SLOVENSKI STANDARD
SIST EN 13068-3:2002

01-junij-2002

Neporuġitveno preskuġanje - Radioskopsko preskuġanje - 3. del: Sploġna naļela radioskopskega preskuġanja kovinskih materialov z rentgenskimi in gama ġarki

Non-destructive testing - Radioscopic testing - Part 3: General principles of radioscopic testing of metallic materials by X- and gamma rays

Zerstörungsfreie Prüfung - Radioskopische Prüfung - Teil 3: Allgemeine Grundlagen für die radioskopische Prüfung von metallischen Werkstoffen mit Röntgen- und Gammastrahlen

Essais non destructifs - Contrôle par radioscopie - Partie 3: Principes généraux de contrôle par radioscopie a l'aide de rayons X et gamma des matériaux métalliques

Ta slovenski standard je istoveten z: **EN 13068-3:2001**

ICS:

19.100	Neporušitveno preskušanje	Non-destructive testing

SIST EN 13068-3:2002 **en**

EUROPEAN STANDARD

NORME EUROPÉENNE

EUROPÄISCHE NORM

EN 13068-3

August 2001

ICS 19.100

English version

Non-destructive testing - Radioscopic testing - Part 3: General principles of radioscopic testing of metallic materials by X- and gamma rays

Essais non destructifs - Contrôle par radioscopie - Partie 3: Principes généraux de l'essai radioscopique à l'aide de rayons X et gamma des matériaux métalliques

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This European Standard was approved by CEN on 25 July 2001.

CEN members are bound to comply with the CEN/CENELEC Internal Regulations which stipulate the conditions for giving this European Standard the status of a national standard without any alteration. Up-to-date lists and bibliographical references concerning such national standards may be obtained on application to the Management Centre or to any CEN member.

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 Management Centre has the same status as the official versions.

CEN members are the national standards bodies of Austria, Belgium, Czech Republic, Denmark, Finland, France, Germany, Greece, Iceland, Ireland, Italy, Luxembourg, Netherlands, Norway, Portugal, Spain, Sweden, Switzerland and United Kingdom.

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Ref. No. EN 13068-3:2001 E

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 February 2002, and conflicting national standards shall be withdrawn at the latest by February 2002.

EN 13068 comprises a series of European Standards of radioscopic systems which is made of the following:

EN 13068-1, *Non-destructive testing - Radioscopic testing - Part 1: Quantitative measurement of image properties.*

EN 13068-2, *Non-destructive testing - Radioscopic testing - Part 2: Qualitative control and long term stability of imaging devices*.

EN 13068-3, *Non-destructive testing - Radioscopic testing - Part 3: General principles of radioscopic testing of metallic materials by X- and gamma-rays*.

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.

Introduction

This part specifies fundamental techniques of radioscopy with the object of enabling repeatable results to be obtained economically. The techniques are based on generally accepted practice and the fundamental theory of the subject.

The goal of this standard is to define a radioscopic technique as close as possible to the radiographic standard EN 444 and EN 462. Due to the specific differences the following deviations are essential:

1) The limited inherent unsharpness of the intensifier based systems in comparison to the film technique requires careful handling with IQI´s. Therefore, the usage of the double wire IQI corresponding to EN 462-5 is additionally introduced for each measurement. The maximum permissible unsharpness is defined in dependence on the wall thickness. The values are calculated from the permissible geometric unsharpness corresponding to the equation f_{min} of EN 444. Due to technical and economical reasons up to the double unsharpness corresponding to EN 444 was accepted for the lower wall thickness range in Table 4 and 5. Contrast enhancement by a lower maximum tube voltage and the requirement for the same minimum wire IQI values corresponding to EN 462-3 yield a compensation for the limitations in the spatial resolution. No values for step hole IQI´s are defined because wire IQI´s are more typical for small structures to detect.

