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## Steel and iron castings — Radiographic testing

*Pièces moulées en acier ou en fonte — Contrôle radiographique*

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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.

The procedures used to develop this document and those intended for its further maintenance are described in the ISO/IEC Directives, Part 1. In particular the different approval criteria needed for the different types of ISO documents should be noted. This document was drafted in accordance with the editorial rules of the ISO/IEC Directives, Part 2 (see [www.iso.org/directives](http://www.iso.org/directives)).

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. Details of any patent rights identified during the development of the document will be in the Introduction and/or on the ISO list of patent declarations received (see [www.iso.org/patents](http://www.iso.org/patents)).

Any trade name used in this document is information given for the convenience of users and does not constitute an endorsement.

For an explanation on the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the WTO principles in the Technical Barriers to Trade (TBT) see the following URL: [Foreword - Supplementary information](http://www.iso.org/foreword).

The committee responsible for this document is ISO/TC 17, *Steel*, Subcommittee SC 11, *Steel castings*.

This third edition cancels and replaces the second edition (ISO 4993:2009), which has been technically revised with the following changes:

- Clause 12 has been deleted;
- [B.3](#), [B.4](#), [B.5](#): ISO 5579 has been added;
- C.3, "light alloys and copper", has been deleted.

## Introduction

Radiography can be used to detect internal discontinuities in castings. The discontinuities can have higher or lower densities than the parent metal.

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# Steel and iron castings — Radiographic testing

## 1 Scope

This International Standard specifies the general requirements for the radiography of steel and iron castings by means of X-rays or gamma-rays, in accordance with procedures given in ISO 5579 and ISO 19232.

## 2 Normative references

The following documents, in whole or in part, are normatively referenced in this document and are indispensable for its application. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

ISO 5579, *Non-destructive testing — Radiographic testing of metallic materials using film and X- or gamma rays — Basic rules*

ISO 19232-1, *Non-destructive testing — Image quality of radiographs — Part 1: Determination of the image quality value using wire-type image quality indicators*

ISO 19232-2, *Non-destructive testing — Image quality of radiographs — Part 2: Determination of the image quality value using step/hole-type image quality indicators*

ISO 19232-3, *Non-destructive testing — Image quality of radiographs — Part 3: Image quality classes*

ISO 19232-4, *Non-destructive testing — Image quality of radiographs — Part 4: Experimental evaluation of image quality values and image quality tables*

ISO 19232-5, *Non-destructive testing — Image quality of radiographs — Part 5: Determination of the image unsharpness value using duplex wire-type image quality indicators*

ASTM E186, *Standard Reference Radiographs for Heavy-Walled (2 to 4 1/2 in. [50.8 to 114 mm]) Steel Castings*

ASTM E192, *Standard Reference Radiographs for Investment Steel Castings for Aerospace Applications*

ASTM E280, *Standard Reference Radiographs for Heavy-Walled (4 1/2 to 12 in. [114 to 305 mm]) Steel Castings*

ASTM E446, *Standard Reference Radiographs for Steel Castings up to 2 in. (50.8 mm) in Thickness*

ASTM E689, *Standard Reference Radiographs for Ductile Iron Castings*

ASTM E802, *Standard Reference Radiographs for Gray Iron Castings up to 4 1/2 in. (114 mm) in Thickness*

ASTM E2660, *Standard Digital Reference Images for Investment Steel Castings for Aerospace Applications*

## 3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO 5579 apply.

## 4 Basis of purchase

The request for radiographic testing and all pertinent information relating thereto, such as sensitivity, coverage, and acceptance criteria, shall be indicated in the enquiry and order.

Unless otherwise specified in the enquiry and order, the radiographic coverage may be of two types, i.e. pilot or regular production inspection. For both types, the manufacturing plan shall show the area

to be examined and the frequency of testing and shall be subject to agreement between the supplier and purchaser.

If requirements are imposed for which there is not an accepted International Standard or other standard available, a detailed specification of such requirements shall be provided.

