SLOVENSKI STANDARD
SIST EN 16407-1:2014

01-julij-2014

Neporušitvene preiskave - Radiografski pregled korozije in nanosov v ceveh z rentgenskimi in gama žarki - 1. del: Tangencialni radiografski pregled

Non-destructive testing - Radiographic inspection of corrosion and deposits in pipes by X - and gamma rays - Part 1: Tangential radiographic inspection

Zerstörungsfreie Prüfung - Durchstrahlungsprüfung auf Korrosion und Ablagerungen in Rohren mit Röntgen- und Gammastrahlen - Teil 1: Tangentielle Durchstrahlungsprüfung

Essais non destructifs - Examen radiographique de la corrosion et des dépôts dans les canalisations, par rayons X et rayons gamma - Partie 1: Examen radiographique tangentiel

Ta slovenski standard je istoveten z: **EN 16407-1:2014**

ICS:

19.100	Neporušitveno preskušanje	Non-destructive testing
23.040.01	Deli cevovodov in cevovodi na splošno	Pipeline components and pipelines in general

SIST EN 16407-1:2014 **en,fr,de**

EUROPEAN STANDARD

NORME EUROPÉENNE

EUROPÄISCHE NORM

EN 16407-1

January 2014

ICS 19.100; 23.040.01

English Version

Non-destructive testing - Radiographic inspection of corrosion and deposits in pipes by X- and gamma rays - Part 1: Tangential radiographic inspection

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This European Standard was approved by CEN on 26 October 2013.

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COMITÉ EUROPÉEN DE NORMALISATION
EUROPÄISCHES KOMITEE FÜR NORMUNG

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Contents

Page

Foreword

This document (EN 16407-1:2014) 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of an identical text or by endorsement, at the latest by July 2014, and conflicting national standards shall be withdrawn at the latest by July 2014.

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. CEN [and/or CENELEC] shall not be held responsible for identifying any or all such patent rights.

EN 16407 consists of the following parts, under the general title *Non-destructive testing — Radiographic inspection of corrosion and deposits in pipes by X- and gamma rays:*

— *Part 1: Tangential radiographic inspection*;

— *Part 2: Double wall radiographic inspection*.

According to the CEN-CENELEC Internal Regulations, the national standards organizations of the following countries are bound to implement this European Standard: Austria, Belgium, Bulgaria, Croatia, Cyprus, Czech Republic, Denmark, Estonia, Finland, Former Yugoslav Republic of Macedonia, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, Netherlands, Norway, Poland, Portugal, Romania, Slovakia, Slovenia, Spain, Sweden, Switzerland, Turkey and the United Kingdom.

1 Scope

This European Standard specifies fundamental techniques of film and digital radiography with the object of enabling satisfactory and repeatable results to be obtained economically. The techniques are based on generally recognized practice and fundamental theory of the subject.

This European Standard applies to the radiographic examination of pipes in metallic materials for service induced flaws such as corrosion pitting, generalized corrosion and erosion. Besides its conventional meaning, “pipe” as used in this standard should be understood to cover other cylindrical bodies such as tubes, penstocks, boiler drums and pressure vessels.

Weld inspection for typical welding process induced flaws is not covered, but weld inspection is included for corrosion/erosion type flaws.

The pipes may be insulated or not, and can be assessed where loss of material due, for example, to corrosion or erosion is suspected either internally or externally.

This part of EN 16407 covers the tangential inspection technique for detection and through-wall sizing of wall loss, including:

a) with the source on the pipe centre line, and

b) with the source offset from it by the pipe radius.

Part 2 of EN 16407 covers double wall radiography, and note that the double wall double image technique is often combined with tangential radiography with the source on the pipe centre line.

This European Standard applies to tangential radiographic inspection using industrial radiographic film techniques, computed digital radiography (CR) and digital detector arrays (DDA).

