INTERNATIONAL STANDARD

ISO 4990

Second edition
2003-11-01

Steel castings — General technical delivery requirements

Pièces moulées en acier — Exigences générales techniques de livraison

Reference number
ISO 4990:2003(E)

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Published in Switzerland

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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 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.