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Steel castings — General technical delivery requirements

Pièces moulées en acier — Exigences générales techniques de livraison

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Contents

Page

Foreword ... **iv**

1 Scope ... **1**

2 Normative references ... **1**

3 Terms and definitions ... **2**

4 Information to be supplied by the purchaser ... **2**
4.1 Enquiry and order requirements ... **2**
4.2 Additional information ... **3**

5 Conditions of manufacture ... **3**
5.1 Foundry practice ... **3**
5.2 Cleaning and dressing ... **3**
5.3 Production welding ... **3**

6 Inspection and testing ... **3**
6.1 Non-specific inspection ... **3**
6.2 Specific inspection ... **4**

7 Marking ... **7**

8 Complaints ... **7**

Annex A (normative) **General conditions for specific inspections and tests** ... **10**

Annex B (normative) **Supplementary requirements** ... **11**

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 4990 was prepared by Technical Committee ISO/TC 17, *Steel*, Subcommittee SC 11, *Steel castings*.

This second edition cancels and replaces the first edition (ISO 4990:1986), Clauses 3, 4, 5, 6 and 9 Table 1, Figure 1 and Annex A of which have been technically revised.

Steel castings — General technical delivery requirements

1 Scope

1.1 This International Standard specifies the general technical delivery requirements for the supply of steel, nickel and cobalt alloy castings, including the requirements for the selection and preparation of samples and test pieces.

1.2 When a material or product standard differs from this delivery specification, the material or product standard shall apply.

1.3 This International Standard also specifies a group of supplementary requirements which may be applied to steel, nickel and cobalt alloy castings. These requirements are provided for use when additional testing or inspection is desired and apply only when individually specified by the purchaser.

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 404:1992, *Steel and steel products — General technical delivery requirements*

ISO 783:1989, *Metallic materials — Tensile testing at elevated temperature*

ISO 3651-2:1998, *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 4948-1:1982, *Steels — Classification — Part 1: Classification of steels into unalloyed and alloy steels based on chemical composition*

ISO 4964:1984, *Steel — Hardness conversions*

ISO 4986:1992, *Steel castings — Magnetic particle inspection*

ISO 4987:1992, *Steel castings — Penetrant inspection*

ISO 4993:1987, *Steel castings — Radiographic inspection*

ISO 6506-1:1999, *Metallic materials — Brinell hardness test — Part 1: Test method*

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

ISO 6929:1987, *Steel products — Definitions and classification*

ISO 8062:1994, *Castings — System of dimensional tolerances and machining allowances*

ISO/TR 9769:1991, *Steel and iron — Review of available methods of analysis*

ISO 10474:1991, *Steel and steel products — Inspection documents*

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

ISO 11971:1997, *Visual examination of surface quality of steel castings*

ISO 14284:1996, *Steel and iron — Sampling and preparation of samples for the determination of chemical composition*

3 Terms and definitions

For the purposes of this document the terms and definitions listed in ISO 404, ISO 4948-1, Clause 9 of ISO 6929:1987 and ISO 11970, as well as following apply. The steel classifications given in Clause 3 of ISO 4948-1:1982 shall also be taken into account.

3.1
inspection document
document necessary for the approval that the technical delivery requirements for the cast products have been met

See Clause 8 of ISO 404:1992 and ISO 10474.

3.2
cast
heat
all the molten metal poured from a single furnace or all the molten metal from two or more furnaces poured into a single ladle

NOTE Some examples are:

— All the molten metal from one or more furnaces poured into a **single ladle**.

— All the molten metal in one melt in a **single furnace**.

The words in **boldface** are the criteria for determining the cast (heat) definition.

4 Information to be supplied by the purchaser

4.1 Enquiry and order requirements

4.1.1 A description of the casting(s) by pattern number and/or drawing. When a pattern is supplied, a description of the pattern equipment shall be included. When a drawing is not supplied the casting is purchased on the basis of the pattern. In that case, the foundry shall not be responsible for the dimensions of the part.

Machining allowances and dimensional tolerances can be selected from ISO 8062.

All modifications to be made to the drawing, for the technical requirements of the manufacturer, shall form the subject of an agreement between the manufacturer and the purchaser.

