SLOVENSKI STANDARD
SIST EN 583-4:2004

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Neporuġitveno preskuġanje ï Ultrazvoļ ne preiskave ï 4. del: Preiskave za odkrivanje nehomogenosti, ki potekajo pravokotno na povrġino

Non-destructive testing - Ultrasonic examination - Part 4: Examination for discontinuities perpendicular to the surface

Zerstörungsfreie Prüfung - Ultraschallprüfung - Teil 4: Prüfung auf Inhomogenitäten senkrecht zur Oberfläche

Essais non destructifs - Contrôle ultrasonore - Partie 4 : Contrôle des discontinuités perpendiculaires a la surface

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Non-destructive testing - Ultrasonic examination - Part 4: Examination for discontinuities perpendicular to the surface

Essais non destructifs - Contrôle ultrasonore - Partie 4: Contrôle des discontinuités perpendiculaires à la surface

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This European Standard was approved by CEN on 20 October 2001.

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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 Management Centre has the same status as the official versions.

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EUROPEAN COMMITTEE FOR STANDARDIZATION
COMITÉ EUROPÉEN DE NORMALISATION
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Contents

Foreword

This document (EN 583-4:2002) 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of an identical text or by endorsement, at the latest by March 2003, and conflicting national standards shall be withdrawn at the latest by March 2003.

This standard consists of the following parts:

EN 583-1, *Non-destructive testing - Ultrasonic examination - Part 1: General principles*

EN 583-2, *Non-destructive testing - Ultrasonic examination - Part 2: Sensitivity and range setting*

EN 583-3, *Non-destructive testing - Ultrasonic examination - Part 3: Transmission technique*

EN 583-4, *Non-destructive testing - Ultrasonic examination - Part 4: Examination for discontinuities perpendicular to the surface*

EN 583-5, *Non-destructive testing - Ultrasonic examination - Part 5: Characterization and sizing of discontinuities*

ENV 583-6, *Non-destructive testing - Ultrasonic examination - Part 6: Time-of-flight diffraction technique as a method for detection and sizing of discontinuities*

This document has been prepared under a mandate given to CEN by the European Commission and the European Free Trade Association, and supports essential requirements of EU Directive(s).

For relationship with EU Directive(s), see informative annex ZA, which is an integral part of this document.

Annex A is informative

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, Malta, Netherlands, Norway, Portugal, Spain, Sweden, Switzerland and the United Kingdom.

1 Scope

This European Standard defines the principles for tandem- and LLT[1]-examination for the detection of discontinuities perpendicular to the surface.

The general principles required for the ultrasonic examination of industrial products are described in EN 583-1. A list of symbols and equations is given in EN 583-2.

The tandem- or LLT-examination should be used for the detection of planar discontinuities with distance to the surface greater than 15 mm. This standard has been prepared for the examination of metallic materials with a thickness between 40 mm and 500 mm with parallel or concentric surfaces. It can, however, be used for other materials and smaller thickness provided special measures are taken.

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 (including amendments).

EN 583-1, *Non-destructive testing - Ultrasonic examination - Part 1: General principles.*

EN 583-2, *Non-destructive testing - Ultrasonic examination - Part 2: Sensitivity and range setting.*

EN 1330-4, *Non-destructive testing - Terminology - Part 4: Terms used in ultrasonic testing.*

3 Terms and definitions

For the purposes of this European Standard, the terms and definitions of EN 1330-4 apply.

4 Tandem examination

4.1 General

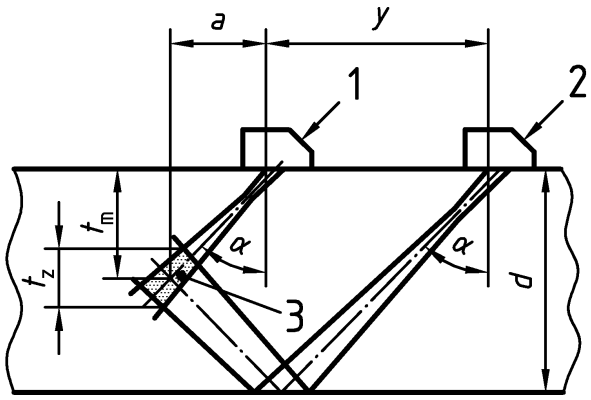
The examination is normally carried out using two similar 45° angle probes, one probe operating as the transmitter and the other probe as receiver. For wall thicknesses greater than approximately 160 mm, probes with different transducer sizes are preferred in order to ensure approximately the same beam diameters in the examination zone.

