SLOVENSKI STANDARD
SIST EN 16016-4:2012

01-februar-2012

Neporušitveno preskušanje - Sevalne metode - Računalniška tomografija - 4. del: Usposobljenost

Non destructive testing - Radiation Methods - Computed Tomography - Part 4: Qualification

Zerstörungsfreie Prüfung - Durchstrahlungsverfahren - Teil 4: Qualifizierung

Essais non destructifs - Moyens utilisant les rayonnements - Tomographie informatisée - Partie 4: Qualification

Ta slovenski standard je istoveten z: **EN 16016-4:2011**

ICS:

19.100	Neporušitveno preskušanje	Non-destructive testing

SIST EN 16016-4:2012 **en,fr,de**

EUROPEAN STANDARD

NORME EUROPÉENNE

EUROPÄISCHE NORM

EN 16016-4

August 2011

ICS 19.100

English Version

Non destructive testing - Radiation methods - Computed tomography - Part 4: Qualification

Essais non destructifs - Méthodes par rayonnements - Tomographie numérisée - Partie 4 : Qualification

Zerstörungsfreie Prüfung - Durchstrahlungsverfahren - Computertomographie - Teil 4: Qualifizierung

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Ref. No. EN 16016-4:2011: E

Contents

Page

Foreword

This document (EN 16016-4:2011) 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of an identical text or by endorsement, at the latest by February 2012, and conflicting national standards shall be withdrawn at the latest by February 2012.

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 16016 consists of the following parts:

— *Non destructive testing — Radiation methods — Computed tomography — Part 1: Terminology*;

— *Non destructive testing — Radiation methods — Computed tomography — Part 2: Principle, equipment and samples*;

— *Non destructive testing — Radiation methods — Computed tomography — Part 3: Operation and interpretation*;

— *Non destructive testing — Radiation methods — Computed tomography — Part 4: Qualification*.

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Introduction

This document gives guidelines for the general principles of X-ray computed tomography (CT) applicable to industrial imaging (in the context of this standard, industrial means non-medical applications); it also gives a consistent set of CT performance parameter definitions, including how these performance parameters relate to CT system specifications. This document deals with computed axial tomography and excludes other types of tomography such as translational tomography and tomosynthesis.

1 Scope

This European Standard specifies guidelines for the qualification of the performance of a CT system with respect to various inspection tasks.

2 Normative references

The following referenced documents are indispensable for the application 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.

EN 16016-1:2011, *Non destructive testing — Radiation method — Computed tomography — Part 1: Terminology*

EN 16016-3:2011, *Non destructive testing — Radiation methods — Computed tomography — Part 3: Operation and interpretation*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in EN 16016-1:2011 apply.

4 Qualification of the inspection

4.1 General

CT is used in industry both for defect testing and dimensional testing and measurement. Since CT does not directly provide measurement of desired quantities such as, for example, pore size or wall thickness, these quantities must be derived from the X-ray linear attenuation data represented by the CT grey values. The detectability of features and the degree of accuracy required depend on the inspection task, the specification of the available test equipment and the analysis and evaluation methods used. When determination of such quantities is required, a special task-specific qualification test of the CT system is required. The qualification measures are described in 4.2 and 4.3. The qualification should be carried out by trained personnel.

4.2 Qualification of defect testing

4.2.1 General

Under test qualification, the suitability of the CT inspection technique for measuring a quantity to the required precision should be verified. The following steps described are typical of those for the successful verification of the suitability of CT for industrial applications.

4.2.2 Quality feature

Typical quantities to be measured are the sizes of pores, cavities, cracks, inclusions, contaminants as well as studies of the material distribution and the assembly and installation position of components. Because the test sample and the type, position and size of the features to be detected determine the properties of a CT system to be used, information such as the following should be known:

a) test object :

   1) dimensions;

   2) weight;

   3) materials;

   4) path length to be X-rayed in the material;

b) test feature:

   1) type;

   2) position;

   3) size;

   4) distribution, frequency;

c) feature detectability:

   1) limiting defect;

   2) limiting feature.

Since the feature detectability strongly influences the specification and therefore the cost of a CT system, special attention must be taken when defining the sensitivity of the tests required. If, due to missing information, no limiting values for features are defined, it is recommended that the best possible sensitivity is used for the specific method and CT system and the attained feature detectability is verified using, for example, destructive tests.

4.2.3 Feature detectability/test system/system parameterisation

The usability of the CT system and the selection of system parameters are determined by the requirements for feature detectability. Typical variables are:

a) spatial resolution:

   1) overall spatial resolution of the CT image;

   2) scan geometry;

   3) detector spatial resolution;

   4) focal spot size of radiation source;

b) contrast resolution:

   1) overall contrast resolution of the CT image;

   2) detector settings;

   3) tube voltage;

   4) tube current;

c) reconstruction/visualisation:

   1) number of projections;

   2) CT grey value dynamic range of the reconstruction or visualisation;

3) CT image size in X, Y and Z axes.

CT system set-up and image quality parameters are described in EN 16016-3:2011, 4.1 and 5.1.

4.2.4 Verification of suitability

4.2.4.1 General

A reliable statement on the defect detection sensitivity and the defect detectability of the CT system used in a test shall be made by stating the degree of accuracy of the test required (tolerance, degree of fluctuation). Several alternative procedures are described in the following.

4.2.4.2 Reference samples with natural defects

If a reference sample with a known defect is available, inspection of this sample is carried out and the detectability is stated after the test has been done.

If a reference sample with unquantified defects is available, inspection of this part is carried out and the defect detectability is stated using a counter-check, using, for example, a destructive test after the CT scan has been done.

4.2.4.3 Reference sample with synthetic defect

If the test feature can be simulated using a synthetic defect, for example, a hole, the defect detectability verification can take place similar to the previous section.

4.2.4.4 Reference sample without specifications

If no specifications are available for the reference sample status and a counter-check is not possible, the test is carried out using the system sensitivity. Sample structures like, for example, wall thicknesses and external dimensional measurements can be used for estimating the defect detectability. Alternatively, reference samples like, for example, wires or spheres of known dimensions can be used.

4.2.5 Consistency check

The CT scan requires several very complex process steps for which the error sources cannot always be excluded. After the scan, the following can be used to trace the possible error sources:

— reconstruction: size, CT slice positions, possible artefacts ;

— CT image scale;

— sinogram (CT grey value and curve progress) or CT projection sequence (comparison between projections, image quality of the projections, intensity changes);

— system status (error messages).

Where errors occur, either they shall be corrected or their causes shall be eliminated and the test repeated.

4.2.6 Documentation

In the qualification report, the relevant parameters and results of the qualification steps are to be described and presented. The CT images are to be archived for a period which is to be agreed with the end-user. The test parameters are to be archived so that an identical test procedure is possible in the case of recurrent test parts and features.