British Standard

BRITISH STANDARD

BS EN
1713:1998
Incorporating
Amendment No. 1

Non-destructive testing of welds — Ultrasonic testing — Characterization of indications in welds

The European Standard EN 1713:1998, with the incorporation of amendment A1:2002, has the status of a British Standard

ICS 25.160.40

National foreword

This British Standard is the English language version of EN 1713:1998, including amendment A1:2002.

The start and finish of text introduced or altered by amendment is indicated in the text by tags [A1⟩ ⟨A1]. Tags indicating changes to CEN text carry the number of the amendment. For example, text altered by CEN amendment A1 is indicated by [A1⟩ ⟨A1].

As agreed by CEN/TC 121/SC 5 resolution 134/2000 and in accordance with amendment A1:2002, the term "examination" has been replaced by "testing" throughout the document.

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Summary of pages

This document comprises a front cover, an inside front cover, the EN title page, pages 2 to 17 and a back cover.

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This British Standard, having been prepared under the direction of the Engineering Sector Board, was published under the authority of the Standards Board and comes into effect on 15 September 1998

Amendments issued since publication

Amd. No.	Date	Comments
13989	15 November 2002	See national foreword

ISBN 0 580 29987 2

EUROPEAN STANDARD
NORME EUROPÉENNE
EUROPÄISCHE NORM

EN 1713
May 1998

+ A1
May 2002

ICS 25.160.40

Descriptors: Welded joints, non-destructive tests, quality control, weld defects, ultrasonic tests, characteristics, classifications

English version

Non-destructive testing of welds — Ultrasonic testing — Characterization of indications in welds

(includes amendment A1:2002)

Contrôle non destructif des assemblages soudés — Contrôle par ultrasons — Caractérisation des indications dans les assemblages soudés (inclut l'amendement A1:2002)

Zerstörungsfreie Prüfung von Schweißverbindungen — Ultraschallprüfung — Charakterisierung von Anzeigen in Schweißnähten (enthält Änderung A1:2002)

This European Standard was approved by CEN on 1 May 1998 and amendment A1 was approved by CEN on 1 May 2002.

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CEN

European Committee for Standardization
Comité Européen de Normalisation
Europäisches Komitee für Normung

Central Secretariat: rue de Stassart 36, B-1050 Brussels

Ref. No. EN 1713:1998 + A1:2002 E

Foreword

This European Standard has been prepared by Technical Committee CEN/TC 121, Welding, the Secretariat of which is held by DS.

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 November 1998, and conflicting national standards shall be withdrawn at the latest by November 1998.

This European Standard 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).

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.

Foreword to amendment A1

This document EN 1713:1998/A1:2002 has been prepared by Technical Committee CEN/TC 121, Welding, the Secretariat of which is held by DS.

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

Annex A is normative.

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Contents

Introduction

Classification of indications as planar or non-planar is based on several parameters:

— welding techniques;
— geometrical position of the indication;
— maximum echo height;
— directional reflectivity;
— echostatic pattern (i.e. A-Scan);
— echodynamic pattern.

The process of classification involves testing each of the parameters against all the others in order to arrive at an accurate conclusion.

For guidance, the flowchart in Annex A gives the classification of internal weld indications suitable for general applications. This flowchart should be applied in conjunction with the two first parameters listed above and not taken in isolation.

Such classification should only be carried out, in accordance with EN 1712, if [A1] defined by specification. [A1]

1 Scope

This standard defines a flowchart procedure, see Annex A, which is devoted to the classification of internal indications as planar or non-planar.

This standard is only suitable for indications located at least 5 mm below the unground surface of the joint, see Figure 1.

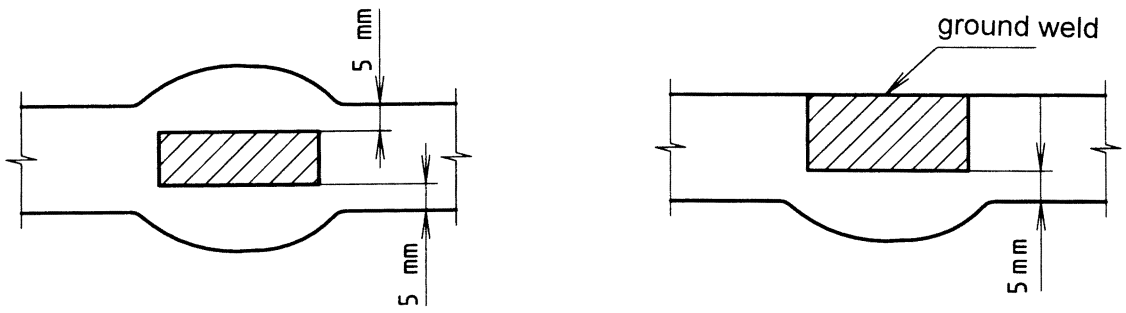

Figure 1 — Location of indications

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.