Castings with a complex geometry might include areas which cannot be radiographically inspected or can only be partly inspected. Such areas shall be identified before starting the radiographic examination. Areas which cannot be radiographically inspected shall be noted by all contracting parties and be marked on the film position plan.

## 5 General

### 5.1 Protection against ionizing radiation

Local, national, or international safety precautions shall be applied when using ionizing radiation.

**WARNING — Exposure of any part of the human body to X-rays or gamma-rays can be highly harmful to health.**

### 5.2 General requirements

This International Standard shall be used in combination with ISO 5579.

## 6 Testing parameters

Unless otherwise requested in the enquiry and order, the radiographic testing may be performed at any point in the manufacturing cycle, before or after the final heat-treatment.

The surface shall be conditioned, if necessary, so that surface irregularities cannot mask or be confused with discontinuities.

Any type of penetrometer or image quality indicator may be used, provided that the sensitivity level indicated by the purchaser is achieved.

The following items shall be agreed upon between contracting parties:

- a) manufacturing stage;
- b) extent of examination;
- c) examination areas;
- d) surface condition;
- e) test class according to ISO 5579 (it is recommended that the examination be performed in accordance with ISO 5579);
- f) information about the film position plan;
- g) marking of examination areas on the casting;
- h) image quality value, in accordance with ISO 19232;
- i) marking of the films;
- j) acceptance criteria.

Any additional items shall be agreed upon between the contracting parties.

Radiographs shall be evaluated by comparison to reference radiographs.



## 7 Personnel qualifications

Operations shall be carried out by qualified personnel. The system of qualification shall be agreed upon between the purchaser and manufacturer and shall form a part of the technical specification or be stated in the enquiry.

## 8 Testing arrangements

The testing arrangements shall be in accordance with [Annex A](#).

## 9 Film position plan

### 9.1 Film position plan for pilot radiography

When requested in the order or enquiry, preliminary shooting sketches shall be prepared by the supplier for submission with the radiographs of the pilot casting for approval by the customer. These sketches shall show the area of the part to be examined and shall include the following information for each exposure:

- a) gamma source or kilovoltage used;
- b) location of radiation source in relation to the area covered and the film;
- c) physical size of the source;
- d) area covered by the film;
- e) placement of the film and location markers;
- f) film-to-source distance;
- g) placement of the image quality indicators or penetrameters and the image quality value;
- h) section thickness;
- i) number and types of films used;
- j) film identification;
- k) thickness and type of intensifying screens;
- l) value of density required;
- m) geometrical unsharpness;
- n) conditions of development of films.

### 9.2 Film position plan for production radiography

The preliminary film position plan may, by agreement between the supplier and the purchaser, be adjusted at the time of the examination of the first casting sample. Subsequent production castings shall be examined in accordance with the finalized shooting sketches, which shall include the information listed in [9.1](#). Any new criteria established for the radiography of the production castings, such as changes in the percentage of coverage for the part or changes in the acceptance standards, shall be stated.

## 10 Rejection/acceptance criteria

The rejection/acceptance criteria shall be specified in the purchase order and shall be based on ASTM E446, ASTM E186, ASTM E280, ASTM E192, ASTM E689, ASTM E802, and ASTM E2660, wherever applicable.

## 11 Foundry responsibility

Unless otherwise specified at the time of the enquiry or order, the responsibility of the manufacturer is limited to the attainment of the criteria specified in the order, in all castings, or portions of castings specifically calling for radiographic examination. Castings or portions of castings not required to be radiographically examined by the foundry shall not be subject to rejection based upon the results of any subsequent radiographic examination. Also, castings shall not be subject to rejection based upon radiographic re-examination subsequent to their acceptance on the basis of the original radiography if such examination is carried out by techniques other than those agreed upon at the time of the enquiry and order and/or in a manner different from that described in the finalized shooting sketch (see 9.2).

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