

# Corrosion resistant steel castings

ICS 77.140.20; 77.140.80

## National foreword

This British Standard is the UK implementation of . It supersedes BS EN 10283:1999 which is withdrawn.

The UK participation in its preparation was entrusted to Technical Committee ISE/111, Steel Castings and Forgings.

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

This publication does not purport to include all the necessary provisions of a contract. Users are responsible for its correct application.

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ICS 77.140.20; 77.140.80

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English Version

**Corrosion resistant steel castings**

Aciers moulés résistant à la corrosion

Korrosionsbeständiger Stahlguss

This European Standard was approved by CEN on 3 January 2010.

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 CEN Management Centre or to any CEN member.

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

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## Foreword

This document (EN 10283:2010) has been prepared by Technical Committee ECISS/TC 111 “Steel castings and forgings”, the secretariat of which is held by AFNOR.

This European Standard shall be given the status of a national standard, either by publication of an identical text or by endorsement, at the latest by August 2010, and conflicting national standards shall be withdrawn at the latest by August 2010.

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. CEN [and/or CENELEC] shall not be held responsible for identifying any or all such patent rights.

This document supersedes EN 10283:1998.

Main changes made: addition of two new steel grades: austenitic grade GX4CrNiMo19-11-3 (1.4443) and ferritic-austenitic grade GX4CrNiMoN26-5-2 (1.4474) in all relevant tables as well as the replacement of the number for fully austenitic grade GX2CrNiMoCuN20-18-6 (1.4593 by 1.4557).

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

## Introduction

This European Standard retains the same format for clauses as EN 1559-1:1997 and EN 1559-2:2000. It should be used in conjunction with these documents. Where no text is given under a clause heading, the corresponding clause of EN 1559-1:1997 or EN 1559-2:2000 applies.

The structure of this standard is as follows:

- clauses and subclauses preceded by ■ indicate no additional conditions to EN 1559-1:1997 or EN 1559-2:2000<sup>1)</sup>;
- subclauses and paragraphs marked with a single dot • indicate that the conditions shall be agreed at the time of enquiry and order;
- subclauses marked with two dots •• indicate that conditions may be agreed at the time of enquiry and order (optional);
- subclauses without dot marking are mandatory.

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1) When additional information is given in a clause or subclause of this standard (versus the same clause or subclause of EN 1559-1:1997 or EN 1559-2:2000) it is preceded by: "In addition to EN 1559:".

## 1 Scope

This European Standard applies to corrosion resistant steel castings for general purposes.

This standard relates to castings manufactured from martensitic, austenitic, fully austenitic and ferritic-austenitic steel grades characterised by their chemical composition (see Table 1) and mechanical properties (see Table 2).

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

In cases where castings are welded:

- to wrought products (plates, tubes, forgings);
- or by non founders;

this European Standard does not apply.

## 2 Normative references

The following referenced documents are indispensable for the application of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

EN 1559-1:1997, *Founding — Technical conditions of delivery — Part 1: General*

EN 1559-2:2000, *Founding — Technical conditions of delivery — Part 2: Additional requirements for steel castings*

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

EN ISO 3651-2, *Determination of resistance to intergranular corrosion of stainless steels — Part 2: Ferritic, austenitic and ferritic-austenitic (duplex) stainless steels — Corrosion test in media containing sulphuric acid (ISO 3651-2:1998)*

## 3 ■ Definitions

## 4 ■ Information to be supplied by the purchaser

## 5 Designations

In addition to EN 1559-2:2000:

For a steel grade manufactured to different strength levels, according to the heat treatment, a suffix shall be added in accordance with EN 10027-1.

## **6 Manufacture**

### **6.1 Manufacturing process**

#### **6.1.1 Melting**

In addition to EN 1559-2:2000:

Alternative processes are left to the discretion of the manufacturer.

#### **6.1.2 Heat treatment**

Unless otherwise agreed, the type of heat treatment represented by its symbol shall comply with Table 2. For some grades there are different options with different mechanical properties given in Table 2.