4.1.2 The material standard, delivery condition, and grade of steel, nickel or cobalt alloy.

4.1.3 The non-destructive inspection procedures to be used, the extent of the non-destructive examination and the acceptance criteria.

4.1.4 The type of inspection document to be provided at the time of supply.

4.2 Additional information

Where appropriate, the enquiry and order shall include additional information, e.g.:

a) any supplementary requirements in accordance with Clause 6;

b) size of a test lot, see 6.2.2.1;

c) procedures for marking (in accordance with Clause 7), machining, protection, packaging, loading, dispatching and the destination;

d) the submission of sample castings for approval before production quantities are produced, see A.1.2;

e) methods of statistical control to be used.

Inspection procedures shall conform to Annex A, including the place of inspection for the purchaser, if the inspection cannot be performed at the manufacturer's works.

5 Conditions of manufacture

5.1 Foundry practice

Unless otherwise agreed at the time of enquiry and order or specified in the material standard, the selection of the method of melting, moulding, heat treatment, etc., is left to the discretion of the manufacturer.

5.2 Cleaning and dressing

All the castings shall be cleaned and dressed well enough to determine compliance with the requirements of 6.2.3. Additional dressing may be agreed upon at the time of the enquiry and order.

5.3 Production welding

Unless specified at the time of the enquiry and order the casting(s) may be subject to production welding without the previous approval of the purchaser. Weld procedures for production welding shall be in accordance with ISO 11970.

For a supplement specifying major finishing welds see B.8.1 and B.8.2.

6 Inspection and testing

6.1 Non-specific inspection

This inspection shall be arranged by the manufacturer, and drawn up to ensure that the specified requirements are complied with.

At the request of the purchaser at the time of the enquiry and ordering, the manufacturer shall supply a statement of compliance or test report on the basis of these non-specific inspections or tests.

6.2 Specific inspection

6.2.1 Documents

Inspection documents shall be agreed upon at the time of the enquiry and order and shall be in accordance with ISO 10474.

If one of the documents for specific inspection and testing from ISO 10474 is ordered, the inspections and tests shall be carried out in accordance with 6.2.2, 6.2.3 and Annex A.

The inspection document shall contain the results of the chemical analysis and mechanical tests, including the results of any other tests required by the specification and by the purchaser. It shall include a statement that castings were manufactured in accordance with the requirements of the specification.

The inspection document shall be signed by an authorized agent of the manufacturer.

In the case of Electronic Data Interchange (EDI), the manufacturer's certification, printed from or used in electronic form, shall be regarded as having the same validity as a counterpart printed in the certifier's facility provided it conforms to any existing agreement between the purchaser and the supplier.

The inspection document shall provide the required traceability to the castings.

6.2.2 Sampling, preparation of test pieces, and mechanical and chemical test methods and requirements

6.2.2.1 Formation of test lots

The method of forming test lots shall be stated in the order. The size of the test lot may be defined in terms of mass or number of castings; e.g., it may be done as follows:

a) by batch: the products may come from heats of the same grade and/or from heat treatments having the same cycles, which may or may not be identified; in this case, the batch is limited to a number of castings or to a tonnage fixed between the parties concerned and constituting the unit of acceptance;

b) by heat: the products are of the same type. They come from the same heat and have undergone the same heat treatment in the same furnace;

c) by piece: for certain products where made necessary by technical requirements;

d) by supplementary agreement (see B.2.3).

6.2.2.2 Test blocks

The test blocks may be cast separately or attached to the castings or cast integrally on the castings. When more than one ladle is used the test block shall be cast integrally. They shall be produced from the same cast (heat) of steel and shall be heat treated in the production furnaces to the same procedure as the casting(s) they represent.

Unless otherwise specified the thickness of the test block shall be 28 mm minimum and the test pieces used for the mechanical tests shall be taken from test blocks with their axes at least 7 mm from the surface. See B.6.1.2 and B.6.1.3.

The test results represent the material from which the castings have been poured. They do not necessarily represent the properties of the castings. These may be affected by solidification conditions and the rate of cooling during heat treatment, which are in turn influenced by casting thickness, size and shape.

