



**International
Standard**

ISO 4991

Steel castings for pressure purposes

Pièces moulées en acier pour service sous pression

**Fourth edition
2024-11**

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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.

The procedures used to develop this document and those intended for its further maintenance are described in the ISO/IEC Directives, Part 1. In particular, the different approval criteria needed for the different types of ISO document should be noted. This document was drafted in accordance with the editorial rules of the ISO/IEC Directives, Part 2 (see www.iso.org/directives).

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Any trade name used in this document is information given for the convenience of users and does not constitute an endorsement.

For an explanation of the voluntary nature of standards, the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the World Trade Organization (WTO) principles in the Technical Barriers to Trade (TBT), see www.iso.org/iso/foreword.html.

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

This fourth edition cancels and replaces the third edition (ISO 4991:2015), which has been technically revised.

The main changes are as follows:

- grade names and numbers have been corrected;
- a cast steel grade for higher temperature applications (550 °C to 700 °C) has been added;
- two austenitic-ferritic stainless steel (duplex) grades have been added for pressure parts up to 250 °C;
- the application temperature range of some special steels has been extended;
- qualification requirements for welders have been added.

Any feedback or questions on this document should be directed to the user's national standards body. A complete listing of these bodies can be found at www.iso.org/members.html.

Steel castings for pressure purposes

1 Scope

This document covers steel castings for pressure containing parts.

It includes materials which are used for the manufacture of components subject to pressure vessel codes and components not subject to codes.

This document relates to castings manufactured from unalloyed and alloyed steel grades (characterized by their chemical composition given in [Table 1](#), and mechanical properties in [Tables 2, 3, 4 and 5](#)).

NOTE [Annex D](#) gives information on ISO grade designation and available UNS numbers which are similar to the ISO grade designation.

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content are requirements for 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 148-1, *Metallic materials — Charpy pendulum impact test — Part 1: Test method*

ISO 4885, *Ferrous materials — Heat treatments — Vocabulary*

ISO/TS 4949, *Steel names based on letter symbols*

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

ISO 6892-1, *Metallic materials — Tensile testing — Part 1: Method of test at room temperature*

ISO 6892-2, *Metallic materials — Tensile testing — Part 2: Method of test at elevated temperature*

ISO 9606-1, *Qualification testing of welders — Fusion welding — Part 1: Steels*

ISO 11970, *Specification and qualification of welding procedures for production welding of steel castings*

ISO 13520, *Determination of ferrite content in austenitic stainless steel castings*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO 4885, ISO/TS 4949 and ISO 4990 apply.

ISO and IEC maintain terminological databases for use in the standardization at the following addresses:

- ISO Online browsing platform: available at <https://www.iso.org/obp>.
- IEC Electropedia: available at <https://www.electropedia.org/>

4 Information to be supplied by the purchaser

Materials specified in this document shall conform to the applicable requirements of ISO 4990, including the supplementary requirements listed in [Annex A](#) that are specified in the enquiry and purchase order.

5 Heat treatment

The type of heat treatment shall conform with [Table 6](#) for the specified grades. The temperatures given are for information only.

When a grade may be delivered at different strength levels depending on the type of heat treatment (see [Table 2](#)), the purchaser shall state at the time of enquiry and order the type of heat treatment required.

The symbols for the type of heat treatment are as follows:

- +N normalized
- +QT quenched and tempered
- +AT solution treated

NOTE For definitions, see ISO 4885.

6 Welding

Welding is permitted, unless otherwise agreed. All the welds shall conform to the same criteria for non-destructive testing as the relevant part of the casting. Welding shall be carried out in accordance with ISO 11970, and the welding personnel for permanent joining of components shall be qualified according to ISO 9606-1.

The welding conditions are given in [Annex B](#).

7 Requirements

7.1 Chemical composition

An analysis of each heat shall be made by the manufacturer to determine the contents of the specified elements.

The chemical composition shall comply with the values given in [Table 1](#).

Permissible deviations for the product analysis are specified in ISO 4990.

7.2 Mechanical properties

The mechanical properties shall comply with the values given in [Tables 2, 3, 4](#) and [5](#).

Mechanical properties shall be measured on test pieces taken from test blocks (according to ISO 4990).

The tensile tests at room temperature shall be carried out in accordance with ISO 6892-1 and, if specified, impact tests in accordance with ISO 148-1.

If required by agreement at the time of enquiry and order, impact energy properties at low temperature shall conform with [Table 3](#).

If required by agreement at the time of enquiry and order, impact energy values at room temperature shall conform with [Table 4](#).

If required by agreement at the time of enquiry and order, verification of the elevated temperature proof stress values shall be carried out at elevated temperatures in accordance with ISO 6892-2. In such a case, the values shall conform with [Table 5](#).

Creep resistance mean values are given for information, for some grades in [Annex C](#).

8 Inspection and testing

8.1 General

For all products ordered to the requirements of this document, specific inspection and testing is required.

8.2 Sampling

Test blocks shall be heat treated in production furnaces to the same procedure as the castings they represent.

