 250 | 300 | 350 | 400 | 450 | 500 | 550 |
| **Standard grades** | | | | | | | | | | | | | | | | | | | | | | |
| X10CrNi18-8 | 1.4310 | AT | | | | | | | | | | | | | | | | | | | | |
| X2CrNi18-9 | 1.4307 | AT | 145 | 130 | 118 | 108 | 100 | 94 | 89 | 85 | 81 | 80 | 180 | 160 | 145 | 135 | 127 | 121 | 116 | 112 | 109 | 108 |
| X2CrNi19-11 | 1.4306 | AT | 145 | 130 | 118 | 108 | 100 | 94 | 89 | 85 | 81 | 80 | 180 | 160 | 145 | 135 | 127 | 121 | 116 | 112 | 109 | 108 |
| X2CrNiN18-10 | 1.4311 | AT | 205 | 175 | 157 | 145 | 136 | 130 | 125 | 121 | 119 | 118 | 240 | 210 | 187 | 175 | 167 | 160 | 156 | 152 | 149 | 147 |
| X5CrNi18-10 | 1.4301 | AT | 155 | 140 | 127 | 118 | 110 | 104 | 98 | 95 | 92 | 90 | 190 | 170 | 155 | 145 | 135 | 129 | 125 | 122 | 120 | 120 |
| X6CrNiTi18-10 | 1.4541 | AT | 175 | 165 | 155 | 145 | 136 | 130 | 125 | 121 | 119 | 118 | 205 | 195 | 185 | 175 | 167 | 161 | 156 | 152 | 149 | 147 |
| X4CrNi18-12 | 1.4303 | AT | 155 | 140 | 127 | 118 | 110 | 104 | 98 | 95 | 92 | 90 | 190 | 170 | 155 | 145 | 135 | 129 | 125 | 122 | 120 | 120 |
| X2CrNiMo17-12-2 | 1.4404 | AT | 165 | 150 | 137 | 127 | 119 | 113 | 108 | 103 | 100 | 98 | 200 | 180 | 165 | 153 | 145 | 139 | 135 | 130 | 128 | 127 |
| X2CrNiMoN17-11-2 | 1.4406 | AT | 215 | 195 | 175 | 165 | 155 | 150 | 145 | 140 | 138 | 136 | 245 | 225 | 205 | 195 | 185 | 180 | 175 | 170 | 168 | 166 |
| X5CrNiMo17-12-2 | 1.4401 | AT | 175 | 158 | 145 | 135 | 127 | 120 | 115 | 112 | 110 | 108 | 210 | 190 | 175 | 165 | 155 | 150 | 145 | 141 | 139 | 137 |
| X6CrNiMoTi17-12-2 | 1.4571 | AT | 185 | 175 | 165 | 155 | 145 | 140 | 135 | 131 | 129 | 127 | 215 | 205 | 192 | 183 | 175 | 169 | 164 | 160 | 158 | 157 |
| X2CrNiMo17-12-3 | 1.4432 | AT | 165 | 150 | 137 | 127 | 119 | 113 | 108 | 103 | 100 | 98 | 200 | 180 | 165 | 153 | 145 | 139 | 135 | 130 | 128 | 127 |
| X2CrNiMoN17-13-3 | 1.4429 | AT | 215 | 195 | 175 | 165 | 155 | 150 | 145 | 140 | 138 | 136 | 245 | 225 | 205 | 195 | 185 | 180 | 175 | 170 | 168 | 166 |
