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Steel castings for pressure purposes

Pièces moulées en acier pour service sous pression

[Revision of second edition (ISO 4991:2005)]

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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 3.

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 International Standard may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights.

International Standard ISO 4991 was prepared by Technical Committee ISO/TC 17, *Steel*, Subcommittee SC 11, *Steel castings*.

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Steel castings for pressure purposes

1 Scope

This International Standard 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 standard relates to castings manufactured from unalloyed and alloyed steel grades (characterised by their chemical composition, table 1, and mechanical properties, tables 2 to 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 normative documents contain provisions which, through reference in this text, constitute provisions of this International Standard. For dated references, subsequent amendments to, or revisions of, any of these publications do not apply. However, parties to agreements based on this International Standard are encouraged to investigate the possibility of applying the most recent editions of the normative documents indicated below. For undated references, the latest edition of the normative document referred to applies. Members of ISO and IEC maintain registers of currently valid International Standards.

ISO 148-1 *Metallic materials - Charpy pendulum impact test – Part 1: Test method*

ISO 488 *Ferrous products -- Heat treatments -- Vocabulary*

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 11970:2001, *Specifications and approval of welding procedures for production welding of steels castings*

ISO 13520:2002, *Steel castings - Estimation of ferrite content in austenitic stainless steel castings.*

3 Terms and definitions

For the purposes of this international standard the terms and definitions given in ISO 4885 and ISO 4990 apply.

4 Information to be supplied by the purchaser

Materials specified in this International Standard shall conform to the applicable requirements of ISO 4990 including the supplementary requirements listed in Annex A that are indicated in the enquiry and purchase order.

5 Heat treatment

The type of heat treatment shall comply 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 annealed

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.

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 percentages of the specified elements.

The chemical composition shall comply with the values given in table 1.

Permissible deviations on check analysis are indicated in ISO 4990.

7.2 Mechanical properties

The mechanical properties shall comply with the values given in tables 2 to 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 according to ISO 6892 and, if specified, impact tests according to ISO 148.

If required by agreement at the time of enquiry and order, impact energy properties at low temperature shall comply with table 3,

If required by agreement at the time of enquiry and order, impact energy values at room temperature shall comply 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 783. In such case the values shall comply with table 5.

Creep resistance mean values are given for information, for some grades in annex C.

8 Inspection and testing

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

8.1 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.

8.2 Formation of test lots

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

8.3 Non-destructive testing

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

- non-destructive methods required,
- area to be examined,
- acceptance criteria required.

8.4 Marking

8.4.1 Castings shall be marked for material identification. In addition, heat numbers, or serial numbers that are traceable to heat numbers, shall be marked on all castings. 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.

8.4.2 Castings shall be marked with the manufacturer's identification or symbol except where other provisions have been made between the manufacturer and purchaser.

8.4.3 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 International standard also specifies a group of 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 measurement is required for austenitic and austenitic-ferritic grades, it may be made using ISO 13520.

Table 1 — Chemical composition, in % by mass

Grade Designation		C	Si	Mn	P	S	Cr	Mo	Ni	V	Cu	Others
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	0,60-1,00	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	0,050 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	0,050 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	0,050 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	0,40 max.	0,05	0,30 max.	
GX10CrMoV9-1		0,08-0,12	0,20-0,50	0,30-0,60	0,030	0,010	8,0-9,5	0,85-1,05	0,40 max.	0,18-0,25	-	Nb 0,060-0,10 N 0,030-0,070 Al 0,02max Ti 0,01 max Zr 0,01 max
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.	W 0,50 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.	
GX2CrNiN19-11	1.4487	0,030 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
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	1.4490	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
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
GX2CrNiMoN 26-7-4	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

^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%

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Table 2 — Tensile properties at room temperature

Grade Designation		Type of Heat treatment ^a	$R_{p0.2}$ MPa *	$R_{p1.0}$ MPa *	R_m MPa *	A % min.
Name	Number					
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	-	860-1000	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		+NT	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
GX2CrNiN19-11	1.4487	+AT	-	230	440-640	30
GX5CrNi19-9	1.4308	+AT	-	200	440-640	30
GX6CrNiNb19-10	1.4552	+AT	-	200	440-640	25
GX2CrNiMoN19-11-2	1.4490	+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	1.4450	+AT	420	-	600-800	20
GX2CrNiMoCuN26-5-3-3	1.4451	+AT	480	-	650-850	22
GX2CrNiMoN 26-7-4	1.4469	+AT	480	-	650-850	22
GX2NiCrMo28-20-2	1.4458	+AT	-	190	430-630	30

^a The type of heat treatment is mandatory
^b Tempering is permitted
* 1 MPa = 1 N/mm²