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Foreword

This document (prEN 583-6:2008) has been prepared by Technical Committee CEN/TC 138 “Non-destructive testing”, the secretariat of which is held by AFNOR.

This document is currently submitted to the Unique Acceptance Procedure.

This document will supersede ENV 583-6:2000.

EN 583, *Non-destructive testing — Ultrasonic examination* 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*

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

1 Scope

This European Standard defines the general principles for the application of the Time-Of-Flight Diffraction (TOFD) technique for both detection and sizing of discontinuities in low alloyed carbon steel components. It could also be used for other types of materials, provided the application of the TOFD technique is performed with necessary consideration of geometry, acoustical properties of the materials and the sensitivity of the examination.

Although it is applicable, in general terms, to discontinuities in materials and applications covered by EN 583-1, it contains references to the application on welds. This approach has been chosen for reasons of clarity as to the ultrasonic probe positions and directions of scanning.

Unless otherwise specified in the referencing documents, the minimum requirements of this standard are applicable.

Unless explicitly stated otherwise, this standard is applicable to the following product classes as defined in EN 583-2:

— class 1, without restrictions;

— classes 2 and 3, restrictions will apply as stated in Clause 9.

The inspection of products of classes 4 and 5 will require special procedures. These are addressed in Clause 9 as well.

The techniques to use TOFD for weld inspection are described in CEN/TS 14751.

The related acceptance criteria are given in prEN 15617.

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

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 12668-1, *Non-destructive testing — Characterization and verification of ultrasonic examination equipment — Part 1: Instruments*

EN 12668-2, *Non-destructive testing — Characterization and verification of ultrasonic examination equipment — Part 2: Probes*

EN 12668-3, *Non-destructive testing — Characterization and verification of ultrasonic examination equipment — Part 3: Combined equipment*

CEN/TS 14751, *Welding — Use of time-of-flight diffraction technique (TOFD) for examination of welds*

prEN 15617, *Non-destructive testing of welds — Time-of-flight diffraction technique (TOFD) — Acceptance levels*

3 Terms, definitions, symbols and abbreviations

3.1 Terms and definitions

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

3.1.1
scanning surface dead zone
zone where indications may be obscured due to the interface echo (lateral wave)

3.1.2
back wall dead zone
dead zone where signals may be obscured by the presence of the back wall echo

3.1.3
A-scan
display of the ultrasonic signal amplitude as a function of time

3.1.4
B-scan
display of the time-of-flight of the ultrasonic signal as a function of probe displacement

3.1.5
non-parallel scan
scan perpendicular to the ultrasonic beam direction (see Figure 4)

3.1.6
parallel scan
scan parallel to the ultrasonic beam direction (see Figure 5)

3.2 Abbreviations

— TOFD: Time-Of-Flight Diffraction

3.3 Symbols

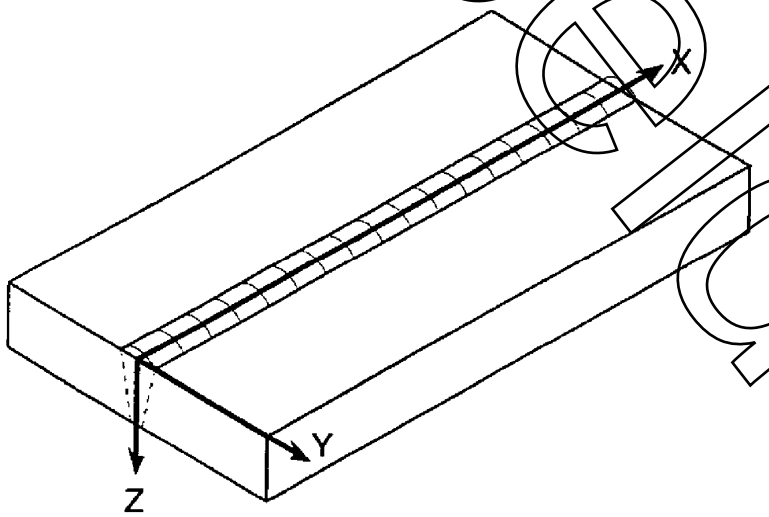

Figure 1 — Coordinate definition

x	coordinate parallel to the scanning surface and parallel to a predetermined reference line. In case of weld inspection this reference line should coincide with the weld. The origin of the axes may be defined as best suits the specimen under examination (see Figure 1);
Δx	discontinuity length;
y	coordinate parallel to the scanning surface, perpendicular to the predetermined reference line (see Figure 1);
δy	error in lateral position;
z	coordinate perpendicular to the scanning surface (see Figure 1);
Δz	discontinuity height;
d	depth of a discontinuity tip below the scanning surface;
δd	error in depth;
D_{ds}	scanning-surface dead zone;
D_{dw}	back wall dead zone;
c	sound velocity;
δc	error in sound velocity;
R	spatial resolution;
t	time-of-flight from the transmitter to the receiver;
Δt	time-of-flight difference between the lateral wave and a second ultrasonic signal;
δt	error in time-of-flight;
t_d	time-of-flight at depth d;
t_p	duration of the ultrasonic pulse measured at 10 % of the peak amplitude;
t_w	time-of-flight of the back wall echo;
S	half the distance between the index points of two ultrasonic probes;
δS	error in half the probe separation;
W	wall thickness.

4 General

4.1 Principle of the technique

The TOFD technique relies on the interaction of ultrasonic waves with the tips of discontinuities. This interaction results in the emission of diffracted waves over a large angular range. Detection of the diffracted waves makes it possible to establish the presence of the discontinuity. The time-of-flight of the recorded signals is a measure for the height of the discontinuity, thus enabling sizing of the defect. The dimension of

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