6.2.2.3 Mechanical tests

6.2.2.3.1 Tensile tests at room temperature

One tensile test shall be carried out per test lot (see 6.2.2.1). The shape, the dimensions and the method shall comply with ISO 6892. The test results shall comply with the specification for the grade of material ordered.

6.2.2.3.2 Impact test

When the test is specified it shall be carried out in accordance with ISO 148. Three Charpy test pieces with V-notches shall be prepared in accordance with 6.2.2.2. The test temperature shall be as shown in the material specification. The average value of absorbed energy from the three test pieces shall be not less than the value indicated in the material specification for the grade specified. Only one of the three values may be below, but not less than 70 % of the minimum specified value.

6.2.2.4 Re-tests

Test results not in compliance with the specification are not valid when due to:

a) defective assembly of the test piece or abnormal functioning of the test machine;

b) defective manufacture of the test pieces;

c) a break in the tensile test piece outside the reference marks;

d) anomalies shown in the test piece.

In all cases, a new test piece shall be taken from the same test block or from another test block belonging to the same test lot and the results obtained can be substituted for those corresponding to the defective piece.

Except as provided, when the results of the test do not comply with the requirements of the material standard, the manufacturer shall, unless otherwise agreed upon at the time of enquiry and order, adopt one of the procedures specified below.

a) Repeat the test that failed, on two additional test pieces. If any of the two new test pieces do not give the specification requirements, the manufacturer may follow the procedure specified in c).

b) In the case of impact tests, if the average value obtained from the three tests does not reach the minimum specified value, or if one of the individual values does not reach the specified minimum (i.e. 70 % of the minimum specified value), the manufacturer may test three additional test pieces. The additional test pieces shall be selected from the same test block or from another block from the same heat and heat treated test lot to represent the castings in question. The results from these additional tests shall be added to the results previously obtained, and the average recalculated. If this new average satisfies the average value specified, the material represented may be considered to satisfy the requirements of the material standard. Where the new average value does not satisfy the specified requirements, or any one of the new values is less than 70 % of the minimum specified value, the manufacturer may then follow the procedure specified in c).

c) Submit the castings and test blocks to a new heat treatment within the limits of the material standard, and then carry out all the tests required in the material standard on the test blocks. In any case, the castings and test bars shall not be submitted to more than two additional heat treatments (excluding tempering), without the approval of the purchaser.

6.2.2.5 Chemical composition

The chemical composition determined from the cast (heat) analysis shall meet the requirements of the specification of the selected grade. When more than one ladle is used to pour a single casting, an analysis of each ladle is required and the analysis of each ladle shall meet the requirements of the specification of the selected grade.

Samples for chemical analysis shall be obtained and prepared in accordance with ISO 14284. When chips are taken, they shall be removed from at least 6 mm below the cast surface when the cast wall section exceeds 15 mm. In case of a dispute, a check analysis may be carried out, subject to the agreement of the purchaser and manufacturer. The check analysis is made on samples used for cast (heat) analysis or on test blocks or test pieces from the cast (heat). In the case of a third party analysis, the permissible deviations in Table 1 apply.

A product analysis may be carried out by the manufacturer, subject to an agreement between the purchaser and manufacturer. The number of samples, their location, and frequency and permissible deviation of the composition range shall be agreed upon at the time of the enquiry and order.

The methods to be applied for the verification of the product analysis shall be agreed upon at the time of ordering. In case of dispute about analytical methods, the chemical composition shall be determined in accordance with a reference method from ISO standards listed in ISO/TR 9769.

Table 1 — Permissible deviations of check analysis with respect to the specified composition range

