
**Abrasion-resistant cast irons —
Classification**

Fontes résistant à l'usure par abrasion — Classification

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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 21988 was prepared by Technical Committee ISO/TC 25, *Cast irons and pig irons*, Subcommittee SC 6, *High alloy cast irons*.

This International Standard is one of a number that has been prepared by ISO/TC 25/SC 6 under the auspices of ISO/TC 25 for the family of cast irons. The Secretariats of ISO/TC 25 and ISO/TC 25/SC 6 are held by BSI; however, the funding and resources for the Secretariat have been provided by the Cast Metals Federation.

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Introduction

This International Standard deals with the classification of abrasion-resistant white cast irons in accordance with their chemical composition and hardness. Such cast irons are widely used in the mining, earth moving, milling and manufacturing industries where high resistance to abrading minerals and other abrading solids is required.

The abrasion resistance of these irons depends upon them having the appropriate structure and hardness for the application. These properties are obtained by careful control of the material composition and the processing route.

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Abrasion-resistant cast irons — Classification

1 Scope

This International Standard defines the grades of abrasion-resistant white cast irons. It specifies the grades in terms of:

- chemical composition;
- hardness.

The types of abrasion-resistant white cast irons covered by this International Standard are:

- a) unalloyed or low alloy cast irons;
- b) nickel-chromium cast irons covering two general types:
 - 4 % Ni 2 % Cr cast irons;
 - 9 % Cr 5 % Ni cast irons;
- c) high chromium cast irons covering five ranges of chromium content:
 - Cr > 11 % to ≤ 14 %;
 - Cr > 14 % to ≤ 18 %;
 - Cr > 18 % to ≤ 23 %;
 - Cr > 23 % to ≤ 30 %;
 - Cr > 30 % to ≤ 40 %.

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/TR 15931, *Designation system for cast irons and pig irons*

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

3 Terms and definitions

For the purposes of this document, the following terms and definitions apply.

3.1

unalloyed or low alloy abrasion-resistant cast iron

cast iron having a structure which consists of eutectic iron carbides in a predominantly pearlitic matrix

3.2

nickel-chromium abrasion-resistant cast iron

cast iron having a structure consisting of either:

- simple eutectic carbides M_3C type ($M = Fe, Cr$) in a matrix which is predominantly martensitic referred to as 4 % Ni 2 % Cr irons; or
- complex eutectic carbides (M_7C_3 and M_3C) in a matrix which is predominantly martensitic, referred to as 9 % Cr 5 % Ni irons

NOTE 1 Both of these materials can contain some bainite and retained austenite.

NOTE 2 All the grades referred to in this subclause are free of pearlite.

3.3

high chromium abrasion-resistant cast iron

cast iron containing between 11 % and 40 % Cr having a structure consisting of complex carbides in a matrix which, in the hardened condition, is predominantly martensitic, but which can also contain some austenite or other transformation products of austenite

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4 Designation

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The material shall be designated by symbols denoting the Brinell hardness and the chemical composition (Chromium content, X denoting high Chromium content), in accordance with the designations given in Tables 1 to 3.

NOTE 1 The symbols given in this International Standard comply with the guidance given in ISO/TR 15931.

NOTE 2 According to the designation system given in ISO/TR 15931, the designations of the material grades have been changed.

5 Order information

The following information shall be supplied by the purchaser:

- a) the complete designation of the material;
- b) any special requirements which have to be agreed upon between the manufacturer and the purchaser by the time of the acceptance of the order.

6 Manufacture

6.1 General

The manufacturing methods for abrasion-resistant cast irons, unless otherwise specified by the purchaser, shall be left to the discretion of the manufacturer. The manufacturer shall ensure that the requirements of this International Standard are met for the material grade specified in the order.

6.2 Heat treatment

Unless otherwise specified by the purchaser, the manufacturer shall supply castings in the condition that he considers to be suitable for the type of casting and the material grade specified.

When it is required to machine castings produced in the high chromium cast iron grades, they shall be ordered in the soft annealed condition. When the purchaser specifies delivery in the soft annealed condition, the subsequent hardening and tempering shall be the responsibility of the purchaser.

NOTE 1 Castings may be supplied in any one of the following conditions:

- as-cast;
- as-cast and tempered;
- hardened;
- hardened and tempered;
- soft annealed;
- soft annealed and hardened;
- soft annealed, hardened and tempered.

NOTE 2 Annex A gives guidance on the types of heat treatment which can be used to obtain the required hardness, structure and properties.

When it is required to machine castings produced in the high chromium cast iron grades, there are two options:

- a) Machining castings in the soft annealed condition

When the purchaser specifies delivery in the soft annealed condition, responsibility for any subsequent hardening and tempering operation shall be agreed between the manufacturer and the purchaser at the time of acceptance of the order. There may be some distortion and scaling of the machined castings due to the heat treatment.

- b) Machining castings in the as-cast or hardened condition

With appropriate equipment, and cutting tools such as cubic boron nitride (CBN), it is feasible to machine high chromium cast iron grades in the as-cast or hardened condition.

