INTERNATIONAL STANDARD

ISO 4991

Second edition
2005-11-01

Steel castings for pressure purposes

Pièces moulées en acier pour service sous pression

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

This second edition cancels and replaces the first edition (ISO 4991:1994), which has been technically revised.

Steel castings for pressure purposes

1 Scope

This International Standard covers steel castings for parts subjected to pressure.

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

This International 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).

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 148:1983, *Steel — Charpy impact test (V-notch)*

ISO 783, *Metallic materials — Tensile testing at elevated temperature*

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

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

ISO 6892:1998, *Metallic materials — Tensile testing at ambient temperature*

ISO 11970, *Specification and approval 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 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 given 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 are given 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.

Heat-treatment conditions are given in Table 6.

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 the 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 this 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 according to the requirements of this International Standard, specific inspection and testing is required.

8.1 Sampling

Test blocks shall be heat treated in production furnaces according 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).

8.4.4 Alternative markings are permitted (see Table 7) unless otherwise agreed.

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

Element Designation	C	Si max.	Mn	P max.	S max.	Cr	Mo	Ni	V	Cu	Others
G240	0,18-0,23 [a]	0,60	0,50-1,20 [a]	0,030	0,025	0,30 max.	0,12 max.	0,40 max.	0,03 max.	0,30 max.	[b]
G280	0,18-0,25 [a]	0,60	0,80-1,20 [a]	0,030	0,025	0,30 max.	0,12 max.	0,40 max.	0,03 max.	0,30 max.	[b]
G17Mn5	0,15-0,20	0,60	1,00-1,60	0,030	0,025	0,30 max.	0,12 max.	0,40 max.	0,03 max.	0,30 max.	[b]
G20Mn5	0,17-0,23	0,60	1,00-1,60	0,030	0,025	0,30 max.	0,12 max.	0,80 max.	0,03 max.	0,30 max.	
G18Mo5	0,15-0,20	0,60	0,80-1,20	0,030	0,025	0,30 max.	0,45-0,65	0,40 max.	0,03 max.	0,30 max.	
G20Mo5	0,15-0,23	0,60	0,50-1,00	0,030	0,025	0,30 max.	0,40-0,60	0,40 max.	0,03 max.	0,30 max.	
G17CrMo5-5	0,15-0,20	0,60	0,50-1,00	0,030	0,025	1,00-1,50	0,45-0,65	0,40 max.	0,03 max.	0,30 max.	