Element	Specified composition range % by mass	Permissible deviation % by mass	Element	Specified composition range % by mass	Permissible deviation % by mass
Carbon	⩽ 0,03	+ 0,005	Nickel	⩽ 1,00	± 0,07
	> 0,03 ⩽ 0,08	± 0,01		> 1,00 ⩽ 2,00	± 0,10
	> 0,08 ⩽ 0,30	± 0,02		> 2,00 ⩽ 5,00	± 0,15
	> 0,30 ⩽ 0,60	± 0,03		> 5,00 ⩽ 10,00	± 0,20
	> 0,60 ⩽ 1,20	± 0,05		> 10,00 ⩽ 20,00	± 0,25
	> 1,20 ⩽ 2,00	± 0,06		> 20,00 ⩽ 30,00	± 0,30
	> 2,00	± 0,08		> 30,00	± 0,50
Silicon	⩽ 2,00	± 0,10	Niobium	⩽ 1,00	± 0,05
	> 2,00	± 0,20		> 1,00	± 0,10
Manganese	⩽ 0,70	± 0,06	Molybdenum	⩽ 1,00	± 0,07
	> 0,70 ⩽ 2,00	± 0,10		> 1,00 ⩽ 2,00	± 0,10
	> 2,00 ⩽ 10,00	± 0,25		> 2,00 ⩽ 5,00	± 0,15
	> 10,00	± 0,40		> 5,00 ⩽ 30,00	± 0,35
Sulfur and phosphorus	⩽ 0,045	+ 0,005	Vanadium	⩽ 0,30	± 0,03
	> 0,045 ⩽ 0,060	+ 0,010		> 0,30 ⩽ 1,00	± 0,07
Chromium	⩽ 2,00	± 0,10	Tungsten	⩽ 1,00	± 0,05
	> 2,00 ⩽ 10,00	± 0,20		> 1,00 ⩽ 3,00	± 0,10
	> 10,00 ⩽ 15,00	± 0,30		> 3,00 ⩽ 6,00	± 0,15
	> 15,00 ⩽ 20,00	± 0,40			
	> 20,00	± 0,50			
Copper	⩽ 2,00	± 0,10	Cobalt	⩽ 25,00	± 0,40
	> 2,00 ⩽ 5,00	± 0,20		> 25,00	± 0,70
Nitrogen	⩽ 0,30	± 0,02	—	—	—

NOTE This table identifies the amount the specification range is increased by and is not related to variations between analyses of the same sample by different laboratories or methods of analysis.

6.2.3 Inspection of castings and requirements for surface appearance and dimensions

6.2.3.1 Non-destructive tests

Examination of the accessible surfaces of the casting shall be carried out visually (see B.9.5).

Unless otherwise specified at the time of the enquiry and order, the castings shall be delivered in the unmachined condition, trimmed, with heads and gates removed. Accessible surfaces shall be free from adhering sand and heat treatment scale.

The castings may be subject to certain non-destructive examinations (liquid penetrant, magnetic particle, radiography, ultrasonic examination, see B.9.1 to B.9.4).

6.2.3.2 Shapes, dimensions and dimensional tolerances

6.2.3.2.1 Shapes and dimensions

The shapes and dimensions of the casting shall comply with the requirements of the order, whether in the form of drawing, pattern or template.

In case of dispute, verification of the dimensions shall be carried out on castings in the as-delivered state.

6.2.3.2.2 Datum points for machining

The purchaser shall indicate the datum points for machining.

7 Marking

By agreement between the purchaser and manufacturer, each casting shall be marked. The marks shall include:

a) symbol of the manufacturer;

b) test lot identification;

c) grade of the cast material or alternative cast material grade identification (see Table 2);

d) other marks requested by the purchaser.

These marks shall be located at a place agreed by the purchaser and manufacturer.

As an alternative to the use of the complete material grade on castings alternative identification, as shown in Table 2, may be used.

By agreement between the purchaser and manufacturer, small castings may be made up into batches and the identifying marks applied to a label attached to each batch.

8 Complaints

If a complaint is made the manufacturer shall be given time to examine the merits of the complaint. The castings in question shall remain available for examination.