| X3CrNiMo17-13-3 | 1.4436 | AT | 175 | 158 | 145 | 135 | 127 | 120 | 115 | 112 | 110 | 108 | 210 | 190 | 175 | 165 | 155 | 150 | 145 | 141 | 139 | 137 |
| X2CrNiMo18-14-3 | 1.4435 | AT | 165 | 150 | 137 | 127 | 119 | 113 | 108 | 103 | 100 | 98 | 200 | 180 | 165 | 153 | 145 | 139 | 135 | 130 | 128 | 127 |
| X2CrNiMoN17-13-5 | 1.4439 | AT | 225 | 200 | 185 | 175 | 165 | 155 | 150 | - | - | - | 255 | 230 | 210 | 200 | 190 | 180 | 175 | - | - | - |
| X1NiCrMoCu25-20-5 | 1.4539 | AT | 205 | 190 | 175 | 160 | 145 | 135 | 125 | 115 | 110 | 105 | 235 | 220 | 205 | 190 | 175 | 165 | 155 | 145 | 140 | 135 |
| **Special grades** | | | | | | | | | | | | | | | | | | | | | | |
| X6CrNiNb18-10 | 1.4550 | AT | 175 | 165 | 155 | 145 | 136 | 130 | 125 | 121 | 119 | 118 | 210 | 195 | 185 | 175 | 167 | 161 | 156 | 152 | 149 | 147 |
| X6CrNiMoNb17-12-2 | 1.4580 | AT | 186 | 177 | 167 | 157 | 145 | 140 | 135 | 131 | 129 | 127 | 221 | 206 | 196 | 186 | 175 | 169 | 164 | 160 | 158 | 157 |
| X2CrNiMo18-15-4 | 1.4438 | AT | 172 | 157 | 147 | 137 | 127 | 120 | 115 | 112 | 110 | 108 | 206 | 186 | 177 | 167 | 157 | 150 | 144 | 140 | 138 | 136 |
| X1CrNiSi18-15-4 | 1.4361 | AT | 185 | 160 | 145 | 135 | 125 | 120 | 115 | - | - | - | 210 | 190 | 175 | 165 | 155 | 150 | - | - | - | - |
| X1NiCrMoCu31-27-4 | 1.4563 | AT | 190 | 175 | 160 | 155 | 150 | 145 | 135 | 125 | 120 | 115 | 220 | 205 | 190 | 185 | 180 | 175 | 165 | 155 | 150 | 145 |
| X1CrNiMoCuN25-25-5 | 1.4537 | AT | 240 | 220 | 200 | 190 | 180 | 175 | 170 | - | - | - | 270 | 250 | 230 | 220 | 210 | 205 | 200 | - | - | - |
| X1CrNiMoCuN20-18-7 | 1.4547 | AT | 230 | 205 | 190 | 180 | 170 | 165 | 160 | 153 | 148 | - | 270 | 245 | 225 | 212 | 200 | 195 | 190 | 184 | 180 | - |
| X1NiCrMoCuN25-20-7 | 1.4529 | AT | 230 | 210 | 190 | 180 | 170 | 165 | 160 | - | - | - | 270 | 245 | 225 | 215 | 205 | 195 | 190 | - | - | - |

