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**Non-destructive testing — Industrial
computed radiography with storage
phosphor imaging plates —**

**Part 2:
General principles for testing of
metallic materials using X-rays and
gamma rays**

*Essais non destructifs — Radiographie industrielle numérisée avec
écrans photostimulables à mémoire —*

*Partie 2: Principes généraux de l'essai radiographique des matériaux
métalliques au moyen de rayons X et gamma*



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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).

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For an explanation on 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 the following URL: www.iso.org/iso/foreword.html.

This document was prepared by the European Committee for Standardization (CEN) in collaboration with ISO Technical Committee ISO/TC 135, *Non-destructive testing*, Subcommittee SC 5, *Radiographic testing*, in accordance with the Agreement on technical cooperation between ISO and CEN (Vienna Agreement).

A list of all parts in the ISO 16371 series can be found on the ISO website.

This corrected version of ISO 16371-2:2017 incorporates the following correction:

— [Figure A.1](#) b) has been corrected.

Non-destructive testing — Industrial computed radiography with storage phosphor imaging plates —

Part 2:

General principles for testing of metallic materials using X-rays and gamma rays

1 Scope

This document specifies fundamental techniques of computed radiography with the aim of enabling satisfactory and repeatable results to be obtained economically. The techniques are based on the fundamental theory of the subject and tests measurements. This document specifies the general rules for industrial computed X-rays and gamma radiography for flaw detection purposes, using storage phosphor imaging plates (IP). It is based on the general principles for radiographic examination of metallic materials on the basis of films, as specified in ISO 5579. The basic set-up of radiation source, detector and the corresponding geometry are intended to be applied in accordance with ISO 5579 and corresponding product standards such as ISO 17636 for welding and EN 12681 for foundry.

This document does not lay down acceptance criteria of the imperfections. Computed radiography (CR) systems provide a digital grey value image which can be viewed and evaluated on basis of a computer only. This practice describes the recommended procedure for detector selection and radiographic practice. Selection of computer, software, monitor, printer and viewing conditions are important but not the main focus of this document.

The procedure it specifies provides the minimum requirements and practice to permit the exposure and acquisition of digital radiographs with a sensitivity of imperfection detection equivalent to film radiography and as specified in ISO 5579. Some application standards, e.g. EN 16407, can require different and less stringent practice conditions.

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 5580, *Non-destructive testing — Industrial radiographic illuminators — Minimum requirements*

ISO 9712, *Non-destructive testing — Qualification and certification of NDT personnel*

ISO 16371-1:2011, *Non-destructive testing — Industrial computed radiography with storage phosphor imaging plates — Part 1: Classification of systems*

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 19232-3:2013, *Non-destructive testing — Image quality of radiographs — Part 3: Image quality classes*

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

EN 12543 (all parts), *Non-destructive testing — Characteristics of focal spots in industrial X-ray systems for use in non-destructive testing*

EN 12679, *Non-destructive testing — Determination of the size of industrial radiographic sources — Radiographic method*

3 Terms and definitions

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

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

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

3.1 computed radiography system

CR system

complete system comprising a *storage phosphor imaging plate* (3.2) and a corresponding read-out unit (scanner or reader) and system software, which converts the information from the IP into a digital image

3.2 storage phosphor imaging plate

imaging plate

IP

photostimulable luminescent material capable of storing a latent radiographic image of a material being examined and upon stimulation by a source of red light of appropriate wavelength, generates luminescence proportional to radiation absorbed

Note 1 to entry: When performing *computed radiography* (3.1), an IP is used in lieu of a film. When establishing techniques related to source size or focal geometries, the IP is referred to as a detector, i.e. source-to-detector distance (SDD).

3.3 structure noise of imaging plate

structure noise of IP

fixed pattern noise measured due to IP structure which is inherent from inhomogeneities in the sensitive layer (graininess) and surface of a *storage phosphor imaging plate* (3.2)

Note 1 to entry: After scanning of the exposed imaging plate, the inhomogeneities appear as overlaid fixed pattern noise in the digital image.

Note 2 to entry: This noise limits the maximum achievable image quality of digital CR images and can be compared with the graininess in film images.

3.4 grey value

GV

numeric value of a pixel in a digital image

Note 1 to entry: This is equivalent to the term pixel value as defined in ASTM E 2033, E 2445, E 2446 and E 2007.

3.5

linearized grey value

GV_{lin}

numeric value of a pixel which is directly proportional to the detector exposure dose, having a value of zero if the detector was not exposed

Note 1 to entry: This is equivalent to the term linearized pixel value as defined in ASTM E 2033, E 2445, E 2446 and E 2007.

3.6

basic spatial resolution of CR system

$SR_b^{detector}$

corresponds to half of the measured detector unsharpness in a digital image and corresponds to the effective pixel size and indicates the smallest geometrical detail, which can be resolved with a CR system at magnification equal to one

Note 1 to entry: For this measurement, the duplex wire IQI is placed directly on the CR imaging plate.