G17CrMo9-10	0,13-0,20	0,60	0,50-0,90	0,030	0,025	2,00-2,50	0,90-1,20	0,40 max.	0,03 max.	0,30 max.	
G12MoCrV5-2	0,10-0,15	0,45	0,40-0,70	0,030	0,025	0,30-0,50	0,40-0,60	0,40 max.	0,22-0,30	0,30 max.	
G17CrMoV5-10	0,15-0,20	0,60	0,50-0,90	0,030	0,025	1,20-1,50	0,90-1,10	0,40 max.	0,20-0,30	0,30 max.	
G25NiCrMo3	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	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	0,15-0,19	0,50	0,55-0,80	0,030	0,025	1,30-1,80	0,45-0,60	3,00-3,50	0,03 max.	0,30 max.	
G9Ni10	0,06-0,12	0,60	0,50-0,80	0,030	0,025	0,30 max.	0,12 max.	2,00-3,00	0,03 max.	0,30 max.	
G9Ni14	0,06-0,12	0,60	0,50-0,80	0,030	0,025	0,30 max.	0,12 max.	3,00-4,00	0,03 max.	0,30 max.	
GX15CrMo5	0,12-0,19	0,80	0,50-0,80	0,030	0,030	4,00-6,00	0,45-0,65	0,40 max.	0,05	0,30 max.	
GX15CrMo9-1	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	0,10 max.	0,40	0,50-0,80	0,030	0,030	11,50-12,50	0,50 max.	0,80-1,50	0,08 max.	0,30 max.	
GX23CrMoV12-1	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
GX3CrNi13-4	0,05 max.	1,00	1,00 max.	0,030	0,015	12,00-13,50	0,70 max.	3,50-5,00	0,08 max.	0,30 max.	
GX4CrNi13-4	0,06 max.	1,00	1,00 max.	0,030	0,030	12,00-13,50	0,70 max.	3,50-5,00	0,08 max.	0,30 max.	
GX4CrNiMo16-5-1	0,06 max.	0,80	1,00 max.	0,030	0,025	15,00-17,00	0,70-1,50	4,00-6,00	0,08 max.	0,30 max.	
GX2CrNiN18-10	0,030 max.	1,50	2,00 max.	0,035	0,030	17,00-19,00	—	9,00-12,00	0,08 max.	0,50 max.	0,12 ⩽ ⩽ 0,20
GX5CrNi19-9	0,07 max.	1,50	1,50 max.	0,035	0,030	18,00-20,00	—	8,00-11,00	0,08 max.	0,50 max.	
GX5CrNiNb19-10	0,07 max.	1,50	1,50 max.	0,035	0,030	18,00-20,00	—	9,00-12,00	0,08 max.	0,50 max.	8 × C ⩽ Nb ⩽ 1,00
GX2CrNiMoN19-11-2	0,030 max.	1,50	2,00 max.	0,035	0,030	18,00-20,00	2,00-2,50	9,00-12,00	0,08 max.	0,50 max.	0,12 ⩽ N ⩽ 0,20
GX5CrNiMo19-11-2	0,07 max.	1,50	1,50 max.	0,035	0,030	18,00-20,00	2,00-2,50	9,00-12,00	0,08 max.	0,50 max.	
GX5CrNiMoNb19-11-2	0,07 max.	1,50	1,50 max.	0,035	0,030	18,00-20,00	2,00-2,50	9,00-12,00	0,08 max.	0,50 max.	8 × C ⩽ Nb ⩽ 1,00
GX2CrNiMoN22-5-3	0,030 max.	1,00	2,00 max.	0,035	0,025	21,00-23,00	2,50-3,50	4,50-6,50	0,08 max.	0,50 max.	0,12 ⩽ N ⩽ 0,20
GX2CrNiMoCuN26-5-3-3	0,030 max.	1,00	1,50 max.	0,035	0,025	25,00-27,00	2,50-3,50	5,00-7,00	0,08 max.	2,75-3,50	0,12 ⩽ N ⩽ 0,22
GX2CrNiMoN 26-7-4	0,030 max.	1,00	1,00 max.	0,035	0,025	25,00-27,00	3,00-5,00	6,00-8,00	0,08 max.	1,30 max.	0,12 ⩽ N ⩽ 0,22
GX2NiCrMo28-20-2	0,030 max.	1,00	2,00 max.	0,035	0,025	19,00-22,00	2,00-2,50	26,00-30,00	0,08 max.	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 %.