2) The principle of compensating the limited spatial resolution by contrast enhancement requires the necessity for image integration for most applications. Thus, the image quality defined in Table 5 for testing of metallic materials is based on radioscopic test images acquired with image integration. Real time testing yields advantages for the perceptibility of oriented structures by the dynamic testing principle and should be applied always as a first step for system and positioning optimization. The wide application of radioscopy for light alloy testing justifies the definition of special limited requirements for this application area in Table 4. Here, class SA testing can be performed by real time radioscopy and class SB testing only needs additional image integration. The user may decide if he does apply Table 4 or 5 depending on his testing problem.

1 Scope

This European Standard specifies general rules for industrial X- and gamma-radioscopy for flaw detection purposes, using radioscopic techniques, applicable to the testing of metallic materials.

It does not lay down acceptance criteria of the discontinuities.

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 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 (including amendments).

EN 462-1, *Non-destructive testing - Image quality of radiographs - Part 1: Image quality indicators (wire type) - Determination of image quality value*

EN 462-3, *Non-destructive testing - Image quality of radiographs - Part 3: Image quality of radiogrammes - Part 3: Image quality classes for ferrous metals*

EN 462-5, *Non-destructive testing - Image Quality of radiographs - Part 2: Image quality indicators (duplex wire type) - Determination of image quality value*

EN 473, *Non-destructive testing - Qualification and certification of NDT personnel - General principles*

EN 1435, *Non-destructive examination of welds - Radiographic examination of welded joints*

EN 12544-1, *Non-destructive testing - Measurement and evaluation of the X-ray tube voltage - Part 1: Voltage divider method*

EN 12544-2, *Non-destructive testing - Measurement and evaluation of the X-ray tube voltage - Part 2: Constancy check by the thick filter method*

EN 12544-3, *Non-destructive testing - Measurement and evaluation of the X-ray tube voltage - Part 3: Spectrometric method*

EN 12681, *Founding - Radiographic inspection*

EN 13068-1, *Non-destructive testing - Radioscopic Testing - Part 1: Quantitative measurement of image properties*

EN 13068-2, *Non-destructive testing - Radioscopic Testing - Part 2: Qualitative control and long term stability of imaging devices*

3 Terms and definitions

For the purposes of this European Standard, the following terms and definitions apply:

3.1
nominal thickness, *t*
nominal thickness of the material in the region under testing [EN 444]

Manufacturing tolerances do not have to be taken into account.

3.2
penetrated thickness, *w*
thickness of material in the direction of the radiation beam calculated on basis of the nominal thickness [EN 444]

3.3
source size, d
size of the source of radiation (in accordance with EN 12679), focal spot size of the used X-ray tube (in accordance with EN 12543-1 to EN 12543-5)

3.4
focus-to-detector distance, FDD
distance between the source of radiation and the detector measured in the direction of the beam

3.5
focus-to-object distance, FOD
distance between the source of radiation and the source side of the test object measured along the central axis of the radiation beam

3.6
terms describing spatial resolution (see annex A)
geometric unsharpness, U_g
inherent (screen) unsharpness, U_i
total unsharpness, U_t

3.7
system parameter (see annex A)
geometric magnification, M

3.8
blooming
light overshoot or streaking in areas with high intensity contrast

4 Radioscopic testing

4.1 Classification of radioscopic techniques

The radioscopic techniques are divided into two classes:

Testing class SA: Basic techniques

Testing class SB: Improved techniques.

Testing class SB techniques will be used when testing class SA may be insufficiently sensitive.

Better techniques compared with testing class SB are possible and may be agreed between the contracting parties by specification of all appropriate testing parameters and improved minimum requirements of the radioscopic system.

The choice of radioscopic technique shall be agreed between the parties concerned.

4.2 Minimum requirements to radioscopic detector systems

The equipment used for radioscopic work can differ in the quality of the results depending on the type of test system.

Three system classes of radioscopic test systems are defined. The standard defines the minimum system class which shall be used for a particular purpose.