Test pieces shall not be cut from the test block until the latter has been heat treated.

8.3 Formation of test lots

The formation of test lots shall be carried out in accordance with ISO 4990.

8.4 Non-destructive testing

The following information shall be given at the time of enquiry and order in accordance with ISO 4990:

- non-destructive testing required,
- area to be tested,
- acceptance criteria.

8.5 Marking

Castings shall be marked for material identification.

- a) Heat numbers or serial numbers that are traceable to heat numbers, shall be marked on all castings.
- b) For small castings, it may be agreed at the time of the enquiry and order that they may be batched and that their identification is marked on a label attached to each batch.
- c) Castings shall be marked with the manufacturer's identification or symbol except where other provisions have been made between the manufacturer and purchaser.
- d) When more than one heat treatment type is available, the heat treatment applied shall be marked with a suffix added to the grade designation (see [Table 2](#)).

9 Supplementary requirements

This document also specifies supplementary requirements, which may be applied to steel castings. These requirements are provided for use when additional testing or inspection is desired and apply only when individually specified by the purchaser.

A list of supplementary requirements which may be used at the option of the purchaser is given in ISO 4990 and in [Annex A](#).

If ferrite determination is required for austenitic and austenitic-ferritic grades, it may be made using ISO 13520.

Table 1 — Chemical composition, in percent, mass fraction

Grade designation		C	Si	Mn	P	S	Cr	Mo	Ni	V	Cu	Other
Name	Number		max.		max.	max.						
GP240GH	1.0619	0,18–0,23 ^a	0,60	0,50–1,20 ^a	0,030	0,020	0,30 max.	0,12 max.	0,40 max.	0,03 max.	0,30 max.	b
GP280GH	1.0625	0,18–0,25 ^a	0,60	0,80–1,20 ^a	0,030	0,020	0,30 max.	0,12 max.	0,40 max.	0,03 max.	0,30 max.	b
G17Mn5	1.1131	0,15–0,20	0,60	1,00–1,60	0,020	0,025	0,30 max.	0,12 max.	0,40 max.	0,03 max.	0,30 max.	b
G20Mn5	1.6220	0,17–0,23	0,60	1,00–1,60	0,020	0,020	0,30 max.	0,12 max.	0,80 max.	0,03 max.	0,30 max.	
G18Mo5	1.5422	0,15–0,20	0,60	0,80–1,20	0,020	0,020	0,30 max.	0,45–0,65	0,40 max.	0,050 max.	0,30 max.	
G20Mo5	1.5419	0,15–0,23	0,60	0,50–1,00	0,025	0,020	0,30 max.	0,40–0,60	0,40 max.	0,050 max.	0,30 max.	
G17CrMo5–5	1.7357	0,15–0,20	0,60	0,50–1,00	0,020	0,020	1,00–1,50	0,45–0,65	0,40 max.	0,050 max.	0,30 max.	
G17CrMo9–10	1.7379	0,13–0,20	0,60	0,50–0,90	0,020	0,020	2,00–2,50	0,90–1,20	0,40 max.	0,050 max.	0,30 max.	
G12MoCrV5–2	1.7720	0,10–0,15	0,45	0,40–0,70	0,030	0,020	0,30–0,50	0,40–0,60	0,40 max.	0,22–0,30	0,30 max.	
G17CrMoV5–10	1.7706	0,15–0,20	0,60	0,50–0,90	0,020	0,015	1,20–1,50	0,90–1,10	0,40 max.	0,20–0,30	0,30 max.	
G25NiCrMo3	1.6553	0,23–0,28	0,80	0,60–1,00	0,030	0,025	0,40–0,80	0,15–0,30	0,40–0,80	0,03 max.	0,30 max.	
G25NiCrMo6	1.6554	0,23–0,28	0,60	0,60–0,90	0,030	0,025	0,70–0,90	0,20–0,30	1,00–2,00	0,03 max.	0,30 max.	
G17NiCrMo13–6	1.6781	0,15–0,19	0,50	0,55–0,80	0,015	0,015	1,30–1,80	0,45–0,60	3,00–3,50	0,05 max.	0,30 max.	
G9Ni10	1.5636	0,06–0,12	0,60	0,50–0,80	0,020	0,015	0,30 max.	0,20 max.	2,00–3,00	0,05 max.	0,30 max.	
G9Ni14	1.5638	0,06–0,12	0,60	0,50–0,80	0,020	0,015	0,30 max.	0,20 max.	3,00–4,00	0,05 max.	0,30 max.	
GX15CrMo5	1.7365	0,12–0,19	0,80	0,50–0,80	0,025	0,025	4,00–6,00	0,45–0,65	-	0,05	0,30 max.	Nb 0,06–0,10 N 0,03–0,07 Al 0,02 max. Ti 0,01 max. Zr 0,01 max.
GX10CrMoV9–1	1.7367	0,08–0,12	0,20–0,50	0,30–0,60	0,030	0,010	8,00–9,50	0,85–1,05	0,40 max	0,18–0,25	-	
GX15CrMo9–1	1.7376	0,12–0,19	1,00	0,35–0,65	0,030	0,030	8,00–10,00	0,90–1,20	0,40 max.	0,05	0,30 max.	
GX8CrNi12–1	1.4107	0,10 max.	0,40	0,50–0,80	0,030	0,020	11,50–12,50	0,50 max.	0,80–1,50	0,08 max.	0,30 max.	
GX23CrMoV12–1	1.4931	0,20–0,26	0,40	0,50–0,80	0,030	0,020	11,30–12,20	1,00–1,20	1,00 max.	0,25–0,35	0,30 max.	
GX3CrNi13–4	1.6982	0,05 max.	1,00	1,00 max.	0,035	0,015	12,00–13,50	0,70 max.	3,50–5,00	0,08 max.	0,30 max.	
GX4CrNi13–4	1.4317	0,06 max.	1,00	1,00 max.	0,035	0,025	12,00–13,50	0,70 max.	3,50–5,00	0,08 max.	0,30 max.	
GX4CrNiMo16–5-1	1.4405	0,06 max.	0,80	1,00 max.	0,035	0,025	15,00–17,00	0,70–1,50	4,00–6,00	0,08 max.	0,30 max.	
GX2CrNi19–11	1.4487	0,03 max.	1,50	2,00 max.	0,035	0,030	18,00–20,00	-	9,00–12,00	-	0,50 max.	0,12 ≤ N ≤ 0,20
GX2CrNi19–11	1.4309	0,03 max.	1,50	2,00 max.	0,035	0,025	18,00–20,00	-	9,00–12,00	-	0,50 max.	N 0,20 max.
GX5CrNi19–10	1.4308	0,07 max.	1,50	1,50 max.	0,040	0,030	18,00–20,00	-	8,00–11,00	-	0,50 max.	
GX5CrNiNb19–11	1.4552	0,07 max.	1,50	1,50 max.	0,040	0,030	18,00–20,00	-	9,00–12,00	-	0,50 max.	8xC ≤ Nb ≤ 1,00
GX2CrNiMoN19–11-2	1.4409	0,030 max.	1,50	2,00 max.	0,035	0,030	18,00–20,00	2,00–2,50	9,00–12,00	-	0,50 max.	0,12 ≤ N ≤ 0,20
GX5CrNiMo19–11-2	1.4408	0,07 max.	1,50	1,50 max.	0,040	0,030	18,00–20,00	2,00–2,50	9,00–12,00	-	0,50 max.	
GX5CrNiMoNb19–11-2	1.4581	0,07 max.	1,50	1,50 max.	0,040	0,030	18,00–20,00	2,00–2,50	9,00–12,00	-	0,50 max.	8xC ≤ Nb ≤ 1,00

