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**Cast steels and alloys with special  
physical properties**

*Aciers et alliages moulés avec caractéristiques physiques particulières*

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## Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

International Standards are drafted in accordance with the rules given in the ISO/IEC Directives, Part 2.

The main task of technical committees is to prepare International Standards. Draft International Standards adopted by the technical committees are circulated to the member bodies for voting. Publication as an International Standard requires approval by at least 75 % of the member bodies casting a vote.

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

ISO 19960 was prepared by Technical Committee ISO/TC 17, *Steel*, Subcommittee SC 11, *Steel castings*.

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# Cast steels and alloys with special physical properties

## 1 Scope

This International Standard specifies cast steel and alloy grades with special physical properties. The cast steel and alloy grades covered by this International Standard are used in applications which require low linear thermal expansion, or low ferromagnetic responses, or low galling properties.

## 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.

ISO 4990:2003, *Steel castings — General technical delivery requirements*

ISO 11970:2001, *Specification and approval of welding procedures for production welding of steel castings*

## 3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO 4990 and the following apply.

### 3.1

#### **galling**

damage or breaking of the surface by friction or abrasion

## 4 General conditions for delivery

Materials furnished according to this International Standard shall conform to the applicable requirements of ISO 4990, including the supplementary requirements that are indicated on the enquiry and purchase order.

## 5 Chemical composition

The cast steel and alloy grades shall conform to the requirements for chemical composition specified in Table 1.

## 6 Mechanical properties

Cast steel and alloy grades used for castings shall conform to the mechanical property requirements given in Table 2 up to the maximum ruling thickness. Verification of impact properties is not required, except when indicated by the customer. Test coupons used to verify the mechanical properties shall not have a thickness exceeding 100 mm. For pieces removed from castings, the test bar location and the mechanical properties required shall be agreed between the manufacturer and purchaser.

For grades GX3NiCo32, GX3NiCo29-17 and G-NiCr13SnBiMo, no mechanical properties are specified.

## 7 Heat treatment

Castings shall be heat treated in accordance with the requirements of Table 3.

## 8 Welding

Castings shall be welded in accordance with the procedures specified in ISO 11970.

## 9 Verification of physical properties

When physical properties are specified, the method of measurement and acceptance requirements shall be the subject of an agreement between the manufacturer and purchaser. Typical values for some physical properties are given in Table 4.

## 10 Marking

Alternative markings are permitted (Table 5), unless otherwise agreed.

## 11 Supplementary requirements

The following supplementary requirements shall apply only when specified on the enquiry and purchase order and agreed upon by the manufacturer and purchaser.

A list of standardized supplementary requirements for use at the option of the purchaser is included in Annex B of ISO 4990. The subclauses of ISO 4990 which are ordinarily considered suitable for use with this International Standard are given in Annex A. Other supplementary requirements, whether or not in ISO 4990, may be used with this International Standard upon agreement by the manufacturer and purchaser.

Table 1 — Chemical composition, % by mass

Designation	C	Si	Mn	P	S	Cr	Mo	Ni	N	Co	Cu	Others
GX12CrNi18-11 <sup>a</sup>	≤ 0,15	≤ 1,50	≤ 2,00	≤ 0,045	≤ 0,030	16,5-18,5	≤ 0,75	10,0-12,0			≤ 0,50	
GX2CrNi18-13 <sup>a</sup>	≤ 0,030	≤ 1,50	≤ 2,00	≤ 0,035	≤ 0,020	16,5-18,5	≤ 1,00	12,0-14,0	0,10-0,20		≤ 0,50	
GX2CrNiMoN18-14 <sup>a</sup>	≤ 0,030	≤ 1,50	≤ 2,00	≤ 0,035	≤ 0,020	16,5-18,5	2,50-3,00	13,0-15,0	0,15-0,25		≤ 0,50	
GX2CrNi19-11 <sup>a</sup>	≤ 0,030	≤ 1,50	≤ 2,00	≤ 0,035	≤ 0,020	18,0-20,0	≤ 1,00	10,0-12,0	0,10-0,20		≤ 0,50	
GX3CrNiMnSi17-9-8 <sup>a</sup>	≤ 0,05	3,5-4,5	7,0-9,0	≤ 0,045	≤ 0,030	16,0-18,0	≤ 1,00	8,0-9,0	0,08-0,18		≤ 0,50	
GX4CrNiMnN22-12-5 <sup>a</sup>	≤ 0,06	≤ 1,00	4,0-6,0	≤ 0,040	≤ 0,030	20,5-23,5	1,50-3,00	11,5-13,5	0,20-0,40		≤ 0,50	0,10 ≤ Nb ≤ 0,30 0,10 ≤ V ≤ 0,30
GX2CrNiMnMoN21-16-5-3 <sup>a</sup>	≤ 0,030	≤ 1,00	4,0-6,0	≤ 0,025	≤ 0,010	20,0-21,5	3,0-3,5	15,0-17,0	0,20-0,35		≤ 0,50	Nb ≤ 0,25
GX3NiCo32 <sup>b</sup>	≤ 0,05	≤ 0,50	≤ 0,60	≤ 0,030	≤ 0,020	≤ 0,25	≤ 1,00	30,5-33,5		4,0-6,5	≤ 0,50	Al ≤ 0,10
GX3NiCo29-17 <sup>b</sup>	≤ 0,05	≤ 0,50	≤ 0,50	≤ 0,030	≤ 0,020	≤ 0,25	≤ 1,00	28,0-30,0		16,0-18,0	≤ 0,50	
GX3Ni36 <sup>b</sup>	≤ 0,05	≤ 0,50	≤ 0,50	≤ 0,030	≤ 0,020	≤ 0,25	≤ 1,00	35,0-37,0			≤ 0,50	
GX3NiS36 <sup>b</sup>	≤ 0,05	≤ 0,50	≤ 0,50	≤ 0,030	0,10-0,20	≤ 0,25	≤ 1,00	35,0-37,0			≤ 0,50	
G-NiCr13SnBiMo <sup>c</sup>	≤ 0,05	≤ 0,50	≤ 1,50	≤ 0,030	≤ 0,030	11,0-14,0	2,00-3,50	balance			≤ 0,50	Fe ≤ 2,0 3,0 ≤ Bi ≤ 5,0 3,0 ≤ Sn ≤ 5,0