[1] AT = solution annealed

**Table 16: Minimum values for the 0,2 % proof strength of austenitic-ferritic steels at elevated temperatures**

| Steel designation | | Heat treatment condition [1] | Minimum 0,2 % proof strength (N/mm²) at a temperature (in °C) of | | | |
|---|---|---|---|---|---|---|
| name | number | | 100 | 150 | 200 | 250 |
| Standard grades | | | | | | |
| X3CrNiMoN27-5-2 | 1.4460 | AT | 360 | 335 | 310 | 295 |
| X2CrNiMoN22-5-3 | 1.4462 | AT | 360 | 335 | 315 | 300 |
| Special grades | | | | | | |
| X2CrNiN23-4 | 1.4362 | AT | 330 | 300 | 280 | 265 |
| X2CrNiMoCuN25-6-3 | 1.4507 | AT | 450 | 420 | 400 | 380 |
| X2CrNiMoN25-7-4 | 1.4410 | AT | 450 | 420 | 400 | 380 |
| X2CrNiMoCuWN25-7-4 | 1.4501 | AT | 450 | 420 | 400 | 380 |
| [1] AT = solution annealed | | | | | | |

**Table 17: Mechanical properties at room temperature of steels in the cold worked condition**

| Steel designation | | Tensile strength level | 0,2 % proof strength $R_{p0,2}$ N/mm² min. | Tensile strength $R_m$ N/mm² | Elongation after fracture A % min. |
|---|---|---|---|---|---|
| name | number | | | | |
| Standard grade (Martensitic steel) | | | | | |
| X14CrMoS17 | 1.4104 | C550[1] | 440 | 550 to 750 | 15 |
| Standard grades (Austenitic steels) | | | | | |
| X2CrNi18-9 | 1.4307 | C700[2] | 350 | 700 to 850 | 20 |
| | | C800[1] | 500 | 800 to 1000 | 12 |
| X2CrNi19-11 | 1.4306 | C700[2] | 350 | 700 to 850 | 20 |
| | | C800[1] | 500 | 800 to 1000 | 12 |
| X5CrNi18-10 | 1.4301 | C700[2] | 350 | 700 to 850 | 20 |
| | | C800[1] | 500 | 800 to 1000 | 12 |
| X8CrNiS18-9 | 1.4305 | C700[2] | 350 | 700 to 850 | 20 |
| | | C800[1] | 500 | 800 to 1000 | 12 |
| X6CrNiTi18-10 | 1.4541 | C700[2] | 350 | 700 to 850 | 20 |
| | | C800[1] | 500 | 800 to 1000 | 12 |
| X2CrNiMo17-12-2 | 1.4404 | C700[2] | 350 | 700 to 850 | 20 |
| | | C800[1] | 500 | 800 to 1000 | 12 |
| X5CrNiMo17-12-2 | 1.4401 | C700[2] | 350 | 700 to 850 | 20 |
| | | C800[1] | 500 | 800 to 1000 | 12 |
| X6CrNiMoTi17-12-2 | 1.4571 | C700[2] | 350 | 700 to 850 | 20 |
| | | C800[1] | 500 | 810 to 1000 | 12 |

[1] The maximum diameter for this tensile strength level shall be agreed at the time of enquiry and order; it should not be greater than 25 mm.

[2] The maximum diameter for this tensile strength level shall be agreed at the time of enquiry and order; it should not be greater than 35 mm.

**Table 18:** Tests to be carried out, test units and extent of testing in specific testing

| Test | [1] | Test unit | Product form | Number of test pieces per sample |
|---|---|---|---|---|
| | | | Rods, bars and sections | |
| Chemical analysis | m | Cast | The cast analysis is given by the manufacturer.[2] | |
| Tensile test at ambient temperature | m | Batch[3] | 1 sample per 25 t; maximum of 2 per test unit | 1 |
| Tensile test at elevated temperature | o | | To be agreed at the time of ordering (see Tables 12 to 16) | 1 |
| Impact test at ambient temperature | o | | To be agreed at the time of ordering (see Tables 8 to 11) | 3 |
| Resistance to intergranular corrosion | o | | To be agreed at the time of ordering if intergranular corrosion is a hazard (see Tables 7, 10 and 11) | 1 |

[1] Tests marked with a "m" (mandatory) shall be carried out as specific tests. In all cases, those marked with an "o" (optional) 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. The products must have 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 19:** Marking of the products

| Marking of | Products | |
|---|---|---|
| | with specific testing[1] | without specific testing[1] |
| Manufacturer's name, trade mark or logo | + | + |
| Steel number or name | + | + |
| Cast number | + | + |
| Identification number[2] | + | (+) |
| Inspector's mark | (+) | - |

[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.
- = no marking necessary.

[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)

## Guidelines for further treatment (including heat treatment) in fabrication

**A.1** The guidelines given in Tables A.1 to A.5 are intended for hot forming and heat treatment.

**A.2** Flame cutting may adversely affect edge areas; where necessary, they should be machined.

**A.3** As the corrosion resistance of stainless steels is only ensured with a metallically clean surface, layers of scale and annealing colours produced during hot forming, heat treatment or welding should be removed as far as possible before use. Finished parts made of steels with approximately 13 % Cr also require the best surface condition (e. g. polished) in order to achieve maximum resistance to corrosion.

**Table A.1:** Guidelines on the temperatures for hot forming and heat treatment[1] of ferritic stainless steels

| Steel designation | | Hot forming | | Heat treatment symbol | Annealing | |
|---|---|---|---|---|---|---|
| name | number | Temperature °C | Type of cooling | | Temperature[2] °C | Type of cooling |
| Standard grades | | | | | | |
| X2CrNi12 | 1.4003 | 1100 to 800 | air | A | 680 to 740 | air |
| X6Cr13 | 1.4000 | | | | 750 to 800 | |
| X6Cr17 | 1.4016 | | | | 750 to 850 | |
| X6CrMoS17 | 1.4105 | | | | 750 to 850 | |
| X6CrMo17-1 | 1.4113 | | | | 750 to 850 | |
| Special grade | | | | | | |
| X2CrMoTiS18-2 | 1.4523 | 1100 to 800 | air | A | 1000 to 1050 | air |

[1] The temperatures of annealing shall be agreed for simulated heat-treated test pieces.