Table 1 (continued)

Grade designation		C	Si	Mn	P	S	Cr	Mo	Ni	V	Cu	Other
Name	Number		max.		max.	max.						
GX2CrNiMoN22-5-3	1.4470	0,030 max.	1,00	2,00 max.	0,035	0,025	21,00-23,00	2,50-3,50	4,50-6,50	-	0,50 max.	0,12 ≤ N ≤ 0,20
GX2CrNiMoCuN26-5-3-3	1.4451	0,030 max.	1,00	1,50 max.	0,035	0,025	25,00-27,00	2,50-3,50	5,00-7,00	-	2,75-3,50	0,12 ≤ N ≤ 0,22
GX2CrNiMoN26-7-4	1.4469	0,030 max.	1,00	1,00 max.	0,035	0,025	25,00-27,00	3,00-5,00	6,00-8,00	-	1,30 max.	0,12 ≤ N ≤ 0,22
GX2NiCrMo28-20-2	1.4458	0,030 max.	1,00	2,00 max.	0,035	0,025	19,00-22,00	2,00-2,50	26,00-30,00	-	2,00 max.	N ≤ 0,20
GX10NiCrSiNb32-20	1.4859	0,05 to 0,15	0,50-1,50	2,00 max.	0,040	0,030	19,00-21,00	0,50 max.	31,00-33,00	-	0,50 max.	0,50 ≤ Nb ≤ 1,50
GX2CrNiMoCuN25-6-3-3 ^c	1.4517	1,00	1,00	1,50 max.	0,035	0,025	24,00-26,50	2,50-3,50	5,00-7,00	-	2,75-3,50	0,12 ≤ N ≤ 0,22
GX2CrNiMoN25-7-3 ^c	1.4417	1,00	1,50	1,50 max.	0,030	0,020	24,00-26,00	3,00-4,00	6,00-8,50	-	1,00 max.	0,12 ≤ N ≤ 0,25, W 1,0 max.

^a For each reduction of 0,01 % carbon below the maximum specified, an increase of 0,04 % manganese above the maximum specified will be permitted to a maximum of 1,40 %.

^b %Cr + %Mo + %Ni + %V + %Cu ≤ 1,00 %.

^c For this steel grade a minimum value of the “pitting index” may be required as P_i = Cr + 3,3Mo +16N ≥ 40.