<sup>a</sup> Low ferromagnetic response grades with magnetic permeability,  $\mu_r \leq 1,01$ .<sup>b</sup> For low linear-expansion grades, see Table 4.<sup>c</sup> Low galling grade.

**Table 2 — Mechanical properties at room temperature**

Designation	$R_{p0,2}^a$ min. MPa <sup>b</sup>	$R_m^a$ MPa <sup>b</sup>	$A^a$ min. %	KV <sup>a</sup> min. J
GX12CrNi18-11	195	440 to 590	20	80
GX2CrNi18-13	210	440 to 640	30	115
GX2CrNiMoN18-14	240	490 to 690	30	80
GX2CrNi19-11	180	≥ 440	30	
GX3CrNiMnSi17-9-8	290	≥ 580	24	
GX4CrNiMnN22-12-5	290	≥ 580	24	
GX2CrNiMnMoNNb21-16-5-3	315	570 to 800	20	65
GX3NiCo32	250	≥ 425	15	
GX3Ni36	175	≥ 260	20	
GX3NiS36	175	≥ 260	20	

<sup>a</sup>  $R_{p0,2}$ : 0,2 % proof stress

$R_m$ : tensile strength

$A$ : percentage elongation after fracture on original gauge-length  $L_0$

$L_0 = 5,65\sqrt{S_0}$  (where  $S_0$  is the original cross-section)

KV: ISO V-notch impact strength.

<sup>b</sup> 1 MPa = 1 N/mm<sup>2</sup>.

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**Table 3 — Heat treatment**

Designation	Treatment <sup>a</sup>
GX12CrNi18-11	Solution anneal 1050 to 1150 °C; quench
GX2CrNi18-13	Solution anneal 1050 to 1150 °C; quench
GX2CrNiMoN18-14	Solution anneal 1050 to 1150 °C; quench
GX2CrNi19-11	Solution anneal 1050 to 1150 °C; quench
GX3CrNiMnSi17-9-8	Solution anneal 1050 to 1150 °C; quench
GX4CrNiMnN22-12-5	Solution anneal 1065 to 1165 °C; quench
GX2CrNiMnMoNNb21-16-5-3	Solution anneal 1080 to 1180 °C; quench
GX3NiCo32	820 to 850 °C; quench + 300 to 350 °C; air
GX3NiCo29-17	820 to 850 °C; quench + 300 to 350 °C; air
GX3Ni36	820 to 850 °C; quench + 300 to 350 °C; air
GX3NiS36	820 to 850 °C; quench + 300 to 350 °C; air
G-NiCr13SnBiMo	as cast

<sup>a</sup> Temperatures are for information only.



Table 4 — Typical values for low linear-expansion grades

Designation	Coefficient of expansion (mm/mm) (10 <sup>-6</sup> K <sup>-1</sup> )				
	20 °C to 100 °C	20 °C to 200 °C	20 °C to 300 °C	20 °C to 500 °C	20 °C to 800 °C
GX3NiCo32	0,63				
GX3NiCo29-17	5,9	5,2	5,1	6,1	10,3
GX3Ni36	1,3	2,1	4,2		
GX3NiS36	1,6	3,0	5,9		

Tableau 5 — Alternative material grade identification

Designation	Alternative identification mark
GX12CrNi18-11	AA8
GX2CrNi18-13	AB8
GX2CrNiMoN18-14	AC8
GX2CrNi19-11	AD8
GX3CrNiMnSi17-9-8	AE8
GX4CrNiMnN22-2-5	AF8
GX2CrNiMnMoNNb21-16-5-3	AG8
GX3NiCo32	AH8
GX3NiCo29-17	AJ8
GX3Ni36	AK8
GX3NiS36	AL8
G-NiCr13SnBiMo	AM8