Table 2 — Alternative material grade identification

Standard	Grade	Alternative identification mark
ISO 3755	20 - 40	AA1
	23 - 45	AB1
	26 - 52	AC1
	30 - 57	AD1
ISO 9477	410 - 620	AA3
	540 - 720	AB3
	620 - 820	AC3
	840 - 1030	AD3
ISO 11972	GX12Cr12	AA4
	GX8CrNiMo12-1	AB4
	GX4CrNi12-4+QT1	AC4
	GX4CrNi12-4+QT2	AD4
	GX4CrNiMo16-5-1	AE4
	GX2CrNi18-10	AF4
	GX2CrNiN18-10	AG4
	GX5CrNi19-9	AH4
	GX6CrNiNb19-10	AJ4
	GX2CrNiMo19-11-2	AK4
	GX2CrNiMoN19-11-2	AL4
	GX5CrNiMo19-11-2	AM4
	GX6CrNiMoNb19-11-2	AN4
	GX2CrNiMo19-11-3	AP4
	GX2CrNiMoN19-11-3	AQ4
	GX5CrNiMo19-11-3	AR4
	GX2CrNiCuMoN26-5-3-3	AS4
	GX2CrNiMoN26-5-3	AT4
ISO 11973	GX30CrSi7	AA5
	GX40CrSi13	AB5
	GX40CrSi17	AC5
	GX40CrSi24	AD5
	GX40CrSi28	AE5
	GX130CrSi29	AF5
	GX25CrNiSi18-9	AG5
	GX25CrNiSi20-14	AH5
	GX40CrNiSi22-10	AJ5
	GX40CrNiSiNb24-24	AK5
	GX40CrNiSi25-12	AL5
	GX40CrNiSi25-20	AM5
	GX40CrNiSi27-4	AN5
	GX40NiCrCo20-20-20	AP5
	GX10NiCrNb31-20	AQ5
	GX40NiCrSi35-17	AR5
	GX40NiCrSi35-26	AS5
ISO 13521	GX120MnMo7-1	AA6
	GX110MnMo13-1	AB6
	GX100Mn13	AC6
	GX120Mn13	AD6
	GX120MnCr13-2	AE6
	GX120MnNi13-3	AF6
	GX120Mn17	AG6
	GX90MnMo14	AH6
	GX120MnCr17-2	AJ6

Table 2 (*continued*)

Standard	Grade	Alternative identification mark
ISO 14737	GS 200+N	AA7
	GS 230+N	AB7
	GS 270+N	AC7
	GS 340+N	AD7
	G20Mn5+N	AE7
	G20Mn5+QT	AF7
	G28Mn6+N	AG7
	G28Mn6+QT1	AH7
	G28Mn6+QT2	AJ7
	G28MnMo6+QT1	AK7
	G28MnMo6+QT2	AL7
	G20Mo5+QT	AM7
	G10MnMoV6-3+NT	AN7
	G10MnMoV6-3+QT	AP7
	G20NiCrMo2-2+NT	AQ7
	G20NiCrMo2-2+QT1	AR7
	G20NiCrMo2-2+QT2	AS7
	G25NiCrMo2-2+NT	AT7
	G25NiCrMo2-2+QT1	AU7
	G25NiCrMo2-2+QT2	AV7
	G30NiCrMo2-2+NT	AW7
	G30NiCrMo2-2+QT1	AX7
	G30NiCrMo2-2+QT2	AY7
	G17CrMo5-5+QT	AZ7
	G17CrMo9-10+QT	BA7
	G25CrMo4+QT1	BB7
	G25CrMo4+QT2	BC7
	G32CrMo4+NT	BD7
	G32CrMo4+QT1	BE7
	G32CrMo4+QT2	BF7
	G42CrMo4+NT	BG7
	G42CrMp4+QT	BH7
	G50CrMo4+QT1	BJ7
	G50CrMo4+QT2	BK7
	G30CrMoV6-4+QT1	BL7
	G30CrMoV6-4+QT2	BM7
	G35CrNiMo6-6+N	BN7
	G35CrNiMo6-6+QT1	BP7
	G35CrNiMo6-6+QT2	BQ7
	G30NiCrMo7-3+NT	BR7
	G30NiCrMo7-3+QT1	BS7
	G30NiCrMo7-3+QT2	BT7
	G40NiCrMo7-3+NT	BU7
	G40NiCrMo7-3+QT1	BV7
	G40NiCrMo7-3+QT2	BW7
	G32NiCrMo8-5-4+QT1	BX7
	G32NiCrMo8-5-4+QT2	BY7

NOTE For ISO standards not listed here the alternative identification marks may be found in the relevant materials standards.