Table 1 — Chemical composition (cast analysis) (% by mass)

	Designation		C max.	Si max.	Mn max.	P max.	S max.	Cr	Mo	Ni	N	Cu	Nb <sup>a</sup>	W max.
	Name	Number												
Martensitic grades	GX12Cr12	1.4011	0,15	1,00	1,00	0,035	0,025	11,50 to 13,50	max. 0,50	max. 1,00	- -	- -	- -	- -
	GX7CrNiMo12-1	1.4008	0,10	1,00	1,00	0,035	0,025	12,00 to 13,50	0,20 to 0,50	1,00 to 2,00	- -	- -	- -	- -
	GX4CrNi13-4	1.4317	0,06	1,00	1,00	0,035	0,025	12,00 to 13,50	max. 0,70	3,50 to 5,00	- -	- -	- -	- -
	GX4CrNiMo16-5-1	1.4405	0,06	0,80	1,00	0,035	0,025	15,00 to 17,00	0,70 to 1,50	4,00 to 6,00	- -	- -	- -	- -
	GX4CrNiMo16-5-2	1.4411	0,06	0,80	1,00	0,035	0,025	15,00 to 17,00	1,50 to 2,00	4,00 to 6,00	- -	- -	- -	- -
	GX5CrNiCu16-4	1.4525	0,07	0,80	1,00	0,035	0,025	15,00 to 17,00	max. 0,80	3,50 to 5,50	max. 0,05	2,50 to 4,00	max. 0,35	- -
Austenitic grades	GX2CrNi19-11	1.4309	0,030	1,50	2,00	0,035	0,025	18,00 to 20,00	-	9,00 to 12,00	max. 0,20	-	-	-
	GX5CrNi19-10	1.4308	0,07	1,50	1,50	0,040	0,030	18,00 to 20,00	-	8,00 to 11,00	-	-	-	-
	GX5CrNiNb19-11	1.4552	0,07	1,50	1,50	0,040	0,030	18,00 to 20,00	-	9,00 to 12,00	-	-	8 x % C ≤ 1,00	-
	GX2CrNiMo19-11-2	1.4409	0,030	1,50	2,00	0,035	0,025	18,00 to 20,00	2,00 to 2,50	9,00 to 12,00	max. 0,20	-	-	-
	GX5CrNiMo19-11-2	1.4408	0,07	1,50	1,50	0,040	0,030	18,00 to 20,00	2,00 to 2,50	9,00 to 12,00	-	-	-	-
	GX5CrNiMoNb19-11-2	1.4581	0,07	1,50	1,50	0,040	0,030	18,00 to 20,00	2,00 to 2,50	9,00 to 12,00	-	-	8 x % C ≤ 1,00	-
	GX4CrNiMo19-11-3	1.4443	0,05	1,50	2,00	0,040	0,030	18,00 to 20,00	2,50 to 3,00	10,00 to 13,00	-	-	-	-
	GX5CrNiMo19-11-3	1.4412	0,07	1,50	1,50	0,040	0,030	18,00 to 20,00	3,00 to 3,50	10,00 to 13,00	-	-	-	-

continued

Table 1 (continued)

