SLOVENSKI STANDARD
SIST EN 12543-4:2000

01-oktober-2000

Neporuġitveno preskuġanje - Znaļ ilnosti goriġļ ne povrġine v industrijskih rentgenskih sistemih za Neporuġitveno preskuġanje - 4. del: Metoda z robom

Non-destructive testing - Characteristics of focal spots in industrial X-ray systems for use in non-destructive testing - Part 4: Edge method

Zerstörungsfreie Prüfung - Charakterisierung von Brennflecken in Industrie-Röntgenanlagen für die zerstörungsfreie Prüfung - Teil 4: Kantenverfahren

Essais non destructifs - Caractéristiques des foyers émissifs des tubes radiogenes industriels utilisés dans les essais non destructifs - Partie 4: Méthode par effet de bord

Ta slovenski standard je istoveten z: **EN 12543-4:1999**

ICS:

19.100	Neporušitveno preskušanje	Non-destructive testing

SIST EN 12543-4:2000 **en**

EUROPEAN STANDARD
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English version

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This European Standard exists in three official versions (English, French, German). A version in any other language made by translation under the responsibility of a CEN member into its own language and notified to the Central Secretariat has the same status as the official versions.

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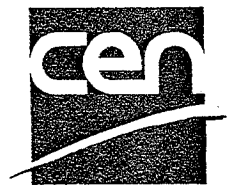

EUROPEAN COMMITTEE FOR STANDARDIZATION
COMITÉ EUROPÉEN DE NORMALISATION
EUROPÄISCHES KOMITEE FÜR NORMUNG

Central Secretariat: rue de Stassart, 36 B-1050 Brussels

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Contents

Foreword

This European Standard has been prepared by Technical Committee CEN/TC 138 "Non-destructive testing", the secretariat of which is held by AFNOR.

This European Standard shall be given the status of a national standard, either by publication of an identical text or by endorsement, at the latest by March 2000, and conflicting national standards shall be withdrawn at the latest by March 2000.

According to the CEN/CENELEC Internal Regulations, the national standards organizations of the following countries are bound to implement this European Standard: Austria, Belgium, Czech Republic, Denmark, Finland, France, Germany, Greece, Iceland, Ireland, Italy, Luxembourg, Netherlands, Norway, Portugal, Spain, Sweden, Switzerland and the United Kingdom.

In the framework of its scope, Technical Committee CEN/TC 138 entrusted CEN/TC 138/WG 1 "Ionizing Radiation" with preparing the following standard:

EN 12543-4, *Non-destructive testing - Characteristics of focal spots in industrial X-ray systems for use in non-destructive testing - Part 4: Edge method.*

EN 12543-4 is a part of series of European Standards with the same number; the other Parts are the following:

EN 12543-1, *Non-destructive testing - Characteristics of focal spots in industrial X-ray systems for use in non-destructive testing - Part 1: Scanning method.*

EN 12543-2, *Non-destructive testing - Characteristics of focal spots in industrial X-ray systems for use in non-destructive testing - Part 2: Pinhole camera radiographic method.*

EN 12543-3, *Non-destructive testing - Characteristics of focal spots in industrial X-ray systems for use in non-destructive testing - Part 3: Slit camera radiographic method.*

EN 12543-5, *Non-destructive testing - Characteristics of focal spots in industrial X-ray systems for use in non-destructive testing - Part 5: Measurement of the effective focal spot size of mini and micro focus X-ray tubes.*

Introduction

In order to cover the different requirements for focal spot size measurement, five different methods are described in EN 12543-1 to EN 12543-5.

The scanning method (EN 12543-1) is dedicated to those applications where quantitative values for the intensity distribution and spot size are needed, i. e. calibration and image processing purposes.

The radiographic methods (EN 12543-2 and EN 12543-3) describe the traditional techniques and are dedicated for certification purposes and for field applications up to 200 kV.

Where no pinhole or slit cameras are available in the field, the edge method (EN 12543-4) may be applied. It represents a very simple method for field application.