Table 2 — Tensile properties at room temperature

Grade designation		Type of heat treatment ^a	$R_{p0,2}$	$R_{p1,0}$	R_m	A
Name	Number		MPa min.	MPa min.	MPa	% min.
GP240GH	1.0619	+N ^b	240	-	420-600	22
GP240GH	1.0619	+QT	240	-	420-600	22
GP280GH	1.0625	+N ^b	280	-	480-640	22
GP280GH	1.0625	+QT	280	-	480-640	22
G17Mn5	1.1131	+QT	240	-	450-600	24
G20Mn5	1.6220	+N ^b	300	-	480-620	20
G20Mn5	1.6220	+QT	300	-	500-650	22
G18Mo5	1.5422	+QT	240	-	440-590	23
G20Mo5	1.5419	+QT	245	-	440-690	22
G17CrMo5-5	1.7357	+QT	315	-	490-690	20
G17CrMo9-10	1.7379	+QT	400	-	590-740	18
G12MoCrV5-2	1.7720	+QT	295	-	510-660	17
G17CrMoV5-10	1.7706	+QT	440	-	590-780	15
G25NiCrMo3	1.6553	+QT1	415	-	620-795	18
G25NiCrMo3	1.6553	+QT2	585	-	725-865	17
G25NiCrMo6	1.6554	+QT1	485	-	690-860	18
G25NiCrMo6	1.6554	+QT2	690	-	860-1 000	15
G17NiCrMo13-6	1.6781	+QT	600	-	750-900	15
G9Ni10	1.5636	+QT	280	-	480-630	24
G9Ni14	1.5638	+QT	360	-	500-650	20
GX15CrMo5	1.7365	+QT	420	-	630-760	16
GX10CrMoV9-1	1.7367	+QT	415	-	585-760	16
GX15CrMo9-1	1.7376	+QT	415	-	620-795	18
GX8CrNi12-1	1.4107	+QT1	355	-	540-690	18
GX8CrNi12-1	1.4107	+QT2	500	-	600-800	16
GX23CrMoV12-1	1.4931	+QT	540	-	740-880	15
GX3CrNi13-4	1.6982	+QT	500	-	700-900	15
GX4CrNi13-4	1.4317	+QT	550	-	760-960	15
GX4CrNiMo16-5-1	1.4405	+QT	540	-	760-960	15
GX2CrNi19-11	1.4487	+AT	-	230	440-640	30
CX2CrNi19-11	1.4309	+AT	-	210	440-640	30
GX5CrNi19-10	1.4308	+AT	-	200	440-640	30
GX5CRNiNb19-11	1.4552	+AT	-	200	440-640	25
GX2CrNiMoN19-11-2	1.4409	+AT	-	230	440-640	30
GX5CrNiMo19-11-2	1.4408	+AT	-	210	440-640	30
GX6CrNiMoNb19-11-2	1.4581	+AT	-	210	440-640	25
GX2CrNiMoN22-5-3	1.4470	+AT	420	-	600-800	20
GX2CrNiMoCuN26-5-3-3	1.4451	+AT	480	-	650-850	22
GX2CrNiMoN26-7-4	1.4469	+AT	480	-	650-850	22
GX2NiCrMo28-20-2	1.4458	+AT	-	190	430-630	30
GX10NiCrSiNb32-20	1.4859	^c	180	-	440-640	22

Table 2 (continued)

Grade designation		Type of heat treatment ^a	$R_{p0,2}$ MPa min.	$R_{p1,0}$ MPa min.	R_m MPa	A % min.
Name	Number					
GX2CrNiMoCuN25-6-3-3	1.4517	+AT	480	-	650-850	22
GX2CrNiMoN25-7-3	1.4417	+AT	480	-	650-850	22

^a The type of heat treatment is mandatory.
^b Tempering is permitted.
^c As-cast.

NOTE 1 MPa = 1 N/mm².

Table 3 — Impact properties at low temperatures

Grade designation		Type of heat treatment	KV	
Name	Number		J min.	°C
G17Mn5	1.1131	+ QT	27	-40
G20Mn5	1.6220	+ N	27	-30
G20Mn5	1.6220	+ QT	27	-40
G18Mo5	1.5422	+ QT	27	-45
G17NiCrMo13-6	1.6781	+ QT	27	-80
G9Ni10	1.5636	+ QT	27	-70
G9Ni14	1.5638	+ QT	27	-90
GX3CrNi13-4	1.6982	+ QT	27	-120
GX2CrNiN19-11	1.4487	+ AT	70	-196
GX2CrNi19-11	1.4309	+AT	70	-196
GX5CrNi19-10	1.4308	+ AT	60	-196
GX2CrNiMoN19-11-2	1.4409	+ AT	70	-196
GX5CrNiMo19-11-2	1.4408	+ AT	60	-196
GX2CrNiMo22-5-3	1.4470	+ AT	40	-40
GX2CrNiMoCuN26-5-3-3	1.4451	+ AT	35	-70
GX2CrNiMoN26-7-4	1.4469	+ AT	35	-70
GX2NiCrMo28-20-2	1.4458	+ AT	60	-196
GX2CrNiMoCuN25-6-3-3	1.4517	+AT	35	-70