	Designation		C max.	Si max.	Mn max.	P max.	S max.	Cr	Mo	Ni	N	Cu	Nb <sup>a</sup>	W max.
	Name	Number												
	GX2CrNiMoN17-13-4	1.4446	0,030	1,00	1,50	0,040	0,030	16,50 to 18,50	4,00 to 4,50	12,50 to 14,50	0,12 to 0,22	-	-	-
Fully austenitic grades	GX2NiCrMo28-20-2	1.4458	0,030	1,00	2,00	0,035	0,025	19,00 to 22,00	2,00 to 2,50	26,00 to 30,00	max. 0,20	max. 2,00	-	-
	GX4NiCrCuMo30-20-4	1.4527	0,06	1,50	1,50	0,040	0,030	19,00 to 22,00	2,00 to 3,00	27,50 to 30,50		3,00 4,00	-	-
	GX2NiCrMoCu25-20-5	1.4584	0,025	1,00	2,00	0,035	0,020	19,00 to 21,00	4,00 to 5,00	24,00 to 26,00	max. 0,20	1,00 3,00	-	-
	GX2NiCrMoN25-20-5	1.4416	0,030	1,00	1,00	0,035	0,020	19,00 to 21,00	4,50 to 5,50	24,00 to 26,00	0,12 to 0,20	-	-	-
	GX2NiCrMoCuN29-25-5	1.4587	0,030	1,00	2,00	0,035	0,025	24,00 to 26,00	4,00 to 5,00	28,00 to 30,00	0,15 to 0,25	2,00 3,00	-	-
	GX2NiCrMoCuN25-20-6	1.4588	0,025	1,00	2,00	0,035	0,020	19,00 to 21,00	6,00 to 7,00	24,00 to 26,00	0,10 to 0,25	0,50 1,50	-	-
	GX2CrNiMoCuN20-18-6	1.4557	0,025	1,00	1,20	0,030	0,010	19,50 to 20,50	6,00 to 7,00	17,50 to 19,50	0,18 to 0,24	0,50 1,00	-	-
Ferritic-austenitic grades	GX4CrNiMoN26-5-2	1.4474	0,05	1,00	2,00	0,035	0,025	25,00 to 27,00	1,30 to 2,00	4,50 to 6,50	0,12 to 0,20	-	-	-
	GX4CrNiN26-7	1.4347	0,05	1,50	1,50	0,035	0,020 0,020	25,00 to 27,00		5,50 to 7,50	0,10 to 0,20	-	-	-
	GX2CrNiMoN22-5-3	1.4470	0,030	1,00	2,00	0,035	0,025	21,00 to 23,00	2,50 to 3,50	4,50 to 6,50	0,12 to 0,20	-	-	-
	GX2CrNiMoN25-6-3	1.4468	0,030	1,00	2,00	0,035	0,025	24,50 to 26,50	2,50 to 3,50	5,50 to 7,00	0,12 to 0,25	-	-	-
	GX2CrNiMoCuN25-6-3-3	1.4517	0,030	1,00	1,50	0,035	0,025	24,50 to 26,50	2,50 to 3,50	5,00 to 7,00	0,12 to 0,22	2,75 to 3,50	-	-
	GX2CrNiMoN25-7-3 <sup>b</sup>	1.4417	0,030	1,00	1,50	0,030	0,020	24,00 to 26,00	3,00 to 4,00	6,00 to 8,50	0,15 to 0,25	max. 1,00	-	1,00
	GX2CrNiMoN26-7-4	1.4469	0,030	1,00	1,00	0,035	0,025	25,00 to 27,00	3,00 to 5,00	6,00 to 8,00	0,12 to 0,22	max. 1,30	-	-
<sup>a</sup>	The niobium content value applies for the sum of niobium + tantalum.													
<sup>b</sup>	For special application a minimum content of 0,5 copper and 0,5 tungsten can be agreed.													

Table 2 — Mechanical properties

	Designation		Heat treatment <sup>a</sup>			Thickness mm max.	Test at room temperature				
	Name	Number	Symbol	Quenching (+ Q) or Sol. Annealing (+ AT) °C	Tempering (+ T) °C		Tensile test				Impact test
							$R_{p0,2}$ MPa* min.	$R_{p1,0}$ MPa* min.	$R_m$ MPa* min.	$A$ % min.	$KV$ J min.
Martensitic grades	GX12Cr12	1.4011	+ QT	950 to 1 050	650 to 750	150	450	-	620	15	20
	GX7CrNiMo12-1	1.4008	+ QT	1 000 to 1 050	620 to 720	300	440	-	590	15	27
	GX4CrNi13-4	1.4317	+ QT1	1 000 to 1 050	590 to 620	300	550	-	760	15	50
			+ QT2	1 000 to 1 050	500 to 530	300	830	-	900	12	35
			+ QT3	1 000 to 1 050	660 to 680 560 to 620	300	500	-	700	16	50
	GX4CrNiMo16-5-1	1.4405	+ QT	1 020 to 1 070	580 to 630	300	540	-	760	15	60
	GX4CrNiMo16-5-2	1.4411	+ QT	1 020 to 1 070	580 to 630	300	540	-	760	15	60
	GX5CrNiCu16-4	1.4525	+ QT1	1 020 to 1 070	560 to 610	300	750	-	900	12	20
+ QT2			1 020 to 1 070	460 to 500	300	1 000	-	1 100	5	-	
Austenitic grades	GX2CrNi19-11	1.4309	+ AT	1 050 to 1 150	-	150	185	210	440	30	80
	GX5CrNi19-10	1.4308	+ AT	1 050 to 1 150	-	150	175	200	440	30	60
	GX5CrNiNb19-11	1.4552	+ AT	1 050 to 1 150	-	150	175	200	440	25	40
	GX2CrNiMo19-11-2	1.4409	+ AT	1 080 to 1 150	-	150	195	220	440	30	80
	GX5CrNiMo19-11-2	1.4408	+ AT	1 080 to 1 150	-	150	185	210	440	30	60
	GX5CrNiMoNb19-11-2	1.4581	+ AT	1 080 to 1 150	-	150	185	210	440	25	40
	GX4CrNiMo19-11-3	1.4443	+ AT	1 080 to 1 150	-	150	185	210	440	30	60
	GX5CrNiMo19-11-3	1.4412	+ AT	1 120 to 1 180	-	150	205	230	440	30	60
	GX2CrNiMoN17-13-4	1.4446	+ AT	1 140 to 1 180	-	150	210	235	440	20	50