Annex A
(normative)

General conditions for specific inspections and tests

A.1 Inspection conditions

A.1.1 General

Inspection documents and conditions should be agreed at the time of the order. Inspection documents are described in ISO 10474.

A.1.2 Place of inspection

Inspections and tests shall be carried out at a place agreed upon between the manufacturer and purchaser.

Samples may be selected in the manufacturer's works. Depending on the type of test, samples may be blocks or castings representative of the product.

A.1.3 Submission for inspection

The manufacturer shall arrange with the purchaser, by mutual agreement, the date of submission for inspection.

The inspection representative shall have free access at any suitable time to the places in which the products to be inspected are manufactured and stored. He may indicate the samples to be selected in accordance with the specification. He shall have the option of attending the selection of samples, the preparation (machining and treatment) of the test pieces and carrying out the tests. However, an inspection representative who visits the workshops shall respect all of the safety regulations in force in the works and shall be accompanied, as far as possible, by a representative of this works.

A.1.4 Conditions of acceptance

If all the requirements of the order, and of this International Standard, are fulfilled, the test lot is considered to conform and is accepted by the purchaser without prejudice to the inspection which may take place later at the purchaser's works within the time limits specified by agreement between the manufacturer and purchaser.

A.2 Rounding-off of test results

The results of the mechanical and chemical tests shall be rounded off using the rules specified in ISO 404.

A.3 Records

Unless otherwise specified in the order, the manufacturer shall maintain records of results of all the required tests performed by the foundry for a minimum period of five years.

Annex B
(normative)

Supplementary requirements

B.1 General

One or more of the following supplementary requirements may be applied when specified in the order. Details of these supplementary requirements shall be as agreed by the manufacturer and purchaser at the time of enquiry and order. The specified tests shall be carried out before delivery of the castings.

B.2 Manufacturing considerations

B.2.1 Steelmaking process

The steelmaking process shall be reported to the purchaser.

B.2.2 Agreed manufacturing procedure

When the castings are manufactured in bulk, the purchaser may ask to approve the manufacturing process. A programme of manufacture and inspection shall be agreed upon. The parties shall agree to a certain number of satisfactory preliminary tests and the manufacture of a sample series of castings. All these conditions taken together constitute an approved test of manufacture by the purchaser. When the results are satisfactory, the purchaser may place subsequent orders with the manufacturer in accordance with these programmes of manufacture and inspection.

B.2.3 Mass of test lots

The mass of the test lot may be specified from one of the following:

a) 500 kg;

b) 1 000 kg;

c) 5 000 kg.

Other methods for making up the test lots for testing by statistical means may be used. Such alternative methods shall be specified in the enquiry and order for bulk manufacture.

B.2.4 Mass and tolerance on mass

If applicable, mass and tolerance on mass shall be agreed upon at the time of the enquiry and order.

B.3 Chemical analysis for residual elements

Chemical analysis for residual elements not listed in the specification shall be as agreed between the manufacturer and purchaser.

B.4 Mechanical tests

B.4.1 Proof stress at elevated temperature

The dimensions of the test pieces and method of tests shall meet the conditions of ISO 6892. The proof stress at elevated temperature shall be determined in accordance with the requirements of ISO 783. The test temperature and proof stress shall be as specified in the material standard or shall be agreed between the manufacturer and purchaser.

B.4.2 Brinell hardness test

Measurement of the hardness at certain points on the castings shall be carried out in accordance with ISO 6506-1. The location on the casting or test block, where hardness tests are to be taken, shall be specified in the enquiry and order.

B.4.3 Alternative hardness tests

Hardness tests other than Brinell hardness tests may be used. Conversion of values shall be in accordance with ISO 4964.

B.4.4 Impact test at low temperatures

Impact strength at low temperatures shall be determined. Test temperatures and energy values shall be as specified in the individual product standards or shall be agreed between the manufacturer and purchaser. Other properties which may be specified include:

a) lateral expansion;

b) percentage of shear area.

B.5 Homogeneity of the test lot

Under conditions agreed upon by the manufacturer and purchaser, the homogeneity of the test lot shall be verified by hardness testing carried out on 5 % of the castings (at least five castings) per test lot.