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

**Table A.2:** Guidelines on the temperatures for hot forming and heat treatment[1] of martensitic stainless steels

| Steel designation | | Hot forming | | Heat treatment symbol | Annealing | | Quenching | | Tempering |
|---|---|---|---|---|---|---|---|---|---|
| name | number | Temperature °C | Type of cooling | | Temperature[2] °C | Type of cooling | Temperature[2] °C | Type of cooling | Temperature °C |
| Standard grades | | | | | | | | | |
| X12Cr13 | 1.4006 | 1100 to 800 | air | A | 745 to 825 | air | - | - | - |
| | | | | QT650 | - | - | 950 to 1000 | oil, air | 680 to 780 |
| X12CrS13 | 1.4005 | | | A | 745 to 825 | air | - | - | - |
| | | | | QT650 | - | - | 950 to 1000 | oil, air | 680 to 780 |
| X20Cr13 | 1.4021 | | slow cooling | A | 745 to 825 | air | - | - | - |
| | | | | QT700 | - | - | 950 to 1050 | oil, air | 650 to 750 |
| | | | | QT800 | - | - | 950 to 1050 | oil, air | 600 to 700 |
| X30Cr13 | 1.4028 | | | A | 745 to 825 | air | - | - | - |
| | | | | QT850 | - | - | 950 to 1050 | oil, air | 625 to 675 |
| X39Cr13 | 1.4031 | | | A | 750 to 850 | furnace, air | - | - | - |
| X46Cr13 | 1.4034 | | | A | 750 to 850 | | - | - | - |
| X50CrMoV15 | 1.4116 | | | A | 750 to 850 | | - | - | - |
| X14CrMoS17 | 1.4104 | | air | A | 750 to 850 | | - | - | - |
| | | | | QT650 | - | - | 950 to 1070 | oil, air | 550 to 650 |
| X39CrMo17-1 | 1.4122 | | slow cooling | A | 750 to 850 | furn., air | - | - | - |
| | | | | QT750 | - | - | 980 to 1060 | oil | 650 to 750 |
| X17CrNi16-2 | 1.4057 | | | A[3] | 680 to 800 | furn., air | - | - | - |
| | | | | QT800[4] | - | - | 950 to 1050 | oil, air | 750 to 800 + 650 to700[4] |
| | | | | QT900 | - | - | 950 to 1050 | oil, air | 600 to 650 |
| X3CrNiMo13-4 | 1.4313 | 1150 to 900 | air | A[3] | 600 to 650 | furn., air | - | - | - |
| | | | | QT650 | - | - | 950 to 1050 | oil, air | 650 to 700 + 600 to 620 |
| | | | | QT780 | - | - | 950 to 1050 | oil, air | 550 to 600 |
| | | | | QT900 | - | - | 950 to 1050 | oil, air | 520 to 580 |
| X4CrNiMo16-5-1 | 1.4418 | | | A[3] | 600 to 650 | air, furn. | - | - | - |
| | | | | QT760 | - | - | 950 to 1050 | oil, air | 590 to 620[5] |
| | | | | QT900 | - | - | 950 to 1050 | oil, air | 550 to 620 |
| Special grades | | | | | | | | | |
| X29CrS13 | 1.4029 | 1100 to 800 | slow cooling | A | 740 to 820 | air | - | - | - |
| | | | | QT850 | - | - | 950 to 1050 | oil, air | 625 to 675 |
| X70CrMo15 | 1.4109 | | | A | 750 to 800 | furnace, air | - | - | - |
| X105CrMo17 | 1.4125 | 1100 to 900 | | A | 780 to 840 | | - | - | - |
| X90CrMoV18 | 1.4112 | 1100 to 800 | | A | 780 to 840 | | - | - | - |

[1] The temperatures of annealing, quenching and tempering shall be agreed for simulated heat-treated test pieces.
[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] Double annealing might be advisable.
[4] In the case that the nickel is at the lower side of the range specified in Table 2, a single tempering at 620 to 720 °C may be sufficient.
[5] Tempering after martensitic transformation.
[6] Either 2 x 4 h or 1 x 8 h as minimum time.