7 Requirements

7.1 Chemical composition

The chemical composition of the grades of abrasion-resistant cast iron shall be in accordance with Tables 1, 2 and 3.

NOTE Unless otherwise specified, other elements may be present, at the discretion of the manufacturer.

7.2 Brinell hardness

The Brinell hardness of the grades of abrasion-resistant cast iron shall be in accordance with Tables 1, 2 and 3.

7.3 Microstructure

Microstructure examination, if required, shall be agreed by the time of acceptance of the order. Where a microstructure examination is agreed, the location for sampling, the methods used to examine the microstructure, and acceptance criteria are subject to that agreement. The microstructure examination shall be performed in accordance with 9.3.

8 Sampling

8.1 Frequency of sampling for chemical analysis

Samples representative of the material shall be produced at a frequency in accordance with the in-process quality assurance procedures used by the manufacturer.

Samples for chemical analysis shall be cast in a manner which ensures that their representative chemical composition can be determined.

8.2 Number and frequency of Brinell hardness tests

Unless otherwise specified by the purchaser by the time of acceptance of the order, the number and frequency of Brinell hardness tests to be carried out shall be in accordance with the in-process quality assurance procedures used by the manufacturer.

In the absence of an in-process quality assurance procedure or any other agreement between the manufacturer and the purchaser, a minimum of one sample shall be produced to confirm the material grade, at a frequency to be agreed between the manufacturer and the purchaser by the time of the acceptance of the order.

9 Testing

9.1 Chemical analysis

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The methods used to determine the chemical composition of the material shall be in accordance with recognized standards. Any requirement for traceability shall be agreed between the manufacturer and the purchaser by the time of acceptance of the order. [ISO 21988:2006](https://standards.iteh.ai/catalog/standards/sist/9b644cf7-f44b-451e-addb-1277a017d1c1/iso-21988-2006)

NOTE Spectrographic, X-ray or wet chemical laboratory techniques are acceptable methods of analysis.

9.2 Hardness test

9.2.1 The Brinell hardness test shall be carried out in accordance with ISO 6506-1.

NOTE Hardness determined by one test method cannot necessarily be compared with that property determined by other test methods. Hardness conversion from other hardness test methods can be done by agreement between the manufacturer and the purchaser. Conversions between Brinell, Vickers and Rockwell C hardness, considered to be applicable to abrasion-resistant cast irons, are given in Annex B, for guidance only.

9.2.2 Each Brinell hardness test shall be carried out on a casting at locations agreed upon between the manufacturer and the purchaser, or on a test block cast-on to the casting itself.

Unless otherwise specified by the purchaser, the dimensions and location of the cast-on test block shall be left to the discretion of the manufacturer.

NOTE A cast-on test block can be used when the size of the casting or the number of castings to be tested makes direct testing on the castings impracticable.

9.2.3 If the test is to be carried out on a cast-on test block, the latter shall not be removed from the casting until after any required heat treatment has been carried out.

9.2.4 When castings are too large or too difficult to be tested in a conventional hardness testing machine, or when there is need for on-line inspection of a large number of castings, a portable hardness testing device may be used. When using portable hardness testing devices, its accuracy shall be validated using a calibrated test block. The use of such devices shall be agreed upon between the manufacturer and the purchaser by the time of acceptance of the order.

9.3 Microstructure sample

Microstructure examination shall be performed on a sample cut from a casting, or from a separately cast or cast-on sample. The sample shall have comparable solidification and cooling conditions as the critical sections of the casting.

NOTE Descriptions of typical microstructures are given for guidance in Annex D.

10 Retests

10.1 Need for retests

Retests shall be carried out if a test is not valid (see 10.2).

Retests are permitted to be carried out if a test result does not meet the specified requirements for the specified grade (see 10.3).

10.2 Test validity

A test is not valid if there is:

- a) a faulty mounting of the test piece or defective operation of the test machine;
- b) a defective test piece because of incorrect pouring or incorrect machining.

In the above cases, a retest shall be taken from the same sample or from a duplicate sample cast at the same time to replace those invalid test results.

The result of the retest shall be used.

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10.3 Nonconforming test results

If any test gives results which do not conform to the specified requirements, for reasons other than those given in 10.2, the manufacturer shall have the option to conduct retests. If the manufacturer conducts retests, two retests shall be carried out for each failed test.

If the results of both retests meet the specified requirements, the material shall be deemed to conform to this International Standard.

If the results of one or both retests fail to meet the specified requirements, the material shall be deemed not to conform to this International Standard.

10.4 Heat treatment of castings

Unless otherwise specified, in the case of castings in the as-cast condition with mechanical properties not in conformance with this International Standard, a heat treatment may be carried out.

In the case of castings which have undergone a heat treatment and for which the test results are not satisfactory, the manufacturer shall be permitted to re-heat-treat the castings and the representative samples. In this event, the samples shall receive the same number of heat treatments as the castings.

In the results of the tests carried out on the test pieces machined from the re-heat-treated samples are satisfactory, then the re-heat-treated castings shall be regarded as conforming to this International Standard.

The number of re-heat treatment cycles shall not exceed two.