Table 2 — Tensile properties at room temperature

Designation	Type of heat treatment [a]	$R_{p0,2}$ MPa [c] min.	$R_{p1,0}$ MPa [c] min.	R_m MPa [c]	A % min.
G240	+N [b]	240	—	420-600	22
G240	+QT	240		420-600	22
G280	+N [b]	280	—	480-640	22
G280	+QT	280		480-640	22
G17Mn5	+QT	240	—	450-600	24
G20Mn5	+N [b]	300	—	480-620	20
G20Mn5	+QT	300	—	500-650	22
G18Mo5	+QT	240	—	440-590	23
G20Mo5	+QT	245	—	440-590	22
G17CrMo5-5	+QT	315	—	490-690	20
G17CrMo9-10	+QT	400	—	590-740	18
G12MoCrV5-2	+QT	295	—	510-660	17
G17CrMoV5-10	+QT	440	—	590-780	15
G25NiCrMo3	+QT1	415	—	620-795	18
G25NiCrMo3	+QT2	585		725-865	17
G25NiCrMo6	+QT1	485	—	690-860	18
G25NiCrMo6	+QT2	690	—	860-1000	15
G17NiCrMo13-6	+QT	600	—	750-900	15
G9Ni10	+QT	280	—	480-630	24
G9Ni14	+QT	360	—	500-650	20
GX15CrMo5	+QT	420	—	630-760	16
GX15CrMo9-1	+QT	415	—	620-795	18
GX8CrNi12-1	+QT1	355	—	540-690	18
GX8CrNi12-1	+QT2	500	—	600-800	16
GX23CrMoV12-1	+QT	540	—	740-880	15
GX3CrNi13-4	+QT	500	—	700-900	15
GX4CrNi13-4	+QT	550	—	760-960	15
GX4CrNiMo16-5-1	+QT	540	—	760-960	15
GX2CrNiN18-10	+AT	—	230	440-640	30
GX5CrNi19-9	+AT	—	200	440-640	30
GX5CrNiNb19-10	+AT	—	200	440-640	25
GX2CrNiMoN19-11-2	+AT	—	230	440-640	30
GX5CrNiMo19-11-2	+AT	—	210	440-640	30
GX5CrNiMoNb19-11-2	+AT	—	210	440-640	25
GX2CrNiMoN22-5-3	+AT	420	—	600-800	20
GX2CrNiMoCuN26-5-3-3	+AT	480	—	650-850	22
GX2CrNiMoN 26-7-4	+AT	480	—	650-850	22
GX2NiCrMo28-20-2	+AT	—	190	430-630	30

[a] The type of heat treatment is mandatory.

[b] Tempering is permitted.

[c] 1 MPa = 1 N/mm^2.

Table 3 — Impact properties at low temperatures

Designation	Type of heat treatment	Impact test (Charpy V)	
		KV J min.	T °C
G17Mn5	+ QT	27	–40
G20Mn5	+ N	27	–30
G20Mn5	+ QT	27	–40
G18Mo5	+ QT	27	–45
G17NiCrMo13-6	+ QT	27	–80
G9Ni10	+ QT	27	–70
G9Ni14	+ QT	27	–90
GX3CrNi13-4	+ QT	27	–120
GX2CrNiN18-10	+ AT	70	–196
GX5CrNi19-9	+ AT	60	–196
GX2CrNiMoN19-11-2	+ AT	70	–196
GX5CrNiMo19-11-2	+ AT	60	–196
GX2CrNiMo22-5-3	+ AT	40	–40
GX2CrNiMoCuN26-5-3-3	+ AT	35	–70
GX2CrNiMoN 26-7-4	+ AT	35	–70
GX2NiCrMo28-20-2	+ AT	60	–196

Table 4 — Impact properties at room temperature

Designation	Type of heat treatment	Impact test KV J min.
G240	+ N	27
G240	+ QT	40
G280	+ N	27
G280	+ QT	40
G20Mo5	+ QT	27
G17CrMo5-5	+ QT	27
G17CrMo9-10	+ QT	40
G12MoCrV5-10	+ QT	27
G17CrMoV5-10	+ QT	27
G25NiCrMo3	+ QT1	27
G25NiCrMo3	+ QT2	27
G25NiCrMo6	+ QT1	27
G25NiCrMo6	+ QT2	40
GX15CrMo5	+ QT	27
GX15CrMo9-1	+ QT	27
GX8CrNi12-1	+ QT1	45
GX8CrNi12-1	+ QT2	40
GX23CrMoV12-1	+ QT	27
GX3CrNi13-4	+ QT	50
GX4CrNi13-4	+ QT	50
GX4CrNiMo16-5-1	+ QT	60