B.6 Test blocks

B.6.1 Test blocks representative of the castings

B.6.1.1 General

The size, shape and location of the test blocks, the corresponding mechanical properties, the conditions under which the test blocks are cast (see 6.2.2.2), and the position of the test pieces shall be as agreed between the manufacturer and the purchaser at the time of the enquiry and order. The test block can be selected as described in B.6.1.2 and B.6.1.3.

B.6.1.2 Test block $t \times t$

The dimensions of the test block may be $t \times t$ instead of 28 mm × 28 mm, where t is the ruling section thickness ($28 < t \leqslant 56$) mm. The ruling section shall be indicated by the purchaser in the enquiry and the order.

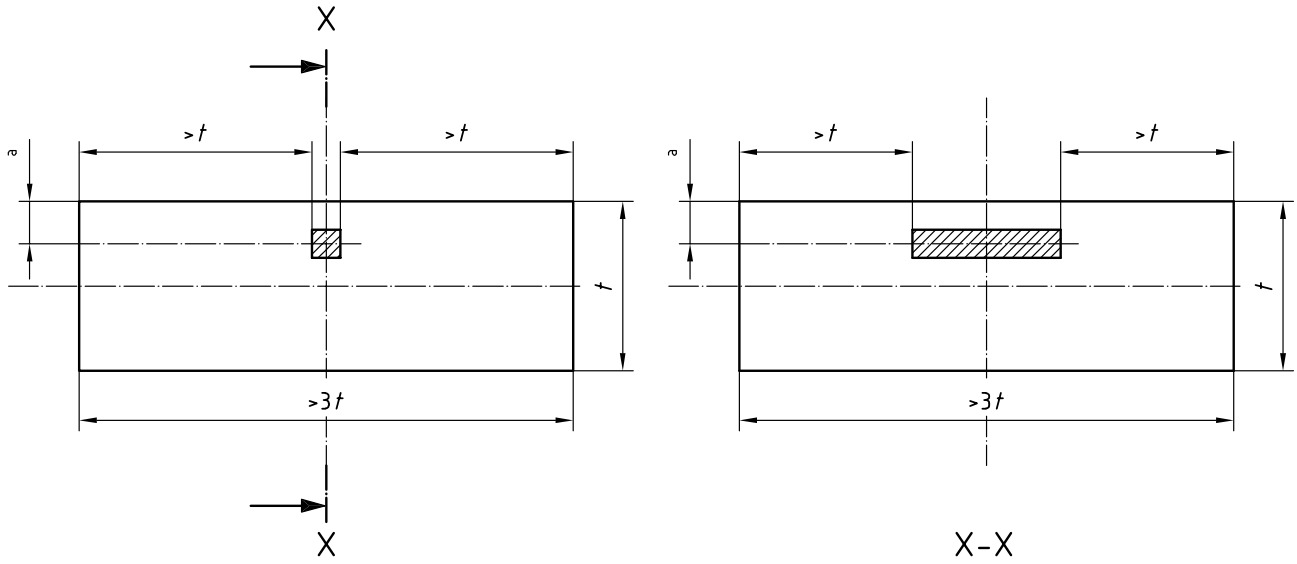
The test pieces shall be taken from the test blocks as follows:

— if the section thickness is $\leqslant$ 56 mm the axis of the test piece shall be $\geqslant$ 14 mm from the cast surface;

— if the section thickness is $>$ 56 mm, the axis of the test piece shall be $t/4$ to not more than $t/3$ from the cast surface.

B.6.1.3 Test block $t \times 3t \times 3t$

When the ruling section thickness is $>$ 56 mm, the dimensions of the test block can be taken as $t \times 3t \times 3t$ where t is the ruling section thickness. The ruling section thickness shall be indicated by the purchaser at the time of the enquiry and order. The maximum dimension of the test block is limited to 500 mm. The test piece shall be taken as shown in Figure B.1.



a $t/4$ to $t/3$

Figure B.1 — Position of the test piece and size of the sample

B.6.2 Heat treatment of separately-cast test blocks

Test blocks shall be heat treated in the same furnace together with the castings that they represent.

B.6.3 Test blocks attached to castings

When the test blocks are attached to the castings, the attachment zone and the method shall be as agreed between the manufacturer and purchaser.