EN 1712*, Non destructive testing of welds — Ultrasonic testing of welded joints — Acceptance levels.*

3 Description

3.1 General

The classification is carried out by the successive application of several discriminatory criteria namely:

— echo amplitude;
— directional reflectivity;
— echostatic pattern (A-Scan);
— echodynamic pattern.

The flowchart procedure is stopped as soon as one of the above criteria is fulfilled.

The probes used for the classification are, as a general rule, the same as those specified for the detection.

The flowchart procedure standardizes a quality control system of classification. Several levels are defined in decibels (dB) by a comparison with the distance amplitude curve (DAC) or by a comparison between the maximum echo heights from the discontinuity when tested at different angles of incidence.

Proposed dB levels for the different stages in the flowchart procedure are given in Table A.1.

Table 1 — Different stages in the flowchart procedure

S1	S2	S3	S4
DAC – 10 dB	DAC + 6 dB	DAC – 6 dB	9 dB/15 dB

The flowchart procedure calls for five stages, each of them having a precise aim:

— 1st stage: to avoid the classification of indications with very low echo amplitudes;
— 2nd stage: to classify all indications with high echo amplitude as planar;
— 3rd stage: primarily to classify lack of fusion;
— 4th stage: primarily to classify inclusions;
— 5th stage: primarily to classify cracks.

NOTE The "hybrid" indications resulting from the association of an inclusion and lack of fusion are classified as planar by the flowchart procedure. An example of this type of flaw is given in Figure A.3.

3.2 Conventions used

The reference echoes shall be obtained on 3 mm side drilled holes.

By convention:

— a negative level value means that the indication has a lower echo amplitude than the reference;
— a positive level value means that the indication has a higher echo amplitude than the reference.

3.3 Echo height criteria

3.3.1 *Low amplitudes (stage 1)*

It is accepted that an indication with a lower echo amplitude than level S1 (DAC – 10 dB) is not significant.

For special applications this value S1 should be lowered if [A1] defined by specification. [A1]

3.3.2 *High amplitudes (stage 2)*

It is assumed that an echo height that is at least equal to the level S2 (DAC + 6dB) comes from a planar indication.

3.4 Directional reflectivity criteria (stage 3)

This stage of the flowchart procedure shall be applicable either to all indications or, if [A1] defined by specification [A1], only to those indications exceeding a specified length. For the range of thicknesses 8 mm $\leq t <$ 15 mm, this length is t and for thicknesses over 15 mm, this length is $t/2$ or 20 mm, whichever is the larger. For indications not exceeding the specified length, proceed to stage 4.

For the criteria below, the angle of incidence of testing which gives the highest echo amplitude, relative to a DAC curve, is taken as reference (H_{dmax}). The minimum echo amplitude, relative to a DAC curve, obtained from the other angles of incidence (H_{dmin}), is compared with H_{dmax}.

To satisfy the directional reflectivity, the two following conditions shall be simultaneously fulfilled:

1) The reflectivity of the indication, for at least one of the angles of incidence is higher than, or equal to, S3 (DAC − 6 dB).

2) There is a high directional reflectivity, namely either:

a) Imbalance of, at least, 9 dB between two angles of incidence of testing, if the testing is carried out with shear waves.

$| H_{dmax} - H_{dmin} | \geq 9$ dB.

b) Imbalance of, at least, 15 dB between two angles of incidence of testing, where one of them is carried out with shear waves, the other with longitudinal waves.

$| H_{dmax} - H_{dmin} | \geq 15$ dB.

The incidence of testing results from the association of a refraction angle and testing conditions (half skip, full skip). Some examples are given in Annex B.

An example of the application of these criteria is given in Figure A.2.

The attenuation of the weld could be taken into account.

Application conditions:

a) normally the wave length of the different angles of incidence of testing shall be almost the same (example: 4 MHz for longitudinal waves and 2 MHz for shear waves);

b) in all cases, the differences between the compared angles of incidence is equal to or greater than 10° (the nominal refraction angles are taken into account);

c) the comparison of reflectivities shall be made at the position on the indication which exhibits the highest reflectivity;

d) such comparisons make sense only if it is certain that the compared echoes come from the same reflectors;

e) it shall be certain before the application of these criteria, that:

— there is no segregation in the base metal;
— there is no corrosion, and the two sides are parallel if full skip is used;
— the materials are isotropic.