continued

Table 2 (continued)

	Designation		Heat treatment <sup>a</sup>			Thickness mm max.	Test at room temperature				
							Tensile test				Impact test
	Name	Number	Symbol	Quenching (+ Q) or Sol.Annealing (+ AT) °C	Tempering (+ T) °C		R <sub>p0,2</sub> MPa* min.	R <sub>p1,0</sub> MPa* min.	R <sub>m</sub> MPa* min.	A %	KV J min.
Fully austenitic grades	GX2NiCrMo28-20-2	1.4458	+ AT	1 080 to 1 180	-	150	165	190	430	30	60
	GX4NiCrCuMo30-20-4	1.4527	+ AT	1 140 to 1 180	-	150	170	195	430	35	60
	GX2NiCrMoCu25-20-5	1.4584	+ AT	1 160 to 1 200	-	150	185	210	450	30	60
	GX2NiCrMoN25-20-5	1.4416	+ AT	1 160 to 1 200	-	150	185	210	450	30	60
	GX2NiCrMoCuN29-25-5	1.4587	+ AT	1 170 to 1 210	-	150	220	245	480	30	60
	GX2NiCrMoCuN25-20-6	1.4588	+ AT	1 200 to 1 240	-	50	210	235	480	30	60
	GX2CrNiMoCuN20-18-6	1.4557	+ AT	1 200 to 1 240	-	50	260	285	500	35	50
Ferritic-austenitic grades	GX4CrNiMoN26-5-2	1.4474	+ AT <sup>b</sup>	1 120 to 1 150	-	150	420	-	600	20	30
	GX4CrNiN26-7	1.4347	+ AT <sup>b</sup>	1 040 to 1 140	-	150	420	-	590	20	30
	GX2CrNiMoN22-5-3	1.4470	+ AT <sup>b</sup>	1 120 to 1 150	-	150	420	-	600	20	30
	GX2CrNiMoN25-6-3	1.4468	+ AT <sup>b</sup>	1 120 to 1 150	-	150	480	-	650	22	50
	GX2CrNiMoCuN25-6-3-3	1.4517	+ AT <sup>b c</sup>	1 120 to 1 150	-	150	480	-	650	22	50
	GX2CrNiMoN25-7-3	1.4417	+ AT <sup>b</sup>	1 120 to 1 150	-	150	480	-	650	22	50
	GX2CrNiMoN26-7-4	1.4469	+ AT <sup>b</sup>	1 120 to 1 150	-	150	480	-	650	22	50

<sup>a</sup> +Q means: quenching in air or liquid. + AT means: solution annealing + quenching in water.  
<sup>b</sup> After solution annealing at high temperature, castings may be cooled to a temperature between 1 040 °C and 1 010 °C prior to water quenching to prevent cracks and to improve corrosion resistance.  
<sup>c</sup> After solution annealing + quenching in water, precipitation hardening is possible by treatment at 480 °C to 510 °C, while ductility, impact energy and corrosion resistance are only slightly lowered.  
\* 1 MPa = 1 N/mm<sup>2</sup>.

## 6.2 Welding operations

### 6.2.1 ■ General

NOTE For austenitic, fully austenitic and ferritic-austenitic (duplex) grades with a carbon content greater than 0,030 %, when welding cannot be followed by heat treatment as solution annealing (+AT), there may be a risk of intergranular corrosion.