**Table A.3:** Guidelines on the temperatures for hot forming and heat treatment[1] of precipitation hardening stainless steels

| Steel designation | | Hot forming | | Heat treatment symbol | Solution annealing | | Precipitation hardening |
|---|---|---|---|---|---|---|---|
| name | number | Temperature °C | Type of cooling | | Temperature[2] °C | Type of cooling | Temperature °C |
| Standard grades | | | | | | | |
| X5CrNiCuNb16-4 | 1.4542 | 1150 to 900 | furnace, air | AT[3] | 1030 to 1050 | oil, air | - |
| | | | | P800 | 1030 to1050 | | 2 h 760 °C/air + 4 h 620 °C/air |
| | | | | P930 | 1030 to 1050 | | 4 h 620 °C/air |
| | | | | P960 | 1030 to 1050 | | 4 h 590 °C/air |
| | | | | P1070 | 1030 to 1050 | | 4 h 550 °C/air |
| X7CrNiAl17-7 | 1.4568 | | air | AT | 1060 to 1080 | water, air | - |
| X5CrNiMoCuNb14-5 | 1.4594 | | furnace, air | AT[3] | 1030 to 1050 | oil, air | - |
| | | | | P930 | 1030 to 1050 | | 4 h 620 °C/air |
| | | | | P1000 | 1030 to 1050 | | 4 h 580 °C/air |
| | | | | P1070 | 1030 to 1050 | | 4 h 550 °C/air |

1) The temperatures of solution annealing shall be agreed for simulated heat-treated test pieces.
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) Not suitable for direct application; prompt precipitation hardening after solution annealing is recommended to avoid cracking.

**Table A.4:** Guidelines on the temperatures for hot forming and heat treatment[1] of austenitic stainless steels

| Steel designation | | Hot forming | | Heat treatment symbol | Solution annealing[2] | |
|---|---|---|---|---|---|---|
| name | number | Temperature °C | Type of cooling | | Temperature [3][4] °C | Type of cooling |
| Standard grades | | | | | | |
| X10CrNi18-8 | 1.4310 | 1200 to 900 | air | AT | 1000 to1100 | water, air[5] |
| X2CrNi18-9 | 1.4307 | | | | 1000 to 1100 | |
| X2CrNi19-11 | 1.4306 | | | | 1000 to 1100 | |
| X2CrNiN18-10 | 1.4311 | | | | 1000 to 1100 | |
| X5CrNi18-10 | 1.4301 | | | | 1000 to 1100 | |
| X8CrNiS18-9 | 1.4305 | | | | 1000 to 1100 | |
| X6CrNiTi18-10 | 1.4541 | | | | 1020 to 1120 | |
| X5CrNi18-12 | 1.4303 | | | | 1000 to 1100 | |
| X2CrNiMo17-12-2 | 1.4404 | | | | 1020 to 1120 | |
| X2CrNiMoN17-11-2 | 1.4406 | | | | 1020 to 1120 | |
| X5CrNiMo17-12-2 | 1.4401 | | | | 1020 to 1120 | |
| X6CrNiMoTi17-12-2 | 1.4571 | | | | 1020 bis 1120 | |
| X2CrNiMo17-12-3 | 1.4432 | | | | 1020 to 1120 | |
| X2CrNiMoN17-13-3 | 1.4429 | | | | 1020 to 1120 | |
| X3CrNiMo17-13-3 | 1.4436 | | | | 1020 to 1120 | |
| X2CrNiMo18-14-3 | 1.4435 | | | | 1020 to 1120 | |
| X2CrNiMoN17-13-5 | 1.4439 | | | | 1020 to 1120 | |
| X3CrNiCu18-9-4 | 1.4567 | | | | 1000 to 1100 | |
| X1NiCrMoCu25-20-5 | 1.4539 | | | | 1050 to 1150 | |
| Special grades | | | | | | |
| X6CrNiNb18-10 | 1.4550 | 1150 to 850 | air | AT | 1020 to 1120 | water, air[5] |
| X6CrNiMoNb17-12-2 | 1.4580 | | | | 1020 to 1120 | |
| X2CrNiMo18-15-4 | 1.4438 | | | | 1020 to 1120 | |
| X1CrNiSi18-15-4 | 1.4361 | 1150 to 900 | | | 1100 to 1160 | |
| X3CrNiCu19-9-2 | 1.4560 | | | | 1000 to 1100 | |
| X6CrNiCuS18-9-2 | 1.4570 | | | | 1000 to 1100 | |
| X3CrNiCuMo17-11-3-2 | 1.4578 | | | | 1000 to 1100 | |
| X1NiCrMoCu31-27-4 | 1.4563 | 1150 to 850 | | | 1050 to 1150 | |
| X1CrNiMoCuN25-25-5 | 1.4537 | 1200 to 950 | | | 1120 to 1180 | |
| X1CrNiMoCuN20-18-7 | 1.4547 | | | | 1140 to 1200 | |
| X1NiCrMoCuN25-20-7 | 1.4529 | | | | 1120 to 1180 | |

[1] The temperatures of solution annealing shall be agreed for simulated heat-treated test pieces.