3.5 Echostatic pattern criteria (stage 4)

At this stage, the echostatic pattern (i.e. A-Scan) is considered.

With the echo height requirements met (neither very high, nor very low) and a low directional reflectivity, if the echostatic pattern is single and smooth the indication is classified as non-planar.

If the echostatic pattern is not single and smooth the next stage of the procedure is followed.

The shape of the echostatic pattern depends on the transducer and equipment used. So, it is imperative to compare the pattern of the indication with that obtained from the reference reflector (3 mm diameter side drilled hole).

3.6 Echodynamic pattern criteria (stage 5)

If the static echo is not single and smooth, it shall be classified as single and jagged, or multiple. This point is made use of at the fifth stage of the flowchart procedure.

The transverse echodynamic pattern of a reflector is the envelope of the resulting echoes when the ultrasonic beam passes it transversely. The analysis takes into account not only the envelope of the curve, but also the behaviour of the echoes inside it.

The pattern can be classified into four types as given in Annex C.

If the transverse echodynamic exhibits pattern 3 (varial class) for at least two angles of incidence, the indication is classified as planar.

Normally, the two angles of incidence chosen are those that give the highest reflectivities.

If only one angle of incidence of testing gives echodynamic pattern 3, it is possible to use a third angle of incidence, or to call for some complementary testing (see **3.7**).

The other types of echodynamic pattern lead to non-planar indications:

— pattern 1: single non-planar;

— pattern 4: cluster of non-planar.

At this stage of the flowchart procedure a pattern 2 cannot be obtained, since such indications would have been classified as planar from the earlier stages (high reflectivity).

3.7 Complementary testing

In case of any doubt the following testing should be carried out:

— analysis of echodynamic pattern in the lateral movement;

— use of additional transducers;

— results from other NDT (i.e. radiography).

The above list is not restrictive.

Annex A (normative)
Classification of internal indications in welds — Flowchart procedure

The flowchart procedure is defined in Figure A.1.