The use of probe angles other than 45° may be necessary to comply with particular geometrical conditions. Probe angles that give rise to mode conversions shall be avoided.

The probes are located in a line with their acoustic axis in the same direction. In this way the sound beam from the rear probe will, after reflection from the opposite surface, intersect the sound beam from the front probe at the centre of the examination zone.

Figure 1 shows the relationship between the spacing of the probes (y) and the examination depth of the crosspoint (t_m) and the height of the examination zone (t_z).

[1] LLT means longitudinal-longitudinal-transverse wave.



Key

1 Probe 1
2 Probe 2
3 Examination zone
a Projection distance
d Material thickness
t_m Examination depth
y Probe distance
t_z Height of examination zone

Figure 1 — Basic principle of tandem technique

When examining objects with plane parallel surfaces the distance between the probes can be defined using the following equation:

$$y = 2 \tan \alpha \, (d - t_m) \quad (1)$$

for 45°

$$y = 2 \, (d - t_m)$$

Scanning shall be performed in either of the following ways:

— both probes are moved along the surfaces with a fixed distance (y).

  In this way only one examination zone is examined at a time, and the scanning shall be repeated with different probe distance until the complete examination volume has been examined;

— both probes are moved simultaneously, such that the sum of their distances from the required plane of intersection, e.g. the vertical weld axis, remains constant, thereby scanning the full object thickness in one continuous movement.

4.2 Time base adjustment

Basically all relevant echoes will appear at the same sound path distance, which corresponds to the V-path. Therefore, the adjustment of the time base is not important. It is, however, recommended that the echo from the V-path is located at a fixed position e.g. eight scale divisions.

4.3 Setting of sensitivity

The setting of sensitivity can be performed using the following reflectors:

— opposite surface, where the V-path echo is used as backwall echo;

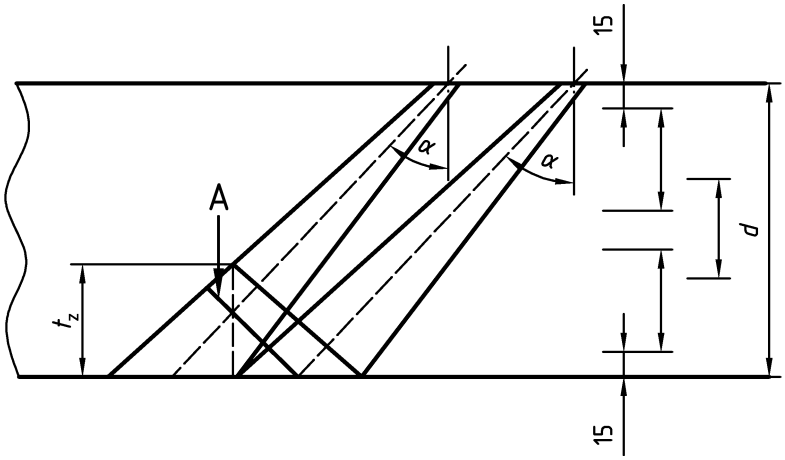
— disc-shaped reflectors perpendicular to the scanning surface (flat bottom holes). The reflectors shall be located at the intersection of the beam axes;

— side drilled holes located at the intersection of the beams and at the borders of the examination zones.

4.4 Determination of examination zones

The division into equally sized examination zones ensures that the sensitivity throughout the thickness does not fall below a certain level. The height of the examination zones is calculated so that the sensitivity at the edges of the examination zones is not more than 6 dB below the sensitivity in the intersection point of the beam axes, see Figure 2 and Clause 1.

All dimensions in millimetres



Key

A Soundbeam diameter

d Material thickness

t_z Height of examination zone

Figure 2 — Examination zones

The height of the examination zone (t_z) can be determined by using a reference block with reflectors in differentiated depths or calculated as follows based on the diameter of the direct beam and the largest sound path in the examination zone closest to the opposite surface (all dimensions in millimetres):

$$t_z \approx \frac{\lambda(d - 15\,\text{mm})}{\sin\alpha \cdot \cos\alpha \cdot D_{\text{eff}}} \tag{2}$$

for 45°

$$t_z \approx \frac{2 \cdot \lambda \cdot (d - 15\,\text{mm})}{D_{\text{eff}}}$$

where

D_{eff} = effective transducer diameter.