[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] The solution annealing may be omitted, if the conditions for hot working and subsequent cooling are such that the requirements for the mechanical properties of the product and the resistance to intergranular corrosion as defined in EURONORM 114 are obtained.

[4] The lower end of the range specified for solution annealing should be aimed at for heat treatment as part of further processing, because otherwise the mechanical properties might be affected. If the temperature of hot forming does not drop below the lower temperature for solution annealing, a temperature of 980 °C is adequate as lower limit for Mo-free steels, a temperature of 1 000 °C for steels with Mo contents up to 3 % and a temperature of 1 020 °C for steels with Mo contents exceeding 3 %.

[5] Cooling sufficiently rapid.

**Table A.5:** Guidelines on the temperatures for hot forming and heat treatment[1] of austenitic-ferritic stainless steels

| Steel designation | | Hot forming | | Heat treatment symbol | Solution annealing[2] | |
|---|---|---|---|---|---|---|
| name | number | Temperature °C | Type of cooling | | Temperature[3] °C | Type of cooling |
| Standard grades | | | | | | |
| X3CrNiMoN27-5-2 | 1.4460 | 1200 to 950 | air | AT | 1020 to 1100 | water, air[4] |
| X2CrNiMoN22-5-3 | 1.4462 | | | | 1020 to 1100 | |
| Special grades | | | | | | |
| X2CrNiN23-4 | 1.4362 | 1200 to 1000 | air | AT | 950 to 1050 | water, air |
| X2CrNiMoCuN25-6-3 | 1.4507 | | | | 1040 to 1120 | water |
| X2CrNiMoN25-7-4 | 1.4410 | | | | 1040 to 1120 | water |
| X2CrNiMoCuWN25-7-4 | 1.4501 | | | | 1040 to 1120 | water |

1) The temperatures of solution annealing shall be agreed for simulated heat-treated test pieces.
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) The solution annealing may be omitted, if the conditions for hotworking and subsequent cooling are such that the requirements for the mechanical properties of the product and the resistance to intergranular corrosion as defined in EURONORM 114 are obtained.
4) Cooling sufficiently rapid.

## Annex B

## (Informative)

## Applicable dimensional standards

EURONORM 17 Wire rod in general purpose non-alloy steel for cold drawing or forming; tolerances, dimensions

EURONORM 58 Hot-rolled flats for general purposes

EURONORM 59 Hot-rolled square bars for general purposes

EURONORM 60 Hot-rolled round bars for general purposes

EURONORM 61 Hot-rolled hexagons

EURONORM 65 Hot-rolled round bars for screws and rivets

ISO 286-1 ISO system of limits and fits - Part 1: Bases of tolerances, deviations and fits

NOTE: The notes in Table 6 contain information concerning tolerances for bright bars; special agreements are necessary if such information should become obligatory.

## Annex C

## (Informative)

## Bibliography


| | |
|---|---|
| EN 10028-7[1)] | 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 10213-4[1)] | Technical delivery conditions for steel castings for pressure purposes - Part 4: Austenitic and austenitic-ferritic steel grades |
| EN 10222-6[1)] | Steel forgings for pressure purposes - Part 6: Austenitic, martensitic and austenitic-ferritic stainless steeels |
| EURONORM 95 | Heat resisting steels - Quality requirements |
| EURONORM 119-5 | Steels for cold heading and cold extruding - Part 5: Quality requirements for stainless steels |
| EURONORM 144 | Round wire rod in stainless and heat resisting steel intended for the production of welding consumables - Quality standard |
| EURONORM 151-1 | Stainless steel wire and strip for springs - Part 1: Technical delivery conditions for wire |
| EURONORM 151-2 | Stainless steel wire and strip for springs - Part 2: Technical delivery conditions for strip |


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