Note 2 to entry: The measurement of unsharpness is described in ISO 19232-5; see also ASTM E 2002.

3.7

basic spatial resolution of a digital image

SR_b^{image}

corresponds to half of the measured image unsharpness in a digital image and corresponds to the effective pixel size in the image and indicates the smallest geometrical detail, which can be resolved in a digital image

Note 1 to entry: For this measurement, the duplex wire IQI is placed directly on the object (source side).

Note 2 to entry: The measurement of unsharpness is described in ISO 19232-5; see also ASTM E 2002.

Note 3 to entry: The effective pixel size of the image (basic spatial resolution of the digital image) depends on pixel pitch, geometrical unsharpness, detector unsharpness and magnification.

3.8

signal-to-noise ratio

SNR

quotient of mean value of the *linearized grey values* (3.5), which is the signal intensity to the standard deviation of the linearized grey values (noise) in a given region of interest in a digital image

Note 1 to entry: The SNR depends on the radiation dose and the CR system properties.

3.9

normalized signal-to-noise ratio

SNR_N

signal-to-noise ratio (3.8), normalized by the basic spatial resolution, SR_b , which may be SR_b^{image} or $SR_b^{detector}$, as measured directly in the digital image and/or calculated from the measured SNR, $SNR_{measured}$, by

$$SNR_N = SNR_{measured} \cdot \frac{88,6\mu m}{SR_b}$$

3.10

contrast-to-noise ratio

CNR

ratio of the difference of the mean signal levels between two image areas to the averaged standard deviation of the signal levels

Note 1 to entry: The contrast-to-noise ratio describes a component of image quality and depends approximately on the product of radiographic attenuation coefficient and SNR. In addition to adequate CNR, it is also necessary for a digital radiograph to possess adequate unsharpness or basic spatial resolution to resolve desired features of interest.

3.11

normalized contrast-to-noise ratio

CNR_N

contrast-to-noise ratio (3.10), normalized by the basic spatial resolution, SR_b, as measured directly in the digital image and/or calculated from the measured CNR, by

$$\text{CNR}_N = \text{CNR} \cdot \frac{88,6\mu\text{m}}{\text{SR}_b}$$

3.12

aliasing

artefacts that appear in an image when the spatial frequency of the input is higher than the output is capable of reproducing

Note 1 to entry: Aliasing often appears as jagged or stepped sections in a line or as moiré patterns.

3.13

nominal thickness

t

thickness of the material in the region under examination

Note 1 to entry: Manufacturing tolerances do not have to be taken into account.

3.14

penetrated thickness

w

thickness of material in the direction of the radiation beam calculated on basis of the *nominal thickness* (3.13) of all penetrated walls

Note 1 to entry: For multiple wall techniques, the penetrated thickness is calculated from the nominal thickness of all penetrated walls.

3.15

source size

d

size of the radiation source or focal spot size

Note 1 to entry: See EN 12543 (X-ray-sources) or EN 12679 (gamma ray sources). Manufacturer's values may be used if they conform to these standards.

3.16

object-to-detector distance

b

largest (maximum) distance between the radiation side of the radiographed part of the test object and the sensitive layer of the detector along the central axis of the radiation beam

3.17**source-to-detector distance****SDD**

distance between the source of radiation and the detector, measured in the direction of the beam

Note 1 to entry: $SDD = f + b$, where f is the *source-to-object distance* (3.18) and b is the *object-to-detector distance* (3.16).

3.18**source-to-object distance** **f**

distance between the source of radiation and the source side of the test object, most distant from the detector, measured along the central beam

3.19**geometric magnification** **v**

ratio of *source-to-detector distance* (3.17) to *source-to-object distance* (3.18)

4 Symbols and abbreviated terms

For the purposes of this document, the symbols and abbreviated terms given in Table 1 apply.

Table 1 — Symbols and abbreviated terms

Symbol	Term
b	object-to-detector distance
CNR	contrast-to-noise ratio
CNR_N	normalized contrast-to-noise ratio
CR	computed radiography
d	source size, focal spot size
D	detector (imaging plate)
fd	source-to-object distance
GV	grey value
GV_{lin}	linearized grey value
IP	storage phosphor imaging plate
IQI	image quality indicator
S	radiation source
SDD	source-to detector-distance
SNR	signal-to-noise ratio
SNR_N	normalized signal-to-noise ratio
SR_b	basic spatial resolution, which may be SR_b^{image} or $SR_b^{detector}$ depending on the context
$SR_b^{detector}$	basic spatial resolution as determined with a duplex wire IQI adjacent to the detector
SR_b^{image}	basic spatial resolution as determined with a duplex wire IQI on the source side of the object
t	nominal thickness
$u_G t$	geometric unsharpness
u_i	inherent unsharpness of the detector system, excluding any geometric unsharpness, measured from the digital image with a duplex wire IQI adjacent to the detector
u_T	total image unsharpness, including geometric unsharpness, measured in the digital image at the detector plane with a duplex wire IQI at the object plane