Criteria for the classifications are the inherent detector unsharpness, the distortion and the homogeneity in accordance with Part 1 of this standard (Table 1) measured without geometric magnification. The values shall be measured with a 6 mm steel plate as test object at 100 kV. Furthermore a check of inherent unsharpness for long term stability is necessary. The measurement shall be done in accordance with EN 13068-1 and EN 13068-2.

Table 1 – Minimum requirements for radioscopic detector systems

Parameter	System classes		
	SC 1	SC 2	SC 3
inherent detector unsharpness U_i better than	0,4 mm	0,5 mm	0,6 mm
distortion $V_{d,i}$ better than	5 %	10 %	20 %
homogeneity $H_{d,i}$ better than	10 %	20 %	30 %

These features shall be measured at a signal to noise ratio better than 50. Distortion and homogeneity shall be measured at 75% of the radius of the used image field.

Systems which do not meet the system classes SC 1 to SC 3 are not subject of this standard.

5 General

5.1 Protection against ionizing radiations

Warning - Exposure of any part of the human body to X-rays or gamma-rays can be highly injurious to health. Wherever X-ray equiment or radioactive sources are in use, appropriate legal requirements are applied.

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

5.2 Surface preparation and stage of manufacture

In general, surface preparation is not necessary, but where surface imperfections or coatings might cause difficulty in detecting discontinuities, the surface shall be ground smooth or the coating shall be removed.

5.3 Identification of radioscopic images

If documentation is necessary, a clear identification shall be affixed to each section of the object being inspected. The images of these symbols shall appear in the radioscopic image outside the region of interest where possible and shall ensure unequivocal identification of the section. In case where a documentation is necessary a clear identification of each image shall be guaranteed.

Alternatively the identification of radioscopic images can be performed by inserting a symbol or reference number into the image, the image header or a parameter file by electronic means. The reference shall be stored as part of the radioscopic image.

5.4 Marking

If documentation is necessary permanent markings on the object to be tested shall be made in order to accurately locate the position of each radioscopic image.

Where the nature of the material and/or its service conditions do not permit permanent marking, the location may be recorded by means of accurate sketches.

5.5 Overlap of images

When testing an area with two or more separate images/video frames, these shall overlap suffiently to ensure that the complete region of interest is radioscopically tested. This can for example be verified by a high density marker on the surface of the object which will appear in the image.

5.6 Personnel qualification

It is assumed that radioscopic testing is performed by qualified and capable personnel. In order to prove this qualification, it is recommended to certify the personnel in accordance with EN 473 or equivalent.

6 Recommended techniques for radioscopic images

6.1 Test arrangements

Where applicable, testing arrangements shall be determined by the specific application standards.

6.2 Radioscopic imaging devices

The imaging properties of the system shall be given in terms as described in EN 13068-1 and EN 13068-2.

6.3 Alignment of beam

The beam of radiation shall be directed to the centre of the area being tested and should be normal to the object surface at that point, except when it can be demonstrated that certain tests are best revealed by a different alignment of the beam. In this case, an appropriate alignment of the beam may be permitted.

Between the contracting parties other ways of radioscopic testing may be agreed upon. Other testing geometries may be carried out with reference to testing related standards.

6.4 Use of filters and collimators

In order to reduce the effect of scattered radiation and blooming, direct radiation shall be collimated as much as possible to the section under testing. Scattered radiation shall be reduced by collimators, filters and masks.

6.5 Choice of tube voltage

To maintain a good flaw sensitivity, the X-ray tube voltage (in accordance with EN 12544-1 to EN 12544-3) should be as low as possible. The maximum values of tube voltage versus penetrated thickness are given in Table 2 for aluminium and light alloys and in Table 3 for steel.

Table 2 – Maximum X-ray voltage for aluminium and light alloys

Penetrated thickness mm	Maximum X-ray voltage kV
5	45
10	50
15	55
25	65
35	75
45	85
55	95
70	110
85	125
100	140
120	160