In order to cover also the micro focus systems, a specific method is presented in EN 12543-5.

1 Scope

This European standard specifies the checking of focal spot dimensions above 0,5 mm of X-ray systems up to and including 500 kV tube voltage, by means of radiographs of sharp edges.

The image quality and the resolution of X-ray images depend highly on the characteristics of the focal spot. The imaging qualities of a focal spot are based on the two dimensional intensity distribution in the object plane.

The edge method is especially useful for the checking of focal spots under field conditions in order to find changes of the focal spot. It cannot be used for an absolute measurement of the focal spot. For absolute measurements the method according to Annex A is applied.

2 Normative References

This European Standard incorporates by dated or undated reference, provisions from other publications. These normative references are cited at the appropriate places in the text and the publications are listed hereafter. For dated references, subsequent amendments to or revisions of any of these publications apply to this European Standard only when incorporated in it by amendment or revision. For undated references the latest edition of the publication referred to applies.

EN 12543-1, *Non-destructive testing - Characteristics of focal spots in industrial X-ray systems for use in non-destructive testing - Part 1: Scanning method.*

EN 584-1, *Non-destructive testing - Industrial radiographic film - Part 1: Classification of film systems for industrial radiography.*

EN 25580, *Non-destructive testing - Industrial radiographic illuminators - Minimum requirements* (ISO 5580:1985).

3 Terms and definitions

For the purposes of this standard, the following definition applies:

Focal spot: the X-ray emitting area on the anode of the X-ray tube as seen from the measuring device [EN 12543-1].

4 Test method

4.1 Principle and equipment

This method is based on indirect measurement of the focal spot size by measuring the geometric unsharpness. For this purpose a sharp edge is imaged on a film using a relatively high geometric magnification.

The following equipment is required for the measurement:

- films with a minimum length of 24 cm without screens,
- film cassettes made of thin plastic material or aluminium,
- lead letters L and W,
- a collimating diaphragm in front of the tube window compatible with the size of the film,
- a steel cylinder or a thick walled pipe of 50 mm to 100 mm diameter and about 100 mm length,
- a support (tripod) to carry the steel cylinder,
- a sheet of lead approximately 200 mm x 100 mm, 1 mm thick or thicker,

- a film processsing unit,
- an illuminator with a uniform and constant brightness according to EN 25580,
- an optical densitometer capable of reading densities of $D \geq 3{,}0$. The densitometer shall permit contrast measurements of $\Delta D = 0{,}01$. Its input diaphragm d_i shall be 2 mm or smaller.

A cylindrical surface is placed as an edge in the beam direction (figure 1). An ordinary steel cylinder or a thick walled pipe with a diameter of 50 mm to 100 mm and with a length of about 100 mm is used for this purpose. A sheet of lead with a thickness of 1 mm or larger is to be wrapped around the cylinder.

Scattering shall be avoided as far as possible. A collimating diaphragm with an opening compatible to the size of the film shall be placed in front of the tube window.

Any use of additional X-ray prefiltering shall be avoided.

For the characterization of the focal spot its size shall be measured in two perpendicular directions. The two measurements shall be made so that:

1) the tube axis and cylinder edge shall be perpendicular for one measurement, lead letter L on film, and

2) the tube axis and cylinder edge shall be parallel to each other for the other measurement, lead letter W on film.

The image of the lead letters shall be in the dark part of the film.

The film shall be positioned always with its longer dimension perpendicular to the cylinder axis. As a result the unsharp image of the edge shall be crosswise on the film in either case.

4.2 Selection of distances and exposure time

Referring to figure 1, the distances f and s represent respectively the source to edge and the edge to film distances and d_c is the diameter of the steel cylinder including the lead covering. An estimate for the relation between f and s may be derived from a given nominal value of the focal spot size. The relation s/f shall be larger than or equal to ten times the diameter of the density meter input diaphragm d_i divided by the focal spot size d_n provided by the manufacturer (see equation1).

