International Standard

ISO 32543-1

First edition

Non-destructive testing — Characteristics of focal spots in industrial X-ray systems —

Part 1: Pinhole camera radiographic method

Essais non destructifs — Caractéristiques des foyers émissifs des tubes radiogènes industriels —

Partie 1: Méthode radiographique par sténopé

PROOF/ÉPREUVE

Reference number
ISO 32543-1:2024(en)

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Published in Switzerland

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Foreword

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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 (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 the European Committee for Standardization (CEN) (EN 12543-2:2021) and was adopted (without modification other than those given below) by Technical Committee(s) ISO/TC 135, *Non-destructive testing*, Subcommittee SC 5, *Radiographic testing.*

The main changes are as follows:

— verbal forms in the Scope and 5.1 NOTE have been modified to meet ISO content requirements;

— definitions in Clause 3 have been modified to remove reference to content outside Clause 3;

— Figures 5, 6 and 7 have been updated;

— keys have been added to Figures 1, 2, 3, 4, 5 and 6;

— change "profile integration" to "profile averaging" when referring to the averaging of the profile lines;

— minor editorial corrections.

A list of all parts in the ISO 32543 series can be found on the ISO website.

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

In order to cover the large range of effective focal spot sizes, different methods are described in the ISO 32543 series.

The pinhole method of ISO 32543-1 is intended for effective focal spot sizes above 0,1 mm and mainly used for sealed standard and mini focus tubes. ASTM E1165 describes the same pinhole procedure.

The edge method of EN 12543-4 is intended for field applications when the users have to observe the effective focal spot on a regular basis and the pinhole method is non-practical.

The edge measurement method of EN 12543-5 is intended for measurement of effective focal spot sizes between 5 µm and 300 µm and mainly for the use with µ-Focus tubes (up to 100 µm) and mini focus tubes with spot sizes of 100 µm to 300 µm.

In the overlapping ranges, the different parts of the EN 12543 series and ISO 32543 series provide comparable values within ±20 % tolerance.

Non-destructive testing — Characteristics of focal spots in industrial X-ray systems —

Part 1:
Pinhole camera radiographic method

1 Scope

This document specifies a method for the measurement of effective focal spot dimensions above 0,1 mm of X-ray systems up to and including 1 000 kV tube voltage by means of the pinhole camera method with digital evaluation. The tube voltage applied for this measurement is restricted to 200 kV for visual film evaluation and can be selected higher than 200 kV if digital detectors are used.

The imaging quality and the resolution of X-ray images depend highly on the characteristics of the effective focal spot, in particular the size and the two-dimensional intensity distribution as seen from the detector plane. Compared to the other methods specified in the EN 12543 series and the ISO 32543 series, this method allows to obtain an image of the focal spot and to see the state of it (e.g. cratering of the anode).

This test method provides instructions for determining the effective size (dimensions) of standard (macro focal spots) and mini focal spots of industrial X-ray tubes. This determination is based on the measurement of an image of a focal spot that has been radiographically recorded with a "pinhole" technique and evaluated with a digital method.

For the characterization of commercial X-ray tube types (i.e. for advertising or trade), the specific FS (Focal spot) values of Annex A can be used.

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 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*

3 Terms and definitions

For the purposes of this document, the following terms and definitions 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/

3.1
actual focal spot
X-ray emitting area of the anode as viewed from a position perpendicular to the anode surface

Note 1 to entry: The actual focal spot is also called thermal focal spot in other literature.

3.2
effective focal spot
X-rays emitting area of the anode as viewed from the image plane of the detector

Note 1 to entry: The effective focal spot is also called optical focal spot in other literature.

3.3
effective focal spot size
focal spot size measured in accordance with this document

3.4
nominal focal spot size
SS
characteristic value for X-ray tubes having measured spot sizes within a defined range

3.5
focal spot class
FS
number used to classify X-ray tubes based on the nominal focal spot size

3.6
basic spatial resolution of the detector
SR_b^{detector}
smallest degree of visible detail within a digital image, determined with the duplex wire image quality indicator (IQI) according to ISO 19232-5 located on the detector (magnification = 1), from the smallest number of the duplex wire pair with less than 20 % modulation depth in a linearized profile and it corresponds to ½ of the detector unsharpness

4 Test equipment

4.1 Essential characteristics of the pinhole

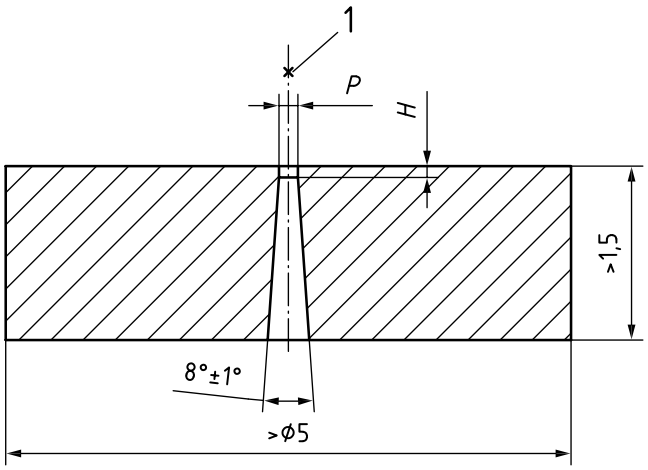
The pinhole camera shall consist of a diaphragm with a pinhole having followed essential dimensions P and H according to Table 1 dependent from the effective focal spot size.

