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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 document 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).

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For an explanation of the voluntary nature of standards, the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the World Trade Organization (WTO) principles in the Technical Barriers to Trade (TBT), see www.iso.org/iso/foreword.html.

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

This fourth edition cancels and replaces the third edition (ISO 4993:2015), which has been technically revised.

The main changes are as follows:

- ~~Annex A~~ Annex A was ~~re-written~~ rewritten to include a table for the various testing arrangements;
- ~~—~~ term “examination” being replaced with testing.

Any feedback or questions on this document should be directed to the user's national standards body. A complete listing of these bodies can be found at www.iso.org/members.html.

Introduction

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

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Steel and iron castings — Radiographic testing

1 Scope

This document specifies the general requirements for the radiography of steel and iron castings by means of X-rays or gamma-rays.

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements 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 5579, *Non-destructive testing — Radiographic testing of metallic materials using film and X- or gamma rays — Basic rules*

[ISO 9712, Non-destructive testing — Qualification and certification of NDT personnel](#)

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 and basic spatial resolution 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*

[E8268, Standard Digital Reference Images for Steel Castings up to 2in. \(50.8 mm\) in Thickness](#)

[E3030, Standard Digital Reference Images for Heavy-Walled \(2 to 412 In. \(50.8 to 114 mm\)\) Steel Castings](#)

3 Terms and definitions

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

ISO and IEC maintain terminology databases for use in standardization at the following addresses:

- ~~—~~ISO Online browsing platform: available at <https://www.iso.org/obp>
- ~~—~~IEC Electropedia: available at <https://www.electropedia.org/>

4 Basis of purchase

The request for radiographic testing and all requirements, see ~~Clause 6~~**Clause 6**, should be indicated in the enquiry and order.

Unless otherwise specified in the enquiry and order, the radiographic coverage can 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. The acceptance criteria, see ~~Clause 10~~**Clause 10**, shall be subject to agreement between the manufacturer and purchaser.

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

5 General

Relevant 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.

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 should be conditioned so that surface irregularities cannot mask or be confused with discontinuities.

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

The following items shall be agreed upon between ~~the~~ purchaser and manufacturer:

- a) ~~a)~~ manufacturing stage;
- b) ~~b)~~ extent of testing;
- c) ~~c)~~ testing areas;
- d) ~~d)~~ surface condition;
- e) ~~e)~~ test class in accordance with ISO 5579;

- f) ~~f)~~ information about the film position plan;
- g) ~~g)~~ marking of testing areas on the casting;
- h) ~~h)~~ image quality value, in accordance with ISO 19232 series;
- i) ~~i)~~ traceability of the films or digital images;
- j) ~~j)~~ acceptance criteria.

Any additional items shall be agreed upon between the purchaser and manufacturer.

Radiographs shall be evaluated by comparison to reference radiographs.

7 Personnel qualifications

Operations shall be carried out by qualified personnel according to ISO 9712. The system of qualification shall be agreed upon between the purchaser and manufacturer.

8 Testing arrangements

Testing arrangements shall be agreed upon between the purchaser and the manufacturer. Some possible arrangements are in [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 manufacturer 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) name, address of test facility performing the testing;
- b) part number and description;
- c) instruction identification number, issue No. and date of issue;
- d) material including requirements for surface preparation;
- e) gamma source or kV used, tube current, exposure time, see [Annex C](#) for additional information about the choice of source used;
- f) physical size of the source;
- g) location of radiation source in relation to the area covered and the film;
- h) angle of beam to film;
- i) object-to-film distance;

- j) film-to-source distance;
- k) section thickness, [Annex B](#)~~Annex B~~ lists various techniques to increase the covered thickness range;
- l) areas of the item to be examined (support by diagrams when required);
- m) placement of the film and location markers;
- n) placement of the image quality indicators or penetrameters and the image quality value;
- o) filters, masks, diaphragms used including the letter B for monitoring the back scatter radiation;
- p) film type, size, quantity, pattern, and identification;
- q) thickness and type of intensifying screens;
- r) value of density;
- s) geometrical unsharpness;
- t) conditions of development of films;
- u) number of sheets that make up the instruction;
- v) associated documents;
- w) prepared by, approved by, associated signatures and qualifications and date.

9.2 Film position plan for production radiography

The preliminary film position plan can, by agreement between the supplier and the purchaser, be adjusted at the time of the testing 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 [9.19.1](#). 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 the applicable standard: ASTM E446, ASTM E186, ASTM E280, ASTM E192, ASTM E689, ASTM E802, ASTM E2660, ~~ASTM E8268~~, or ~~ASTM E3030~~.

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 testing. 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 testing. Also, castings shall not be subject to rejection based upon radiographic re-testing subsequent to their acceptance on the basis of the original radiography if such testing is carried