The number of examination zones is calculated as follows:

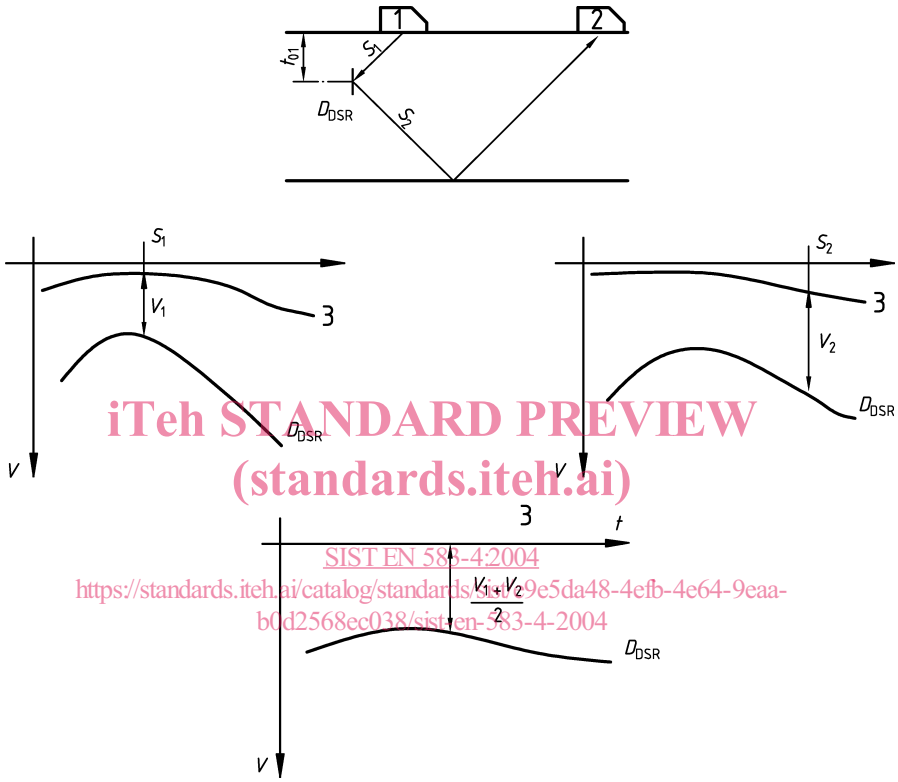
$$n_{tz} = \left| \frac{d - 30\,\text{mm}}{t_z} + 1 \right|, \quad n_{tz} = 1, 2, 3 \tag{3}$$

The probe distance, y, see Figure 1, is adjusted for each examination zone with the intersection of the beam axes in the centre of the zone. Alternatively, the width and number of the examination zones can be determined graphically using scale drawings of the calculated or measured 6 dB beam profiles.

4.5 DGS-diagram for tandem examination

DGS-diagrams for tandem examination may be derived from the general DGS-diagram or based on probe specific diagrams.

The diagrams are prepared as shown in Figure 3. The mean value of the gain differences V_1 and V_2 are derived from the specific diagrams for the probes or from the general DGS diagram. These are used to establish a distance amplitude curve (DAC) for specific tandem examinations, based on this disk-shaped reflector (DSR).



Key

D_{DSR}	Disk-shaped reflector
S	Sound path distance
t	Depth
V	Gain
1, 2	Probe 1, probe 2
3	Backwall

Figure 3 — Preparation of tandem DGS diagram

4.6 Corrections of sensitivity

Depending on the method used for sensitivity setting, corrections for transfer and attenuation losses may be applicable.

In addition to this, compensation shall be made for the reduction of sensitivity that will occur at the edges of the examination zone. Either 6 dB or the value measured on disc-shaped reflectors (flat bottom holes) at the border of the examination zones should be used.

4.7 Object with concentric surfaces

The use of 45° angle probes is limited to $d/D \leq 0{,}04$ for convex scanning surfaces and $d/D \leq 0{,}05$ for concave scanning surfaces. Where applicable, the angles of incidence shall be changed to prevent mode conversions that can result in reduced sensitivity.

The probe spacing (y) for the examination of such surfaces may be calculated using the equations in 4.7.1 or 4.7.2.