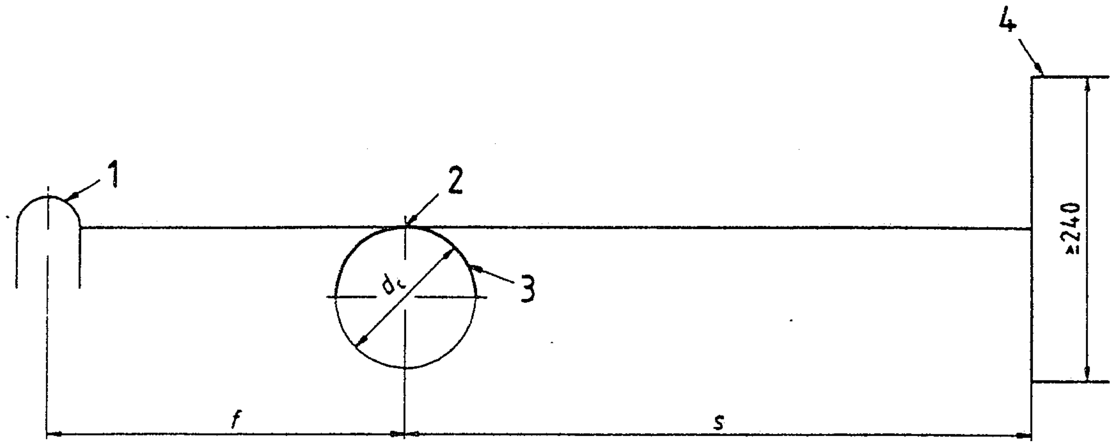
$$s / f \geq 10 \cdot d_i / d_n \qquad (1)$$

NOTE If the distance s gets impractically long, the diameter of the densitometer input diaphragm d_i should be decreased to 1 mm or below.

The ratio f / d_c shall be larger than 5.

As an example a film to focus distance ($f + s$) of about 2 meters is appropriate for a 300 kV/5 mA X-ray tube.

Dimensions in millimetre



Key

1 source/focal spot
2 edge
3 1mm lead sheet
4 film

Figure 1 – Setup for measuring the focal spot size

If the nominal focal spot size is not known, the relation between *s* and *f* has to be found experimentally by a preliminary determination of the focal spot size using the present edge method.

The part of the film completely exposed shall have a density of $D = 2{,}5 \pm 0{,}3$. The exposure time shall exceed 30 s.

5 Measurement and determination of the focal spot size

5.1 Measurement

Subsequently, the density profile on the processed film (figure 2) is evaluated in order to measure u_g.

If one considers the film to be divided into three zones of differing density, namely the light zone, the transition zone and the dark zone, then the density profiles in the light and the dark zones shall be as uniform as possible, i. e. no sharp fluctuations. If the density variation over the length of either zone (i. e. along the length of the film) is more than 2 % of the total contrast, then it is necessary to check the protection against scattered radiation and to repeat the exposure.

The geometric unsharpness u_g will be determined in terms of the contrast which is the difference in density (D) measured at the darkest and the brightest region on the film. If a hand held density meter is used, the density shall be measured at a fixed point on the illuminator, where the zero adjustment of the densitometer was made. In this case, it is necessary to slide the film instead of moving the densitometer.

The zero adjustment of the densitometer shall be checked before and after the measurement. In case of deviations the measurement has to be repeated.

First the total contrast between dark and bright zone is measured. Then the two points of 5 % and 95 % of the contrast are marked on the film. The distance between these points is the geometric unsharpness u_g.

In order to illustrate the procedure for the measurement of the geometric unsharpness, a density profile is shown in figure 2, and the points with 5 % and 95 % of the total contrast are projected on the abscissa. The length of this projection is u_{gl} or u_{gw} dependent on the orientation of the tube axis.

The focal spot size shall be determined according to the following equations :

$$l = u_{gl} \cdot f/s \quad (2)$$

$$w = u_{gw} \cdot f/s \quad (3)$$

where

l focal spot length
w focal spot width
f distance between focal spot and edge (figure 1),
s edge to film distance.