The test blocks shall not be detached before the manufacturer has carried out the final heat treatment of the castings.

B.7 Heat treatment

B.7.1 Type of heat treatment

The type of heat treatment applied to the castings shall be reported to the purchaser.

B.7.2 Details of the treatment

When agreed upon by the purchaser and manufacturer in the enquiry and the order, the time/temperature cycle of the applied heat treatment shall be reported to the purchaser.

B.8 Finishing weld

B.8.1 Prior agreement relating to major finishing welds

Unless otherwise agreed, finishing welds shall be considered major when the depth of the cavity prepared for welding exceeds 40 % of the wall thickness or 25 mm whichever is the smaller.

When not specified in the product standard, major finishing welds are subject to prior approval of the purchaser, by agreement in the enquiry or the order.

B.8.2 Weld maps (sketches)

Major finishing welds shall be documented on drawings or photographs showing the location and extent of the weld. Documentation shall be submitted to the purchaser at the completion of the order.

B.9 Non-destructive tests

B.9.1 Liquid penetrant inspection

The castings shall be examined by liquid penetrant inspection in order to detect any surface discontinuities. The examination shall be carried out in accordance with ISO 4987. The area(s) to be examined and the levels of acceptance shall be as agreed between the manufacturer and purchaser.

B.9.2 Magnetic particle inspection

The castings shall be examined by magnetic particle inspection in order to detect discontinuities on or near to the surface. The examination shall be carried out in accordance with ISO 4986. The area(s) to be examined and the levels of acceptance shall be as agreed between the manufacturer and purchaser.

B.9.3 Radiographic inspection

The castings shall be examined by radiography in order to detect internal discontinuities. The examination shall be carried out in accordance with ISO 4993. The extent of the examination and the levels of acceptance shall be as agreed between the manufacturer and purchaser.

B.9.4 Ultrasonic inspection

The castings shall be tested by ultrasonics in order to detect internal discontinuities. The extent of the examination, the method of testing and the levels of acceptance shall be as agreed between the manufacturer and purchaser.

B.9.5 Visual inspection

The castings shall be examined visually. ISO 11971 may be used to establish typical and acceptable surface requirements. The extent of the examination and the levels of acceptance shall be as agreed between the manufacturer and the purchaser.

B.9.6 Examination of weld preparation for production welds

Production welds include finishing and joint welds, in accordance with ISO 11970, shall be examined by the non-destructive inspection method specified in the enquiry and in the order.

Magnetic particle or liquid penetrant examination of surfaces prepared for welding shall be performed to verify removal of discontinuities found unacceptable by the inspection method specified for the casting.

Examinations shall be carried out in accordance with the requirements described in B.9.1, B.9.2, B.9.3 and B.9.4 dependent upon the inspection technique used. The acceptance criteria shall be as agreed between the manufacturer and purchaser. Unless otherwise specified, the same acceptance criteria as for the base material in the same area is required.

B.10 Miscellaneous tests

B.10.1 Intergranular corrosion tests

The criteria for acceptance shall be as agreed between the manufacturer and purchaser at the time of the enquiry and the order.

The test shall be carried out in accordance with the test methods described in ISO 3651-2 or by any other method agreed upon by the manufacturer and purchaser.

B.10.2 Magnetic tests

The specified characteristic is normally magnetic permeability. The choice of test methods and acceptance criteria shall be as agreed between the manufacturer and purchaser.

B.10.3 Pressure tightness

Castings shall be tested with the specified fluid at the specified pressure and for the time indicated.

The castings submitted to the test shall not be in an oxidized condition and shall not receive any protective coating, covering, or impregnation before the tests.

In the case of pressure vessel castings, reference shall be made to the test conditions indicated in the test standards for these vessels.

The manufacturer is responsible for the satisfactory performance of the castings under the pressure tightness test. It is realised that the foundry may be unable to perform the test prior to shipment, or that the purchaser may wish to defer testing until additional work or machining has been performed on the casting.

B.11 Surface treatment

If the order so specifies, the unmachined or machined castings may be subjected to a protective treatment.

ICS 77.140.80

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