Table 5 — Tensile properties at elevated temperatures

Designation	Type of heat treatment	Tensile test								
		R_p at elevated temperature °C (MPa [b])								
		°C	100	200	300	350	400	450	500	550
		R_p	min.	min.	min.	min.	min.	min.	min.	min.
G240	+ N	0,2 %	210	175	145	135	130	125	—	—
G240	+ QT		210	175	145	135	130	125	—	—
G280	+ N		250	220	190	170	160	150	—	—
G280	+QT		250	220	190	160	160	150	—	—
G20Mo5	+ QT	0,2 %	—	190	165	155	150	145	135	—
G17CrMo5-5	+ QT		—	250	230	215	200	190	175	160
G12MoCrV5-2	+ QT		264	244	230	—	214	—	194	144
G17CrMoV5-10	+ QT		—	385	365	350	335	320	300	260
G17CrMo9-10	+ QT		—	355	345	330	315	305	280	240
GX15CrMo5	+ QT	0,2 %	—	390	380	—	370	—	305	250
GX15CrMo9-1	+ QT		—	375	355	345	320	295	265	—
GX23CrMoV12-1	+QT		—	450	430	410	390	370	340	290
GX4CrNi13-4	+QT		515	485	455	440	—	—	—	—
GX4CrNiMo16-5-1	+QT		515	485	455	—	—	—	—	—
GX2CrNiN18-10	+ AT	1 %	165	130	110	100	—	—	—	—
GX5CrNi19-9	+ AT		160	125	110	—	—	—	—	—
GX5CrNiNb19-10	+ AT		165	145	130	—	120	—	110	100
GX2CrNiMoN19-11-2	+ AT		175	145	115	—	105	—	—	—
GX5CrNiMo19-11-2	+ AT		170	135	115	—	105	—	—	—
GX5CrNiMoNb19-11-2	+ AT		185	160	145	—	130	—	120	115
GX2CrNiMoN22-5-3 [a]	+ AT	0,2 %	330	280	—	—	—	—	—	—
GX2CrNiMoCuN26-5-3-3 [a]	+ AT		390	330	—	—	—	—	—	—
GX2CrNiMoN 26-7-4 [a]	+ AT		390	330	—	—	—	—	—	—
GX2NiCrMo28-20-2	+ AT	1 %	165	135	120	—	110	—	—	—

[a] Austenitic-ferritic steel grades are not recommended in applications above 250 °C.

[b] 1 MPa = 1 N/mm^2.

Table 6 — Heat-treatment conditions

Designation	Type of heat treatment [a]	Heat treatment °C [b]	
		Normalizing (+N) or Quenching (+Q) or Solution Annealing (+AT) air or liquid	Tempering (+T)
G240 [c]	+N [d]	900 – 980	—
G240 [c]	+QT	900 – 980	600 – 700
G280 [c]	+N [d]	900 – 980	—
G280 [c]	+QT	900 – 980	600 – 700
G17Mn5	+QT	890 – 980	600 – 700
G20Mn5 [c]	+N [d]	900 – 980	
G20Mn5 [c]	+QT	900 – 980	610 – 660
G18Mo5	+QT	900 – 980	600 – 700
G20Mo5	+QT	920 – 980	650 – 730
G17CrMo5-5	+QT	920 – 960	680 – 730
G17CrMo9-10	+QT	930 – 970	680 – 740
G12MoCrV5-2	+QT	950 – 1000	680 – 720
G17CrMoV5-10	+QT	920 – 960	680 – 740
G25NiCrMo3 [c]	+QT1	970 – 960	600 – 700
G25NiCrMo3 [c]	+QT2	870 – 960	600 – 680
G25NiCrMo6 [c]	+QT1	850 – 920	600 – 650
G25NiCrMo6 [c]	+QT2	850 – 920	600 – 650
G17NiCrMo13-6	+QT	890 – 930	600 – 640
G9Ni10	+QT	830 – 890	600 – 650
G9Ni14	+QT	820 – 900	590 – 640
GX15CrMo5	+QT	930 – 990	680 – 730
GX15CrMo9-1	+QT	960 – 1020	680 – 730
GX8CrNi12-1 [c]	+QT1	1000 – 1060	680 – 730
GX8CrNi12-1 [c]	+QT2	1000 – 1060	600 – 680
GX23CrMoV12-1	+QT	1030 – 1080	700 – 750
GX3CrNi13-4 [e]	+QT	1000 – 1050	670 – 690
			590 – 620
GX4CrNi13-4	+QT	1000 – 1050	590 – 620
GX4CrNiMo16-5-1	+QT	1020 – 1070	580 – 630
GX2CrNiN18-10	+AT	1050 – 1150	—
GX5CrNi19-9	+AT	1050 – 1150	—
GX5CrNiNb19-10 [f]	+AT	1050 – 1150	—
GX2CrNiMoN19-11-2	+AT	1080 – 1150	—
GX5CrNiMo19-11-2	+AT	1080 – 1150	—
GX5CrNiMoNb19-11-2 [f]	+AT	1080 – 1150	—
GX2CrNiMoN22-5-3 [g]	+AT	1120 – 1150	—
GX2CrNiMoCuN26-5-3-3 [g]	+AT	1120 – 1150	—
GX2CrNiMoN 26-7-4 [g]	+AT	1140 – 1180	—
GX2NiCrMo28-20-2	+AT	1100 – 1180	—