Table 4 — Impact properties at room temperature

Grade designation		Type of heat treatment	KV J min.
Name	Number		
GP240GH	1.0619	+ N	27
GP240GH	1.0619	+ QT	40
GP280GH	1.0625	+ N	27
GP280GH	1.0625	+ QT	40
G20Mo5	1.6220	+ QT	27
G17CrMo5-5	1.7357	+ QT	27
G17CrMo9-10	1.7379	+ QT	40
G12MoCrV5-10	1.7720	+ QT	27
G17CrMoV5-10	1.7706	+ QT	27

Table 4 (continued)

Grade designation		Type of heat treatment	KV J min.
Name	Number		
G25NiCrMo3	1.6553	+ QT1	27
G25NiCrMo3	1.6553	+ QT2	27
G25NiCrMo6	1.6554	+ QT1	27
G25NiCrMo6	1.6554	+ QT2	40
GX15CrMo5	1.7365	+ QT	27
GX15CrMo9-1	1.7376	+ QT	27
GX8CrNi12-1	1.4107	+ QT1	45
GX8CrNi12-1	1.4107	+ QT2	40
GX23CrMoV12-1	1.4931	+ QT	27
GX3CrNi13-4	1.6982	+ QT	50
GX4CrNi13-4	1.4317	+ QT	50
GX4CrNiMo16-5-1	1.4405	+ QT	60
GX2CrNi19-11	1.4309	+AT	80
GX5CrNi19-10	1.4308	+AT	60
GXCrNiMo19-11-2	1.4408	+AT	60
GX5CrNiMoNb19-11-2	1.4581	+AT	60
GX2NiCrMo28-20-2	1.4458	+AT	60
GX10NiCrSiNb32-20	1.4859	a	27

^a As-cast.

Table 5 — Tensile properties at elevated temperatures

Grade designation		Type of heat treatment	R_p at elevated temperature °C (MPa ^b)								
Name	No.		R_p	100 °C	200 °C	300 °C	350 °C	400 °C	450 °C	500 °C	550 °C
				min.	min.	min.	min.	min.	min.	min.	min.
GP240GH	1.0619	+ N	0,2 %	210	175	145	135	130	125	-	-
GP240GH	1.0619	+ QT	0,2 %	210	175	145	135	130	125	-	-
GP280GH	1.0625	+ N	0,2 %	250	220	190	170	160	150	-	-
GP280GH	1.0625	+ QT	0,2 %	250	220	190	160	160	150	-	-
G20Mo5	1.6220	+ QT	0,2 %	-	190	165	155	150	145	135	-
G17CrMo5-5	1.7357	+ QT	0,2 %	-	250	230	215	200	190	175	160
G12MoCrV5-2	1.7720	+ QT	0,2 %	264	244	230	-	214	-	194	144
G17CrMoV5-10	1.7706	+ QT	0,2 %	-	385	365	350	335	320	300	260
G17CrMo9-10	1.7379	+ QT	0,2 %	-	355	345	330	315	305	280	240
GX15CrMo5	1.7365	+ QT	0,2 %	-	390	380	-	370	-	305	250
GX15CrMo9-1	1.7376	+ QT	0,2 %	-	375	355	345	320	295	265	-
GX23CrMoV12-1	1.4331	+QT	0,2 %	-	450	430	410	390	370	340	290
GX4CrNi13-4	1.4317	+QT	0,2 %	515	485	455	440	-	-	-	-
GX4CrNiMo16-5-1	1.4405	+QT	0,2 %	515	485	455	-	-	-	-	-
GX2CrNi18-10	1.4487	+ AT	1 %	165	130	110	100	-	-	-	-
GX2CrNi19-11	1.4309	+AT	1 %	165	130	110	100	-	-	-	-
GX5CrNi19-10	1.4308	+ AT	1 %	160	125	110	-	-	-	-	-
GX5CrNiNb19-11	1.4552	+ AT	1 %	165	145	130	-	120	-	110	100
GX2CrNiMoN19-11-2	1.4409	+ AT	1 %	175	145	115	-	105	-	-	-
GX5CrNiMo19-11-2	1.4408	+ AT	1 %	170	135	115	-	105	-	-	-

Table 5 (continued)