Table 1 — Dimensions of the pinhole

Focal spot size mm	Diameter *P* µm	Height *H* µm
0,1 to 0,3	10 ± 5	20 ± 5
> 0,3 to 1,0	30 ± 5	75 ± 10
> 1,0	100 ± 5	500 ± 10

The essential dimensions *P* and *H* are shown in Figure 1.

Dimensions in millimetres



Key

1 focal spot

P pinhole diameter

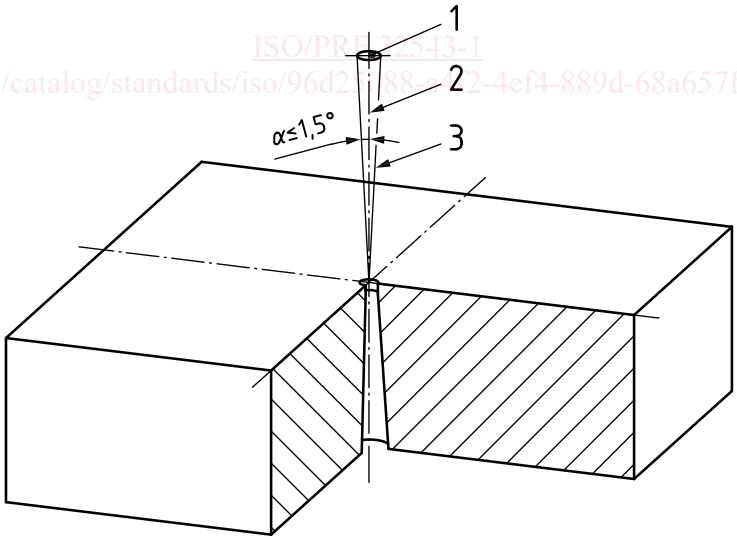
H pinhole height

Figure 1 — Essential dimensions of a pinhole diaphragm

The pinhole diaphragm shall be made of tungsten or of a similar absorbent material (e.g. gold, platinum, tantalum or related alloys).

4.2 Alignment and position of the pinhole camera

The angle between the beam direction and the pinhole axis (see Figure 2) shall be smaller than ±1,5°. When deviating from Figure 2, the direction of the beam shall be indicated.



Key

1 focal spot

2 beam direction

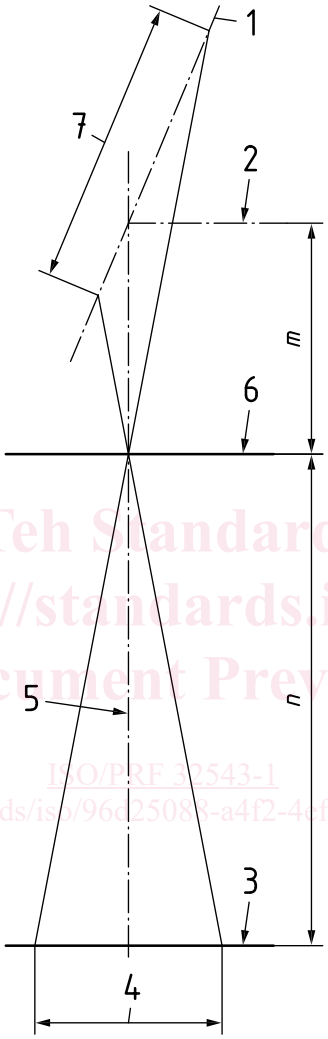
3 maximum deviation of the axis of the pinhole

Figure 2 — Alignment of the pinhole camera

The incident face of the pinhole diaphragm shall be placed at a distance m from the focal spot so that the variation of the magnification over the extension of the actual focal spot does not exceed ±5 % in the beam direction. In no case shall this distance be less than 100 mm.

4.3 Position of the radiographic image detector

The radiographic image detector [film, imaging plate (CR) or digital detector array (DDA)] shall be placed normal to the beam direction at a distance *n* from the incident face of the pinhole diaphragm determined from the applicable magnification according to Figure 3 and Table 2.



Key

1 plane of anode
2 reference plane
3 radiographic image detector
4 magnified length of the effective focal spot
5 beam direction
6 incident face of the diaphragm
7 physical length of the actual focal spot
n distance from pin hole to detector
m distance from focal spot centre to pin hole

Figure 3 — Beam direction dimensions and planes