Alternatively, the probe spacing can be determined graphically using scale drawings of the calculated or measured 6 dB beam profiles.

NOTE In Annex A of this standard nomograms are given for the determination of the distances for concave and convex scanning surfaces without calculation.

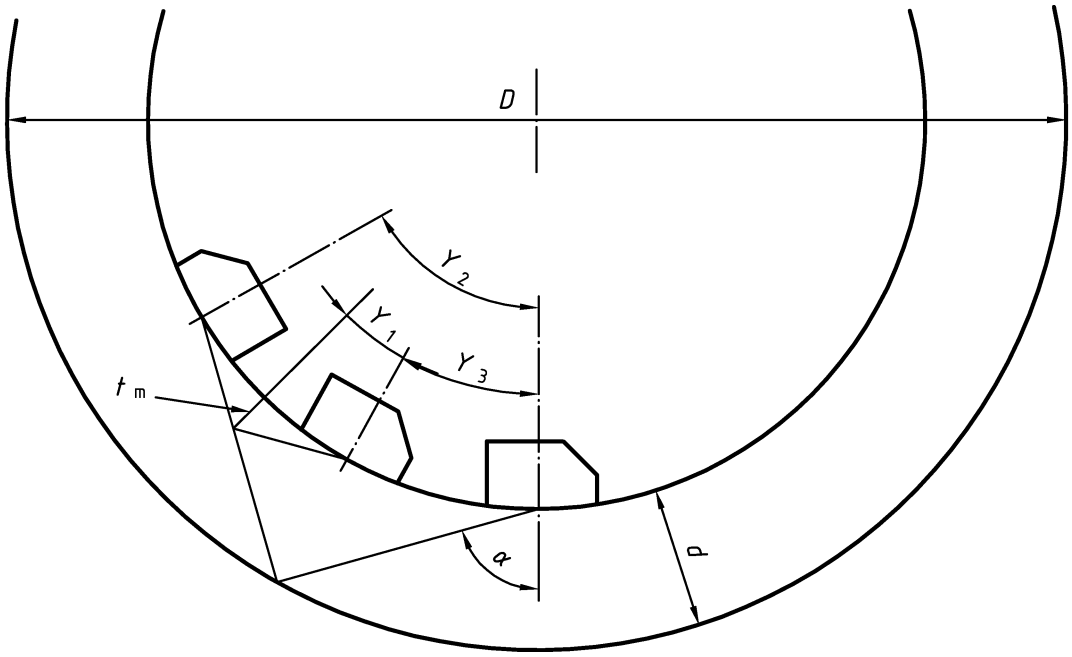
4.7.1 Concave scanning surface

$$y_1 = \frac{\pi(D-2d)}{360^\circ}\left\{\alpha - \arcsin\left[\left(\frac{1}{1+\frac{2tm}{(D-2d)}}\right)\sin\alpha\right]\right\} \tag{4}$$

Tandem zone:

$$y_2 = \frac{\pi(D-2d)}{180^\circ}\left\{\alpha - \arcsin\left[\left(1-\frac{2d}{D}\right)\sin\alpha\right]\right\} \tag{5}$$

$$y_3 = \frac{\pi(D-2d)}{180^\circ}\left\{\arcsin\left[\left(\frac{1}{1+\frac{2tm}{(D-2d)}}\right)\sin\alpha\right] - \arcsin\left[\left(1-\frac{2d}{D}\right)\sin\alpha\right]\right\} \tag{6}$$



Key

D External diameter of concentric surface

d Material thickness

t_m Examination depth of the crosspoint

Figure 4 — Concave scanning surface

4.7.2 Convex scanning surface

$$y_1 = \frac{\pi D}{360°}\left\{\arcsin\left[\left(\frac{1}{1-\frac{2tm}{D}}\right)\sin\alpha\right]-\alpha\right\} \tag{7}$$

Tandem zone:

$$y_2 = \frac{\pi D}{180°}\left\{\arcsin\left[\left(\frac{1}{1-\frac{2d}{D}}\right)\sin\alpha\right]-\alpha\right\} \tag{8}$$

$$y_3 = \frac{\pi D}{180°}\left\{\arcsin\left[\left(\frac{1}{1-\frac{2d}{D}}\right)\sin\alpha\right]-\arcsin\left[\left(\frac{1}{1-\frac{2tm}{D}}\right)\sin\alpha\right]\right\} \tag{9}$$