2 Normative references

The following documents, in whole or in part, are normatively referenced in this document and are indispensable for its application. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

EN 14784-1, *Non-destructive testing — Industrial computed radiography with storage phosphor imaging plates — Part 1: Classification of systems*

EN ISO 11699-1, *Non-destructive testing — Industrial radiographic films — Part 1: Classification of film systems for industrial radiography (ISO 11699-1)*

EN ISO 11699-2, *Non-destructive testing — Industrial radiographic films — Part 2: Control of film processing by means of reference values (ISO 11699-2)*

EN ISO 17636-1:2013, *Non-destructive testing of welds — Radiographic testing — Part 1: X- and gamma-ray techniques with film (ISO 17636-1:2013)*

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

3 Terms and definitions

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

3.1
actual wall thickness
t_{act}
actual wall thickness of the pipe

3.2
basic spatial resolution of a digital detector
$SR_b^{detector}$
half of the measured detector unsharpness in a digital image which corresponds to the effective pixel size and indicates the smallest geometrical detail, which can be resolved with a digital detector at magnification equal to one

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

Note 2 to entry: The measurement of unsharpness is described in EN ISO 19232-5, see also ASTM E2736 [18] and ASTM E1000 [16].

3.3
comparator
C
reference object of defined dimension *c* and material for dimensional calibration of a radiographic image

3.4
computed radiography
CR
storage phosphor imaging plate system
complete system comprising a storage phosphor imaging plate (IP) and a corresponding read-out unit (scanner or reader), which converts the information from the IP into a digital image

3.5
detector
D
radiographic image detector consisting of a NDT film system (see EN ISO 11699-1) or a digital radiography system using an imaging plate system (CR system) or a DDA system

Note 1 to entry: Film systems and IPs can be used as flexible and curved detectors or in planar cassettes.

3.6
digital detector array system
DDA system
electronic device converting ionizing or penetrating radiation into a discrete array of analogue signals which are subsequently digitised and transferred to a computer for display as a digital image corresponding to the radiologic energy pattern imparted upon the input region of the device

3.7
maximum penetrated thickness
w_{max}
maximum thickness of material for a pipe which occurs for a tangent to the inner pipe surface

3.8
measured wall thickness
***t*meas**
measured wall thickness of the pipe on the radiograph or digital image

3.9
nominal wall thickness
t
thickness of the pipe material only where manufacturing tolerances do not have to be taken into account

3.10
normalized signal-to-noise ratio
SNR_N
signal-to-noise ratio, SNR, normalised by the basic spatial resolution, SR_b, as measured directly in the digital image and/or calculated from the measured SNR, $SNR_{measured}$, by:

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

3.11
object-to-detector distance
b
distance between the radiation side of the test object and the detector surface measured along the central axis of the radiation beam

3.12
outside diameter
***D*e**
nominal outside diameter of the pipe

3.13
pipe centre to detector distance
PDD
distance between the pipe centre and the detector

3.14
pixel size
geometrical centre-to-centre distance between adjacent pixels in a row (horizontal pitch) or column (vertical pitch) of the scanned image

[SOURCE: EN 14096-2:2003, 3.2]

3.15
signal-to-noise ratio
SNR
ratio of mean value of the linearized grey values to the standard deviation of the linearized grey values (noise) in a given region of interest in a digital image

3.16
source size
d
size of the radiation source

[SOURCE: EN 12679:1999, 2.1]

3.17
source-to-detector distance
SDD
distance between the source of radiation and the detector measured in the direction of the beam

3.18
source-to-object distance
f
distance between the source of radiation and the source side of the test object measured along the central axis of the radiation beam

3.19
source-to-pipe centre distance
SPD
distance between the source of radiation and the pipe centre (pipe axis) measured in the direction of the beam

3.20
storage phosphor 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

4 Classification of radiographic techniques

The tangential radiographic techniques are divided into two classes:

— basic technique TA;

— improved technique TB.

The basic techniques, TA, are intended for tangential radiography of generalized wall loss, such as that due to erosion or large scale corrosion.

The improved techniques, TB, should be used for the more demanding tangential radiography of localized corrosion pitting flaws, which require higher sensitivity for detection and sizing.

Further technique improvements beyond TB are possible and may be agreed between the contracting parties by specification of all appropriate test parameters.

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

5 General

5.1 Protection against ionising radiation

WARNING — Exposure of any part of the human body to X-rays or gamma-rays can be highly injurious to health. Wherever X-ray equipment or radioactive sources are in use, appropriate legal requirements shall be applied. Local or national or international safety precautions when using ionizing radiation shall be strictly applied.