Grade designation		Type of heat treatment	R_p at elevated temperature °C (MPa ^b)								
Name	No.		R_p	100 °C	200 °C	300 °C	350 °C	400 °C	450 °C	500 °C	550 °C
				min.	min.	min.	min.	min.	min.	min.	min.
GX5CrNiMoNb19-11-2	1.4581	+ AT	1 %	185	160	145	-	130	-	120	115
GX2CrNiMoN22-5-3 ^a	1.4470	+ AT	0,2 %	330	280	-	-	-	-	-	-
GX2CrNiMoCuN26-5-3-3 ^a	1.4451	+ AT	0,2 %	390	330	-	-	-	-	-	-
GX2CrNiMoN26-7-4 ^a	1.4469	+ AT	0,2 %	390	330	-	-	-	-	-	-
GX2NiCrMo28-20-2	1.4458	+ AT	1 %	165	135	120	-	110	-	-	-
GX10NiCrSiNb32-20	1.4859	-	1 %	155	135	125	-	120	-	110	107
GX2CrNiMoCuN25-6-3-3 ^c	1.4517	+AT	0,2 %	390	330	c	c	c	c	c	c
GX2CrNiMoN25-7-3 ^c	1.4417	+AT	0,2 %	390	330	c	c	c	c	c	c

^a Austenitic-ferritic steel grades are not recommended in applications above 250 °C.
^b 1 MPa = 1 N/mm².
^c These steel grades are not to be used for temperatures higher than 250 °C.

Table 6 — Heat treatment conditions

Grade designation		Type of heat treatment ^a	Heat treatment °C ^b	
Name	Number		Normalizing (+N) or Quenching (+Q) or Solution treatment (+AT) air or liquid	Tempering (+T)
GP240GH ^c	1.0619	+N ^d	900 – 980	-
GP240GH ^c	1.0619	+QT	900 – 980	600 – 700
GP280GH ^c	1.0625	+N ^d	900 – 980	-
GP280GH ^c	1.0625	+QT	900 – 980	600 – 700
G17Mn5	1.1131	+QT	890 – 980	600 – 700
G20Mn5 ^c	1.6220	+N ^d	900 – 980	-
G20Mn5 ^c	1.6220	+QT	900 – 980	610 – 660
G18Mo5	1.5422	+QT	900 – 980	600 – 700
G20Mo5	1.5419	+QT	920 – 980	650 – 730
G17CrMo5-5	1.7357	+QT	920 – 960	680 – 730
G17CrMo9-10	1.7379	+QT	930 – 970	680 – 740
G12MoCrV5-2	1.7720	+QT	950 – 1 000	680 – 720
G17CrMoV5-10	1.7706	+QT	920 – 960	680 – 740
G25NiCrMo3 ^c	1.6553	+QT1	970 – 960	600 – 700
G25NiCrMo3 ^c	1.6553	+QT2	870 – 960	600 – 680
G25NiCrMo6 ^c	1.6554	+QT1	850 – 920	600 – 650
G25NiCrMo6 ^c	1.6554	+QT2	850 – 920	600 – 650
G17NiCrMo13-6	1.6781	+QT	890 – 930	600 – 640
G9Ni10	1.5636	+QT	830 – 890	600 – 650
G9Ni14	1.5638	+QT	820 – 900	590 – 640
GX15CrMo5	1.7365	+QT	930 – 990	680 – 730
GX10CrMoV9-1	1.7367	+NT	1 040 – 1 080	730 – 800
GX15CrMo9-1	1.7378	+QT	960 – 1 020	680 – 730
GX8CrNi12-1 ^c	1.4107	+QT1	1 000 – 1 060	680 – 730
GX8CrNi12-1 ^c	1.4107	+QT2	1 000 – 1 060	600 – 680
GX23CrMoV12-1	1.4931	+QT	1 030 – 1 080	700 – 750
GX3CrNi13-4 ^e	1.6982	+QT	1 000 – 1 050	670 – 690 +590 – 620
GX4CrNi13-4	1.4317	+QT	1 000 – 1 050	590 – 620
GX4CrNiMo16-5-1	1.4405	+QT	1 020 – 1 070	580 – 630

Table 6 (continued)

Grade designation		Type of heat treatment ^a	Heat treatment °C ^b	
Name	Number		Normalizing (+N) or Quenching (+Q) or Solution treatment (+AT) air or liquid	Tempering (+T)
GX2CrNiN19-11	1.4487	+AT	1 050 – 1 150	-
GX2CrNi19-11	1.4309	+AT	1 050-1 150	-
GX5CrNi19-10	1.4308	+AT	1 050 – 1 150	-
GX5CrNiNb19-11 ^f	1.4552	+AT	1 050 – 1 150	-
GX2CrNiMoN19-11-2	1.4409	+AT	1 080 – 1 150	-
GX5CrNiMo19-11-2 ^f	1.4408	+AT	1 080 – 1 150	-
GX5CrNiMoNb19-11-2	1.4581	+AT	1 080 – 1 150	-
GX2CrNiMoN22-5-3 ^g	1.4470	+AT	1 120 – 1 150	-
GX2CrNiMoCuN26-5-3-3 ^g	1.4451	+AT	1 120 – 1 150	-
GX2CrNiMoN26-7-4 ^g	1.4469	+AT	1 140 – 1 180	-
GX2NiCrMo28-20-2	1.4458	+AT	1 100 - 1 180	-
GX10NiCrSiNb32-20	1.4859	^h	-	-
GX2CrNiMoN22-5-3	1.4470	+AT	1 120-1 150 ^g	-
GX2CrNiMoN25-7-3	1.4417	+AT	1 120-1 150 ^g	-

^a The type of heat treatment is mandatory.