[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 upon.

[g] After solution annealing, castings may be cooled down to 1010 °C to 1040 °C prior to water quenching.

Table 7 — Alternative identification marks

Designation	Alternative identification mark
G240+N	AA2
G240+QT	AB2
G280+N	AC2
G280+QT	AD2
G17Mn5+QT	AE2
G20Mn5+N	AF2
G20Mn5+QT	AG2
G18Mo5+QT	AH2
G20Mo5+QT	AJ2
G17CrMo5-5+QT	AK2
G17CrMo9-10+QT	AL2
G12MoCrV5-2+QT	AM2
G17CrMoV5-10+QT	AN2
G25NiCrMo3+QT1	AP2
G25NiCrMo3+QT2	AQ2
G25NiCrMo6+QT1	AR2
G25NiCrMo6+QT2	AS2
G17NiCrMo13-6+QT	AT2
G9Ni10+QT	AU2
G9Ni14+QT	AV2
GX15CrMo5+QT	AW2
GX15CrMo9-+QT	AX2
GX8CrNi12-1+QT1	AY2
GX8CrNi12-1+QT2	AZ2
GX23CrMoV12-1+QT	BA2
GX3CrNi13-4+QT	BB2
GX4CrNi13-4+QT	BC2
GX4CrNiMo16-5-1+QT	BD2
GX2CrNiN18-10+AT	BE2
GX5CrNi19-9+AT	BF2
GX5CrNiNb19-10+AT	BG2
GX2CrNiMoN19-11-2+AT	BH2
GX5CrNiMo19-11-2+AT	BJ2
GX5CrNiMoNb19-11-2+AT	BK2
GX2CrNiMoN22-5-3+AT	BL2
GX2CrNiMoCuN26-5-3-3+AT	BM2
GX2CrNiMoN 26-7-4+AT	BN2
GX2NiCrMo28-20-2+AT	BP2

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 Tables 2 to 5 shall apply up to the maximum ruling-wall thickness given in Table A.1.

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

Test blocks greater than 150 mm can be used, if agreed to by the 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	Maximum ruling-wall thickness mm
G240	100
G280	100
G17Mn5	50
G20Mn5 +QT	100
G18Mo5	100
G20Mo5	100
G17CrMo5-5	100
G12CrMoV5-2	100
G17CrMoV5-10	150
G17CrMo9-10	150
G17NiCrMo13-6	200
GX15CrMo5	150
GX8CrNi12-1	300
GX23CrMoV12-1	150
GX3CrNi13-4	300
GX4CrNi13-4	300
GX4CrNiMo16-5-1	300
GX2CrNiN18-10	150
GX5CrNi19-9	150
GX5CrNiNb19-10	150
GX2CrNiMoN19-11-2	150
GX5CrNiMo19-11-2	150
GX5CrNiMoNb19-11-2	150
GX2CrNiMoN22-5-3	150
GX2CrNiMoCuN26-5-3-3	150
GX2CrNiMoN 26-7-4	150
GX2NiCrMo28-20-2	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 casting

A.9 Intergranular corrosion test

A.10 Pressure tightness

A.11 Ferrite measurement 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