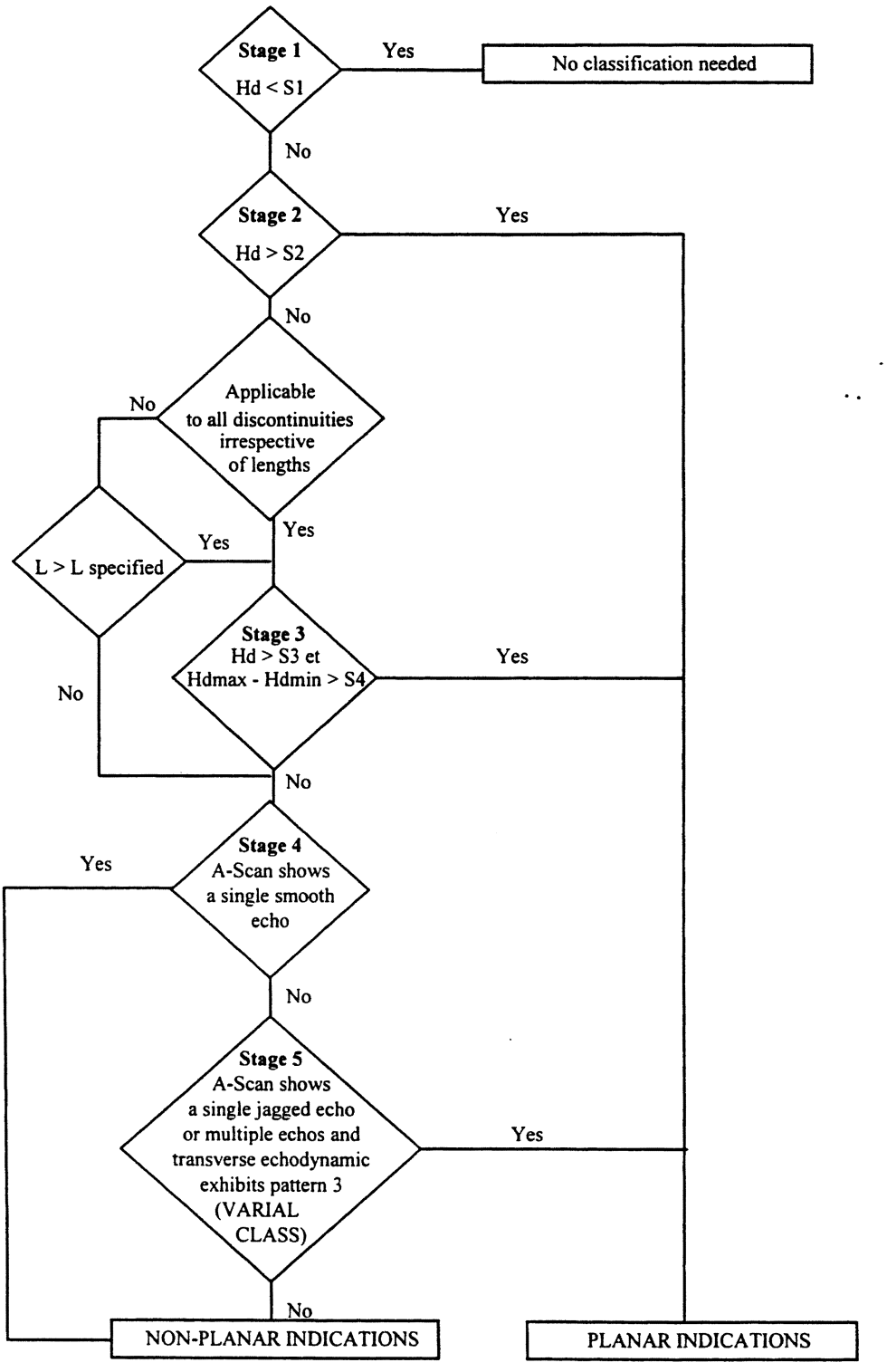

Figure A.1 — Flowchart procedure

Table A.1 — Flowchart procedure

S1	S2	S3	S4
DAC – 10 dB	DAC + 6 dB	DAC – 6 dB	9 dB/15 dB

H_d is the indication echo amplitude

1) (S1 = DAC – 10 dB): This means that all indications below this level are not classified.

2) (S2 = DAC + 6 dB): An indication being at least twice as reflective as the reference is classified as planar.

3) (S3 = DAC − 6 dB): If the indication echo amplitude at least half of the reference and, if the imbalance reflectivity is greater or equal to S4, the indication is classified as planar:

— with S4 = 9 dB for shear waves;

— with S4 = 15 dB between reflections obtained with a shear and a longitudinal wave.

The angles at which the ultrasonic beam is incident upon the indication shall have a difference of at least 10°. The comparison shall be made upon the same area of the indication.

4) and 5) These criteria shall be fulfilled for at least two angles of testing.

5) If the echodynamic does not exhibit pattern 3, the indication is classified as non-planar.

The echo patterns are those defined in Annex C.

NOTE The reference echoes should be obtained on 3 mm side drilled holes.