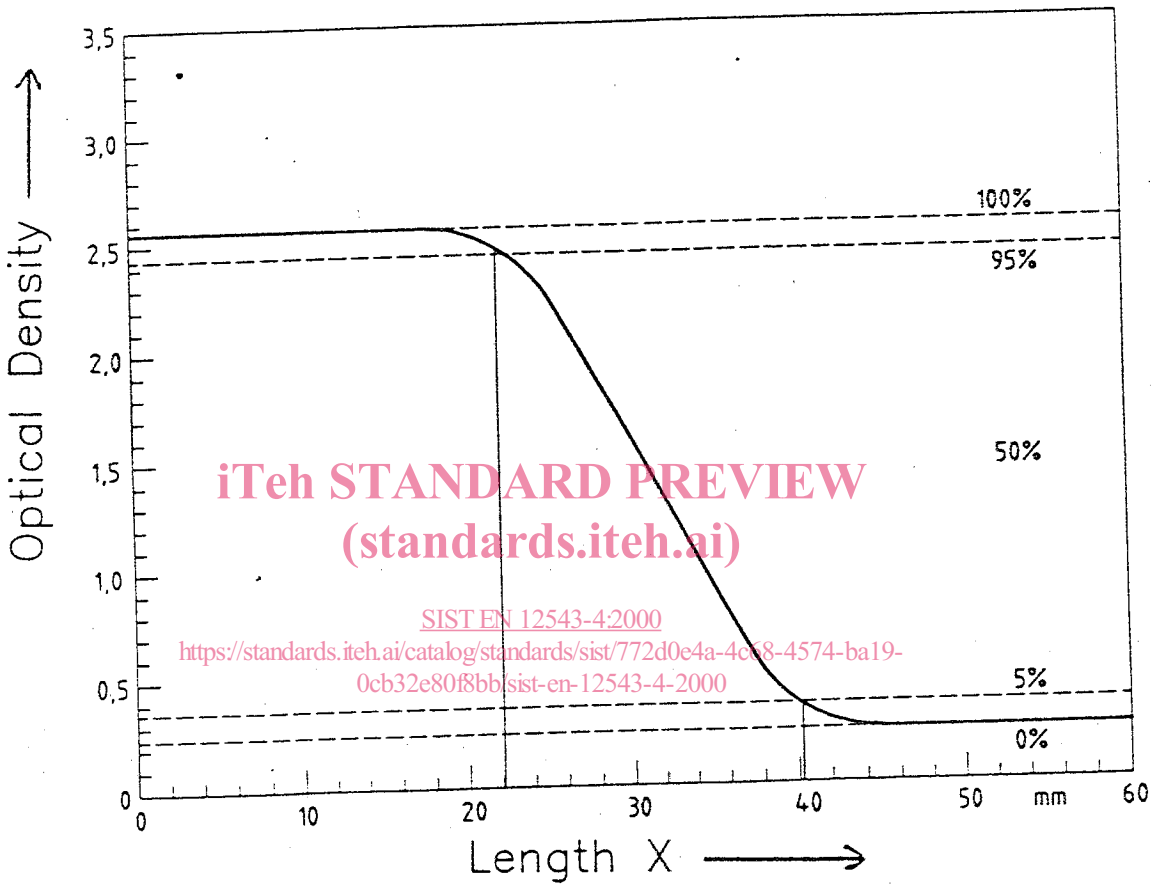


Figure 2 – Example for a density profile on the film and its evaluation

5.2 Determination

Each focal spot size is defined by its size l (length) in the direction of the tube axis and its size w (width) in the perpendicular direction.

The larger of these sizes shall be used as the "focal spot size d".

If the larger of the values l or w exceeds the value d_n given within the specification of the tube, a more precise method for the measurement of the focal spot size shall be applied before further use of the tube (see for example Annex A).
If the focal spot size will be certified, the measurement result has to meet the values of EN 12543-1 within an uncertainty of ± 10 %.