### 6.2.2 Production welding

In addition to EN 1559-2:2000:

Information on preheat, and interpass temperatures as well as on postweld heat-treatment is given in Annex A.

## 6.3 ■ Further processing

## 7 Requirements

### 7.1 ■ General

### 7.2 Materials

#### 7.2.1 Chemical composition

In addition to EN 1559-2:2000:

- the chemical composition determined by a cast analysis shall conform with the values given in Table 1;
- permissible deviations between the specified cast analysis and the check analysis on test blocks are indicated EN 1559-2:2000;
- elements unspecified shall not be intentionally added without agreement of the purchaser other than for the purpose of finishing the heat. If not otherwise agreed the maximum values in percent by mass (% by mass) given in Table 3 shall apply.

**Table 3 — Maximum contents of unspecified elements (% by mass)**

Steel types	Element	
	V	Cu
Martensitic steel grades	0,08	0,30
Austenitic and ferritic-austenitic steel grades	-	0,50

#### 7.2.2 Mechanical properties

**7.2.2.1** The mechanical properties shall conform to the values given in Table 2. They are verified on test blocks, see 8.4. In all cases the maximum thickness shall be limited to 150 mm.

●● In cases where the ruling thickness specified by the purchaser is above the maximum thickness given in Table 2, the mechanical properties shall be agreed.

**7.2.2.2** The values of yield and tensile strength also apply to the casting itself up to the maximum wall thickness as given in Table 2.

The yield strength values at room temperature correspond to:

- 0,2 % proof strength ( $R_{p0,2}$ ) for martensitic, austenitic, fully austenitic and ferritic-austenitic steels;
- 1,0 % proof strength ( $R_{p1,0}$ ) for austenitic and fully austenitic steels.

### **7.2.3 ■ Other properties**

## **7.3 ■ Casting**

### **7.3.1 ■ Chemical composition**

### **7.3.2 ■ Mechanical properties**

### **7.3.3 ■ Non destructive testing**

### **7.3.4 ■ Condition of the casting**

### **7.3.5 ■ Mass of the casting**

### **7.3.6 ■ Additional requirements regarding the condition of the casting**

## **7.4 Corrosion behaviour**

Austenitic steel grades shall be resistant to intergranular corrosion when tested according to EN ISO 3651-2.

NOTE All grades of this European Standard have performed satisfactory for long time. However it is difficult to provide absolute information on corrosion resistance. Values obtained under laboratory test conditions are not always adequate for the real application. Additives and contamination in the corrosive media can give rise to different results.

- Grades may be selected by the "pitting index" P.I. = % Cr + 3,3 x % Mo + 16 x % N.

Based upon this a minimum pitting index can be required by agreement.

## **8 Testing and documents on material testing**

### **8.1 General**

In addition to EN 1559-1:1997:

- a) Castings manufactured according to this standard may be supplied with an inspection document according to EN 10204;
- b) If, in the case of specific inspection, the issue of an inspection certificate has been agreed this shall include the following:
  - 1) the amounts of all elements specified (for the cast analysis) for the steel grade required;
  - 2) the results of the mechanical test as required for the specific steel grade;
  - 3) a statement on the result of agreed dimensional check and non destructive testing;

- 4) •• the result of any further mutually agreed testing.

## 8.2 ■ Inspection and testing

### 8.3 Test unit sampling

#### 8.3.1 Formation of test units

For castings under 1 000 kg in mass the delivered quantity shall be subdivided into lots covering castings of the same type from the same melt and having undergone the same heat treatment. The mass of a lot (test unit) shall not be greater than 5 000 kg.

8.3.2 For casting more than 1 000 kg in mass, each individual casting shall be regarded as the test unit.

#### 8.4 ■ Samples (test blocks)

### 8.5 Test methods

- a) ■ Tensile test at room temperature;
- b) tensile test at elevated temperature not applicable;
- c) ■ impact test;
- d) ■ ferrite content;
- e) ■ hardness test;
- f) ■ homogeneity of test units (hardness test);
- g) ■ pressure or leak testing;
- h) •• intergranular corrosion test.

The test, carried out in accordance with EN ISO 3651-2, shall be agreed at the time of enquiry and order.

- i) •• Tests for magnetic properties.