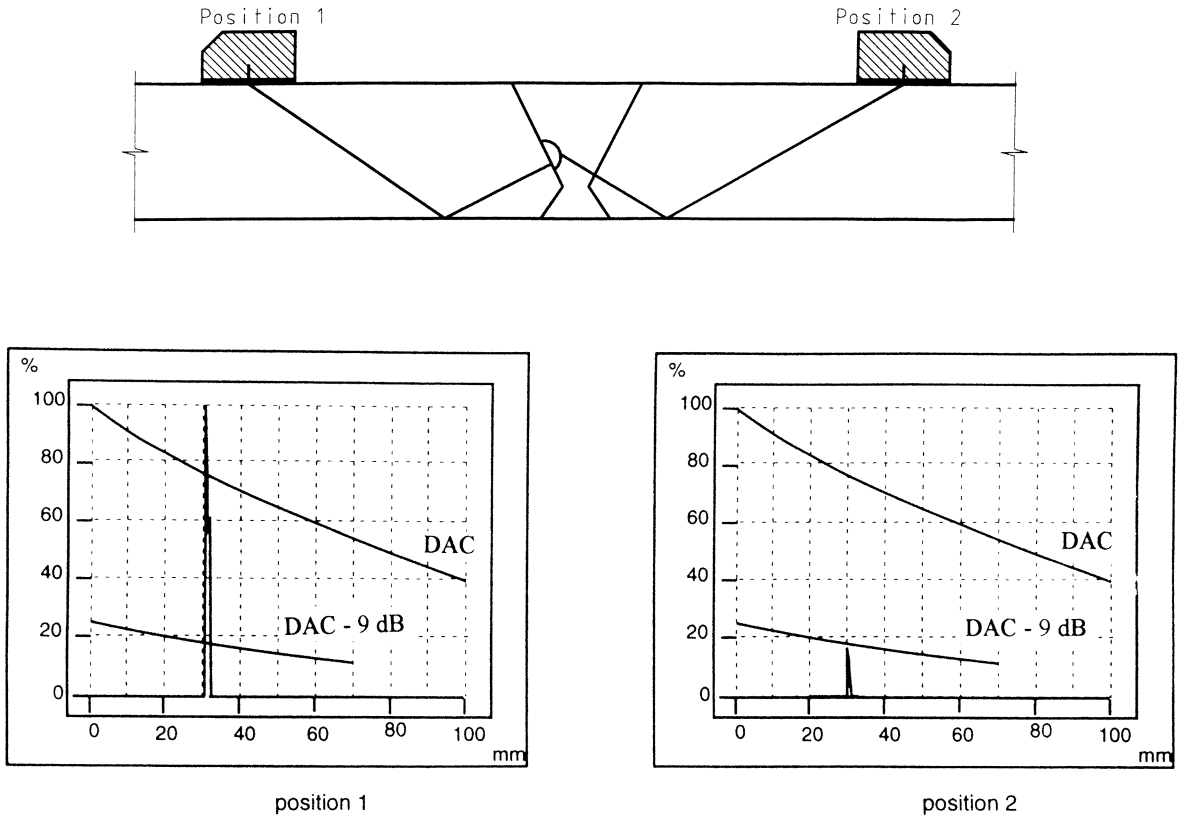

Figure A.2 — Example of application of directional reflectivity criteria

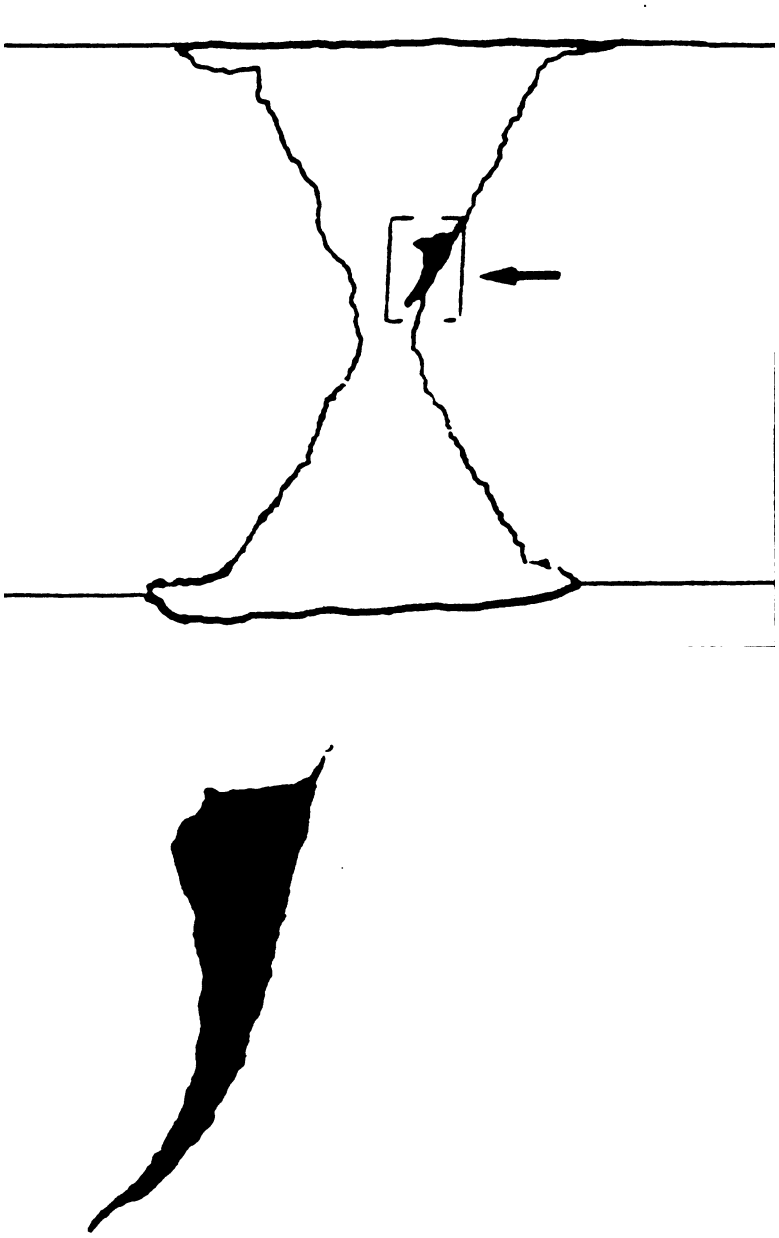

Figure A.3 — Example of hybrid indication — Inclusion and lack of fusion

Annex B (informative)
Testing incidence

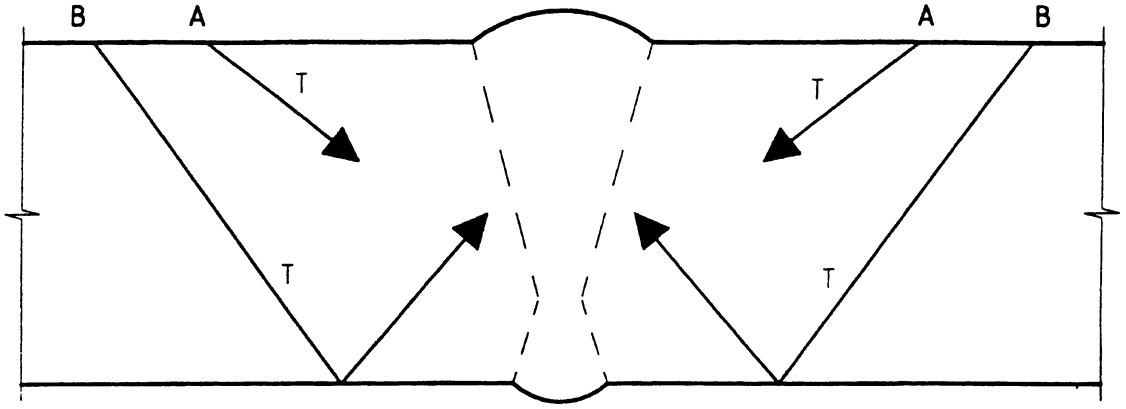

Figure B.1a — Transverse wave, T

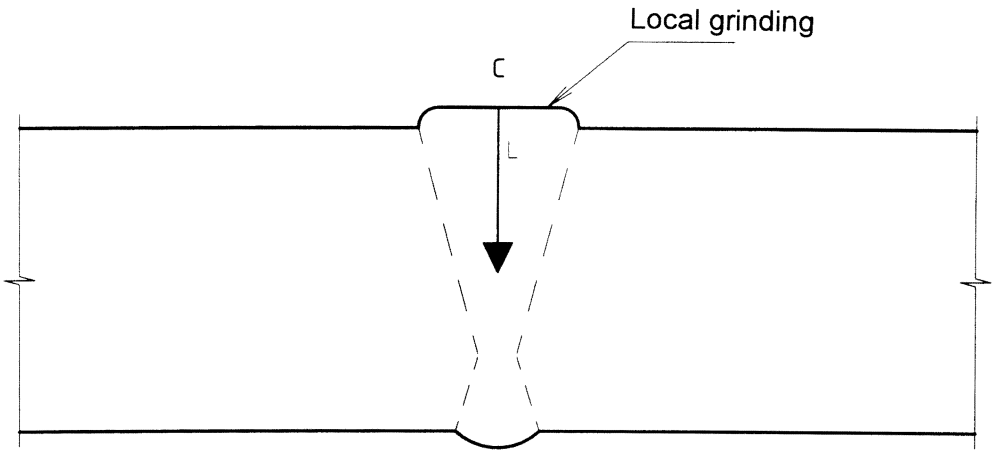

Figure B.1b — Longitudinal wave, L

Figure B.1

Annex C (informative)
Basic echodynamic patterns of reflectors

C.1 Pattern 1

Point-like reflector response, Figure C.1. At any probe position, the A-Scan shows a single sharp echo. As the probe is moved this rises in amplitude smoothly to a single maximum before falling smoothly to noise level.

C.2 Pattern 2

Extended smooth reflector response, Figure C.2. At any probe position, the A-Scan shows a single sharp echo. When the ultrasonic beam is moved over the reflector the echo rises smoothly to a plateau and is maintained, with minor variations in amplitude of up to 4 dB, until the beam moves off the reflector, when the echo will fall smoothly to noise level.

C.3 Pattern 3

Extended rough reflector response. There are two variants of this pattern, depending upon the angle of incidence of the probe beam on the reflector.

C.4 Pattern 3 a

Near normal incidence, Figure C.3a. At any probe position, the A-Scan shows a single but ragged echo. As the probe is moved this may undergo large (> ± 6 dB) random fluctuations in amplitude. The fluctuations are caused by reflection from different facets of the reflector, and by random interference of waves scattered from groups of facets.