^b The temperatures are for information only.

^c According to the required tensile properties the heat treatment symbol is added to the designation.

^d Tempering is permitted.

^e This grade requires double tempering. The second temper shall not be higher than the first temper.

^f For improving the corrosion resistance, a special stabilization heat treatment in the range of 600 °C to 650 °C for GX5CrNiNb19-10 and 550 °C to 600 °C for GX5CrNiMoNb19-11-2 may be agreed.

^g After solution annealing castings may be cooled down to 1 040 °C to 1 010 °C prior to water quenching.

^h As-cast.

Annex A (normative)

Supplementary requirements

- A.1** Agreed manufacturing procedure
- A.2** Reporting of the steel making process
- A.3** Chemical analysis for residual elements
- A.4** Details of the heat treatment
- A.5** Mass and tolerance on mass
- A.6** Prior agreement to major finishing welds
- A.7** Weld maps
- A.8** Test blocks

A.8.1 Test blocks representative of the castings

The maximum ruling wall thickness shall be indicated by the purchaser at the time of the enquiry and order.

The mechanical properties reported in the [Tables 2, 3, 4](#) and [5](#) shall apply up to the maximum ruling wall thickness given in [Table A.1](#).

The test block thickness shall be the maximum ruling wall thickness up to 150 mm.

Test blocks greater than 150 mm can be used if agreed to by purchaser and manufacturer at the time of enquiry and order.

When the ruling thickness exceeds the value given in [Table A.1](#), lower mechanical properties can be agreed at the time of the enquiry and order.

Table A.1 — Maximum ruling wall thickness

Grade designation		Maximum ruling wall thickness mm
Name	Number	
GP240GH	1.0619	100
GP280GH	1.0625	100
G17Mn5	1.1131	50
G20Mn5	1.6220	100
G18Mo5	1.5422	100
G20Mo5	1.5419	100
G17CrMo5-5	1.7357	100
G12CrMoV5-2	1.7720	100
G17CrMoV5-10	1.7706	150

Table A.1 (continued)

Grade designation		Maximum ruling wall thickness mm
Name	Number	
G17CrMo9-10	1.7379	150
G17NiCrMo13-6	1.6781	200
GX15CrMo5	1.7365	150
GX10CrMoV9-1	1.7367	—
GX8CrNi12-1	1.4107	300
GX23CrMoV12-1	1.4931	150
GX3CrNi13-4	1.6982	300
GX4CrNi13-4	1.4317	300
GX4CrNiMo16-5-1	1.4405	300
GX2CrNiN19-11	1.4487	150
GX5CrNi19-10	1.4308	150
GX5CrNiNb19-11	1.4552	150
GX2CrNiMoN19-11-2	1.4409	150
GX5CrNiMo19-11-2	1.4408	150
GX6CrNiMoNb19-11-2	1.4581	150
GX2CrNiMoN22-5-3	1.4470	150
GX2CrNiMoCuN26-5-3-3	1.4451	150
GX2CrNiMoN26-7-4	1.4469	150
GX2NiCrMo28-20-2	1.4458	150
GX10NiCrSiNb32-20	1.4859	150
GX2CrNiMoCuN25-6-3-3	1.4517	150
CX2CrNiMoN25-7-3	1.4417	150

A.8.1.1 Test block $t \times t$

A.8.1.2 Test block $t \times 3t \times 3t$

A.8.2 Test blocks attached to castings

A.9 Intergranular corrosion test

A.10 Pressure tightness

A.11 Ferrite determination in austenitic and austenitic-ferritic steels in accordance with ISO 13520

A.12 Verification of impact properties at room temperature

A.13 Verification of impact properties at low temperature

A.14 Verification of tensile properties at elevated temperature

Annex B
(informative)

Welding conditions

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Table B.1 — Welding conditions