5.2 Personnel qualification

Testing shall be carried out by proficient, suitably trained and qualified personnel and, where applicable, shall be supervised by competent personnel nominated by the employer or, by delegation of the employer, the inspection company in charge of testing. To demonstrate appropriate qualification it is recommended that personnel be certified according to EN ISO 9712 or an equivalent formalised system. Operating authorization for qualified persons shall be issued by the employer in accordance with a written procedure. NDT operations, unless otherwise agreed, shall be authorized by a competent and qualified NDT supervisory individual (Level 3 or equivalent) approved by the employer.

The personnel shall prove additional training and qualification in digital industrial radiology if digital detectors are being used.

5.3 Identification of radiographs

Symbols shall be affixed to each section of the object being radiographed. The images of these symbols shall appear in the radiograph outside the region of interest where possible and shall ensure unambiguous identification of the section.

5.4 Marking

Permanent markings should be made on the object to be examined in order to accurately locate the position of each radiograph.

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 films or digital images

When radiographing an area with two or more films or separate detectors, the films or detectors shall overlap sufficiently to ensure that the complete region of interest is radiographed. This shall be verified by a high density marker on the surface of the object which will appear on each film or detector. If the radiographs will be taken sequentially, the high density marker shall be visible on each of the radiographs.

5.6 Types and positions of image quality indicators (IQI)

5.6.1 Single wire or step hole IQIs

For tangential radiography, single wire or step hole IQIs are not applicable.

5.6.2 Duplex wire IQI (digital radiographs)

IQIs in accordance with EN ISO 19232-5 should be used for measurement of the basic spatial resolution of the CR/DDA system in a reference radiograph (see 7.1.3 and Annex A). The duplex wire IQI shall be placed adjacent to the imaging plate or detector array and positioned a few degrees tilted (2° to 5°) to the digital rows or columns of the digital image.

6 Recommended techniques for making radiographs

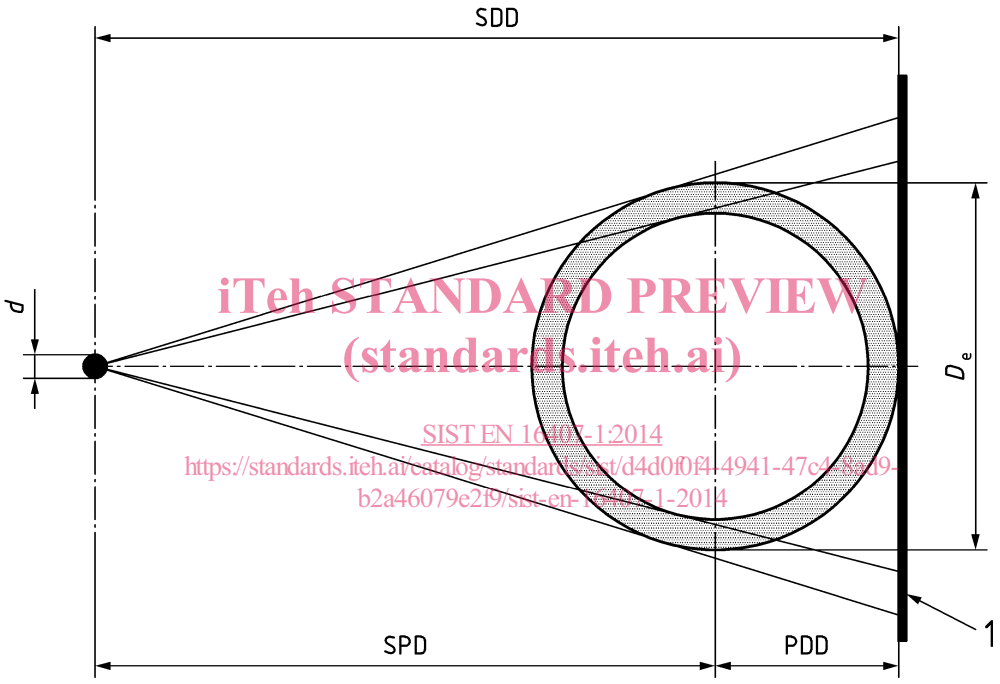
6.1 Test arrangements

6.1.1 General

Normally radiographic techniques in accordance with 6.1.2 and 6.1.3 shall be used. For both techniques, the film or digital detector shall be placed as close to the pipe as possible.

6.1.2 Radiation source located on the pipe centre line

For this arrangement the source is located in front of the pipe and with the film/detector at the opposite side, as shown in Figure 1. The pipe can be non insulated (Figure 1 a)) or insulated (Figure 1 b)).



a) non insulated pipe