In addition to EN 1559-2:2000: magnetic permeability shall be specified at the time of enquiry and order.

- j) ■ Other tests for any other properties shall be agreed.

### 8.6 ■ Invalidation of tests

### 8.7 ■ Retests

### 8.8 ■ Sorting and reprocessing

## 9 ■ Marking

## 10 ■ Packaging and surface protection

## **11 ■ Complaints**

## **12 Supplementary information**

Information on physical properties of the steel grades is given in Annex B.



## Annex A (informative)

### Welding conditions

**Table A.1 — Welding conditions**

	Designation		Preheat temperature °C <sup>a</sup>	Max. interpass temp. °C	Post weld heat treatment <sup>b</sup>	
	Name	Number			minor welds	major welds
Martensitic grades	GX12Cr12	1.4011	250 to 300	350	+ T	+ T
	GX7CrNiMo12-1	1.4008	150 to 200	300	+ T	+ T
	GX4CrNi13-4	1.4317	20 to 200	c	+ T	+ T
	GX4CrNiMo16-5-1	1.4405	no preheat	200	+ T	+ T
	GX4CrNiMo16-5-2	1.4411	no preheat	200	+ T	+ T
	GX5CrNiCu16-4	1.4525	20 to 100	120	+ T	+ T
Austenitic grades	GX2CrNi19-11	1.4309	no preheat	c	none <sup>d</sup>	none <sup>d</sup>
	GX5CrNi19-10	1.4308	no preheat	c	+ AT	+ AT
	GX5CrNiNb19-11	1.4552	no preheat	c	none <sup>d</sup>	none <sup>d</sup>
	GX2CrNiMo19-11-2	1.4409	no preheat	c	none <sup>d</sup>	none <sup>d</sup>
	GX5CrNiMo19-11-2	1.4408	no preheat	c	+ AT	+ AT
	GX5CrNiMoNb19-11-2	1.4581	no preheat	c	none <sup>d</sup>	none <sup>d</sup>
	GX4CrNiMo19-11-3	1.4443	no preheat	c	+ AT	+ AT
	GX5CrNiMo19-11-3	1.4412	no preheat	c	+ AT	+ AT
	GX2CrNiMoN17-13-4	1.4446	20 to 100	c	+ AT	+ AT
Fully austenitic grades	GX2NiCrMo28-20-2	1.4458	20 to 100	200	none <sup>d</sup>	+ AT
	GX4NiCrCuMo30-20-4	1.4527	20 to 100	200	+ AT	+ AT
	GX2NiCrMoCu25-20-5	1.4584	20 to 100	200	none <sup>d</sup>	+ AT
	GX2NiCrMoN25-20-5	1.4416	20 to 100	200	+ AT	+ AT
	GX2NiCrMoCuN29-25-5	1.4587	20 to 100	200	none <sup>d</sup>	+ AT
	GX2NiCrMoCuN25-20-6	1.4588	20 to 100	200	none <sup>d</sup>	+ AT
	GX2CrNiMoCuN20-18-6	1.4557	20 to 100	200	+ AT	+ AT
Ferritic-austenitic grades	GX4CrNiMoN26-5-2	1.4474	20 to 100	250 <sup>e</sup>	+ AT <sup>e</sup>	+ AT <sup>e</sup>
	GX4CrNiN26-7	1.4347	20 to 100	250 <sup>e</sup>	+ AT <sup>e</sup>	+ AT
	GX2CrNiMoN22-5-3	1.4470	20 to 100	250 <sup>e</sup>	+ AT <sup>e</sup>	+ AT
	GX2CrNiMoN25-6-3	1.4468	20 to 100	250 <sup>e</sup>	+ AT <sup>e</sup>	+ AT
	GX2CrNiMoCuN25-6-3-3	1.4517	20 to 100	250 <sup>e</sup>	+ AT <sup>e</sup>	+ AT
	GX2CrNiMoN25-7-3	1.4417	20 to 100	250 <sup>e</sup>	+ AT <sup>e</sup>	+ AT
	GX2CrNiMoN26-7-4	1.4469	20 to 100	250 <sup>e</sup>	+ AT <sup>e</sup>	+ AT
<sup>a</sup>	The preheat temperature is related to the geometry and the thickness of the casting and climatic conditions.					
<sup>b</sup>	+ T: tempering (same as tempering carried out on the base material). + AT: solution annealing + water quenching (same as solution annealing carried out on the base material) (see Table 2). Air quenching may be agreed for very small and thin castings, according to corrosion conditions.					
<sup>c</sup>	At the discretion of the manufacturer unless otherwise agreed.					
<sup>d</sup>	Special arrangement may be agreed upon according to corrosion conditions.					
<sup>e</sup>	For low preheat and low interpass temperature ( $\leq 150$ °C) the post weld heat treatment may be suppressed by agreement.					