Grade designation		Preheat temperature ^a °C	Max. interpass temperature °C	Post heat treatment °C
Name	Number			
GP240GH	1.0619	20 to 150	350	Not necessary
GP280GH	1.0625	20 to 150	350	Not necessary
G17Mn5	1.1131	20 to 150	350	Not necessary
G20Mn5	1.6220	20 to 150	350	Not necessary
G18Mo5	1.5422	20 to 200	350	>650
G20Mo5	1.5419	20 to 200	350	>650
G17CrMo5-5	1.7357	150 to 250	350	>650
G12MoCrV5-2	1.7720	200 to 300	400	>680
G17CrMoV5-10	1.7706	200 to 300	400	>680
G25NiCrMo6	1.6554	150 to 250	350	b
G17CrMo9-10	1.7379	150 to 250	350	>680
G17NiCrMo13-6	1.6781	20 to 200	350	>580
G9Ni10	1.5636	20 to 150	350	>570
G9Ni14	1.5638	20 to 200	300	>560
GX15CrMo5	1.7365	150 to 250	350	650
GX10CrMoV9-1	1.7367			
GX15CrMo9-1	1.7376	200 to 300	350	680
GX8CrNi12-1	1.4107	100 to 200	350	Same as normal tempering temperature
GX4CrNiMo16-5-1	1.4405	Not necessary	200	Same as normal tempering temperature
GX3CrNi13-4	1.6982	20 to 200	c	c
GX4CrNi13-4	1.4317	100 to 200	300	Same as normal tempering temperature
GX23CrMoV12-1	1.4931	20 to 450	450	>680 °C after cooling under 80 °C to 130 °C
GX2CrNiN19-11	1.4487			d
GX5CrNi19-10	1.4308			d
GX5CrNiNb19-11	1.4552			d
GX2CrNiMoN19-11-2	1.4409	Not necessary	c	d
GX5CrNiMo19-11-2	1.4408	Not necessary		d
GX5CrNiMoNb19-11-2	1.4581	Not necessary		d
GX2CrNiMoN22-5-3	1.4470	20 to 100	250	d
GX2CrNiMoCuN26-5-3-3	1.4451	20 to 100	250	d
GX2CrNiMoN26-7-4	1.4469	20 to 100	250	d
GX2NiCrMo28-20-2	1.4458	20 to 100	150	d
GX10NiCrSiNb32-20	1.4859	Not necessary	200	For wall thickness >80 mm, annealing at ≥850 °C is necessary to reduce residual stresses
GX2CrNiMoN22-5-3	1.4470	20 to 100	250	d
GX2CrNiMoCuN26-5-3-3	1.4517	20 to 100	250	d
GX2CrNiMoN25-7-3	1.4417			
GX2CrNiMoN26-7-4	1.4469	20 to 100	250	d

^a The preheating temperature is related to the geometry and the thickness of the casting and climate conditions.

^b The post heat treatment shall be at least 20 °C but no more than 50 °C below the tempering temperature.

^c At the discretion of the manufacturer unless otherwise agreed.

^d Depending on the corrosion resistance and mechanical property requirements, +AT may be necessary.

Annex C
(informative)

Creep properties

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Table C.1 — Creep properties

Grade designation		Creep resist- ance	400°C			450°C			500°C			550°C			600°C			650°C			700°C		
Name	Number		10 000	100 000	200 000	10 000	100 000	200 000	10 000	100 000	200 000	10 000	100 000	200 000	10 000	100 000	200 000	10 000	100 000	200 000	10 000	100 000	200 000
GP240GH	1.0619	σ_r	205	160	145	132	83	71	74	40	32	-	-	-	-	-	-	-	-	-	-	-	-
		σ_{A_1}	147	110	-	88	50	-	43	20	-	-	-	-	-	-	-	-	-	-	-	-	-
GP280GH	1.0625	σ_r	210	165	-	135	85	-	75	42	-	-	-	-	-	-	-	-	-	-	-	-	-
		σ_{A_1}	148	110	-	90	52	-	45	22	-	-	-	-	-	-	-	-	-	-	-	-	-
G20Mo5	1.5419	σ_r	360	310	290	275	205	180	160	85	70	66	30	23	-	-	-	-	-	-	-	-	-
		σ_{A_1}	-	-	-	185	150	130	125	65	50	41	15	10	-	-	-	-	-	-	-	-	-
G17CrMo5-5	1.7357	σ_r	420	370	356	321	244	222	187	117	96	98	55	44	-	-	-	-	-	-	-	-	-
		σ_{A_1}	271	222	-	196	145	-	130	81	-	65	35	-	-	-	-	-	-	-	-	-	-
G17CrMo9-10	1.7379	σ_r	404	324	304	282	218	200	188	136	120	106	66	52	58	28	22	-	-	-	-	-	-
		σ_{A_1}	350	300	278	229	168	148	141	96	80	70	40	31	36	189	14	-	-	-	-	-	-
G12MoCrV5-2	1.7379	σ_r	-	-	-	365	277	-	208	140	-	135	75	-	89	-	-	-	-	-	-	-	-
		σ_r	463	419	395	340	275	254	229	171	157	151	96	83	80	28	19	-	-	-	-	-	-
G17CrMoV5-10	1.7706	σ_r	427	385	356	305	243	218	196	133	110	120	70	49	50	18	10	-	-	-	-	-	-
		σ_{A_1}	-	-	-	228 ^a	165 ^a	-	168	106	-	93	58	-	51	-	-	-	-	-	-	-	-
GX15CrMo5	1.7365	σ_r	-	-	-	383	309	279	269	207	187	167	118	103	83	49	39	-	-	-	-	-	-
		σ_r	504	426	394	305	259	239	219	171	153	131	91	77	66	34	25	-	-	-	-	-	-
GX5CrNi19-9	1.4308	σ_r	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
		σ_r	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
GX5CrNiNb19-11	1.4552	σ_r	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
		σ_r	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
GX5CrNi-Mo19-11-2	1.4408	σ_r	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
		σ_r	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
GX10Ni-CrSiNb32-20	1.4859	σ_r	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
		σ_{A_1}	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-