## Annex B (informative)

### Physical properties

**Table B.1 — Physical properties**

	Designation		Density kg/dm <sup>3</sup> At 20 °C	Specific Heat J/(kg·K) At 20 °C	Thermal conductivity		Mean thermal expansion 10 <sup>-6</sup> ·K <sup>-1</sup> From 20 °C up to		
					W/(m·K) at		100 °C	300 °C	500 °C
	Name	Number	At 20 °C	At 20 °C	50 °C	100 °C	100 °C	300 °C	500 °C
Martensitic grades	GX12Cr12	1.4011	7.7	440	25	26	10,5	11,3	12
	GX7CrNiMo12-1	1.4008	7,7	460	25	26	10,5	11,3	12
	GX4CrNi13-4	1.4317	7,7	460	26	27	10,5	11	12
	GX4CrNiMo16-5-1	1.4405	7,8	460	17	18	10,8	11,5	12
	GX4CrNiMo16-5-2	1.4411	7,8	460	17	18	11,0	11,8	12,3
	GX5CrNiCu16-4 + QT1 + QT2	1.4525	7,8	460	17,5	18,5	11,8	12,8	13,4
Austenitic grades	GX2CrNi19-11	1.4309	7,88	530	15,2	16,5	16,8	17,9	18,6
	GX5CrNi19-10	1.4308	7,88	530	15,2	16,5	16,8	17,9	18,6
	GX5CrNiNb19-11	1.4552	7,88	530	15,2	16,5	16,8	17,9	18,6
	GX2CrNiMo19-11-2	1.4409	7,9	530	14,5	15,8	15,8	17	17,7
	GX5CrNiMo19-11-2	1.4408	7,9	530	14,5	15,8	15,8	17	17,7
	GX5CrNiMoNb19-11-2	1.4581	7,9	530	14,5	15,8	15,8	17	17,7
	GX4CrNiMo19-11-3	1.4443	7,9	530	14,5	15,8	15,8	17	17,7
	GX5CrNiMo19-11-3	1.4412	7,9	530	14,5	15,8	15,8	17	17,7
	GX2CrNiMoN17-13-4	1.4446	7,9	530	13,5	15	16	18	19
Fully austenitic grades	GX2NiCrMo28-20-2	1.4458	8,0	500	16	17	14,5	16,2	17
	GX4NiCrCuMo30-20-4	1.4527	8,0	500	15	16	14,5	16,2	17
	GX2NiCrMoCu25-20-5	1.4584	8,0	500	17	21	14,5	15,8	17
	GX2NiCrMoCuN29-25-5	1.4416	8,0	450	12,2	13,2	15,1	15,8	16,6
	GX2NiCrMoN25-20-5	1.4587	8,0	500	17	21	14,5	15,8	17
	GX2NiCrMoCuN25-20-6	1.4588	8,0	500	15	16	16,5	17,5	18,5
	GX2CrNiMoCuN20-18-6	1.4557	7,9	500	15	16	16,5	17,5	18,5
Ferritic-austenitic grades	GX4CrNiMoN26-5-2	1.4474	7,7	450	17	18	13	14	-
	GX4CrNiN26-7	1.4347	7,7	500	15	-	12,5	13,5	14,5
	GX2CrNiMoN22-5-3	1.4470	7,7	450	18	19	13	14	-
	GX2CrNiMoN25-6-3	1.4468	7,7	450	17	18	13	14	-
	GX2CrNiMoCuN25-6-3-3	1.4517	7,7	450	17	18	13	14	-
	GX2CrNiMoN25-7-3	1.4417	7,7	450	17	18	13	14	-
	GX2CrNiMoN26-7-4	1.4469	7,7	450	17	18	13	14	-

## **Bibliography**

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