C.5 Pattern 3 b

Oblique incidence, “travelling echo pattern”, Figure C.3b. At any probe position, the A-Scan shows an extended train of signals (“subsidiary peaks”) within a bell-shaped pulse envelope. As the probe is moved each subsidiary peak travels through the pulse envelope, rising to its own maximum towards the centre of the envelope, and then falling. The overall signal may show large (> ± 6 dB) random fluctuations in amplitude.

C.6 Pattern 4

Multiple reflector response, Figure C.4. At any probe position, the A-Scan shows a cluster of signals which may or may not be well resolved in range. As the probe is moved the signals rise and fall at random but the signal from each separate reflector element, if resolved, shows Pattern 1 response.

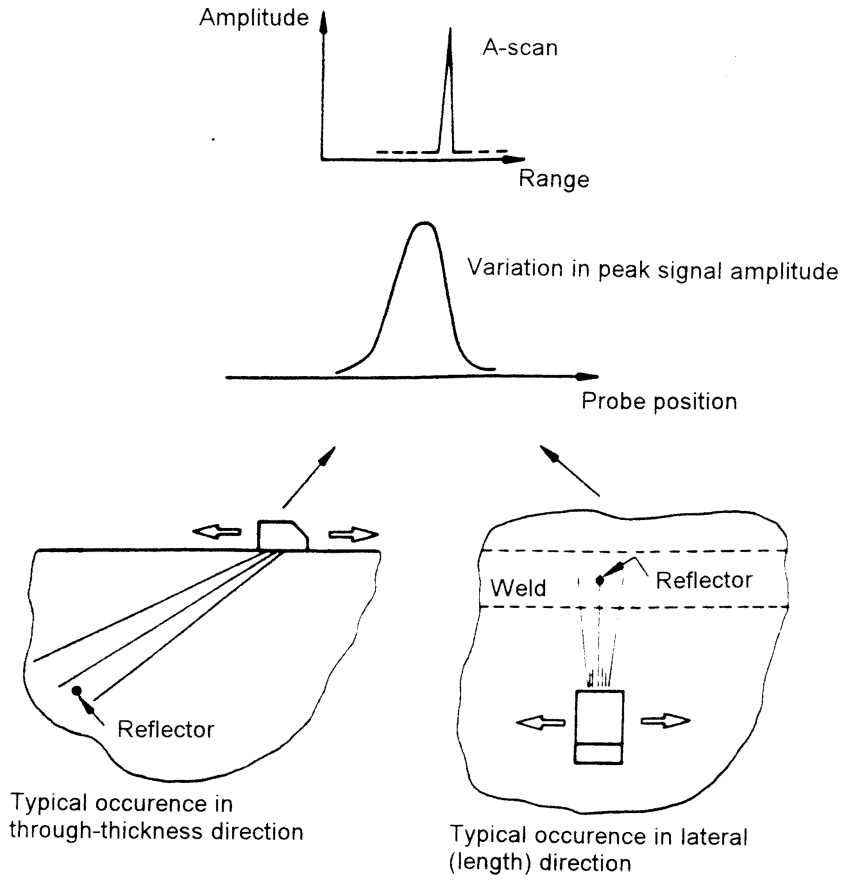

Figure C.1 — Pattern 1 ultrasonic response

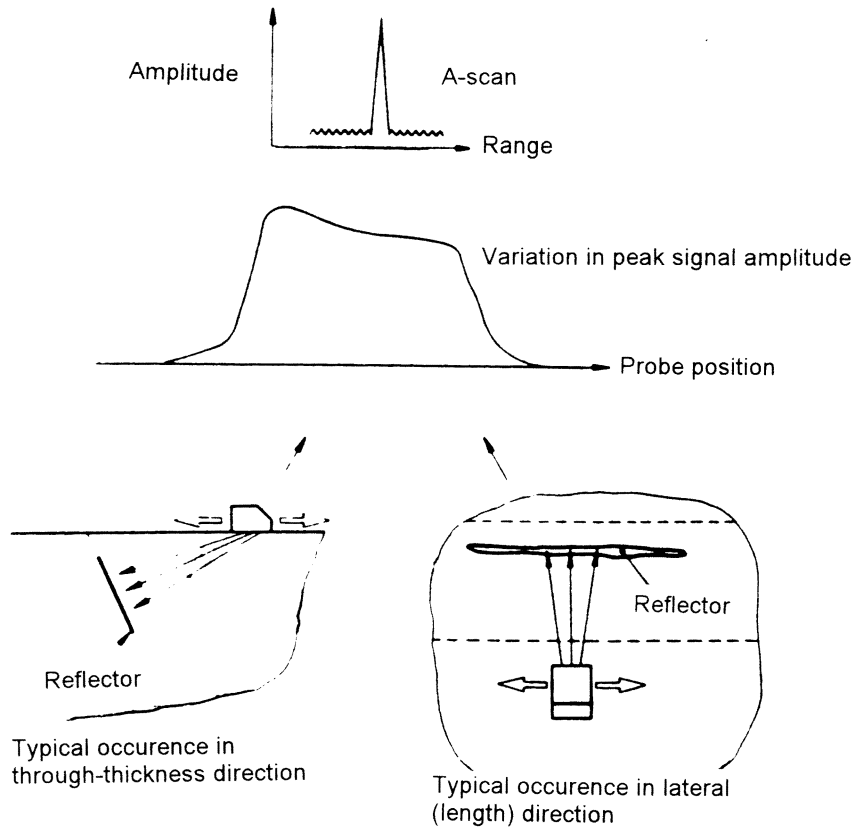

Figure C.2 — Pattern 2 ultrasonic response

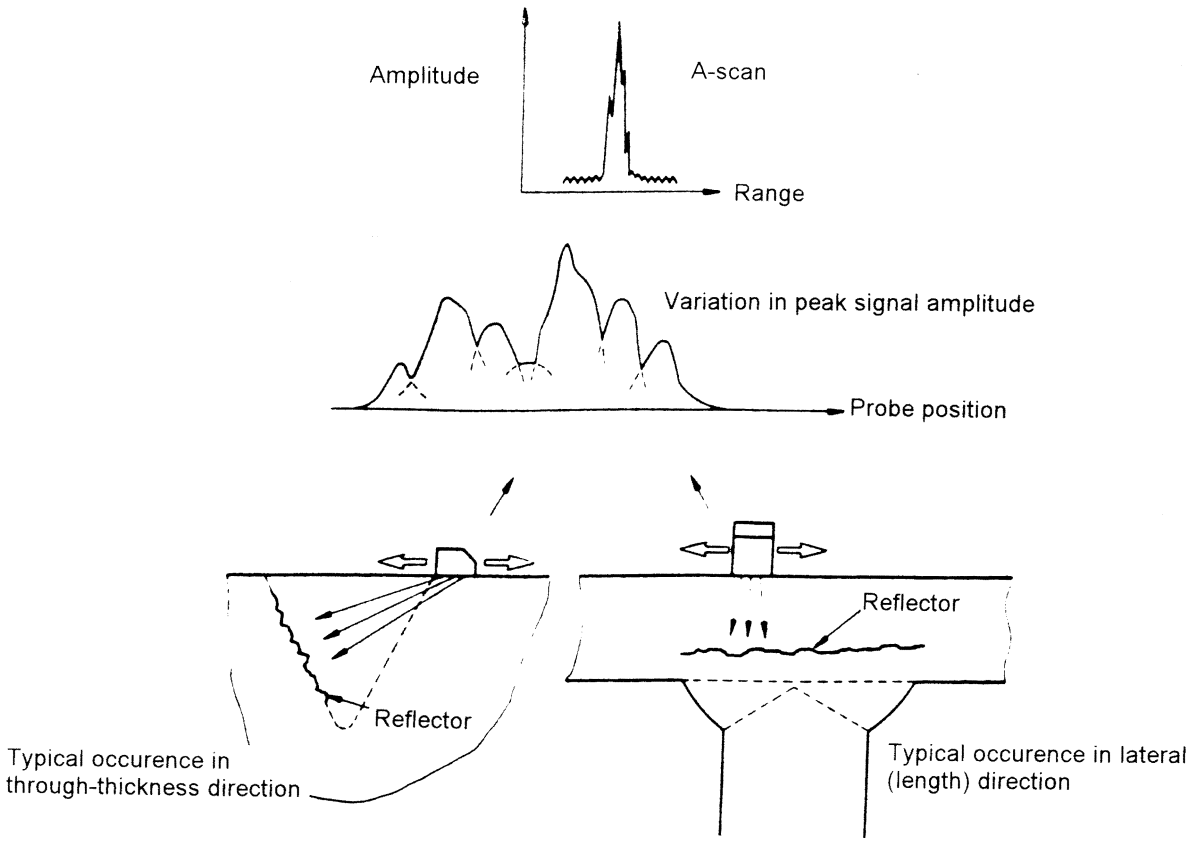

Figure C.3a — Pattern 3a ultrasonic response

Figure C.3

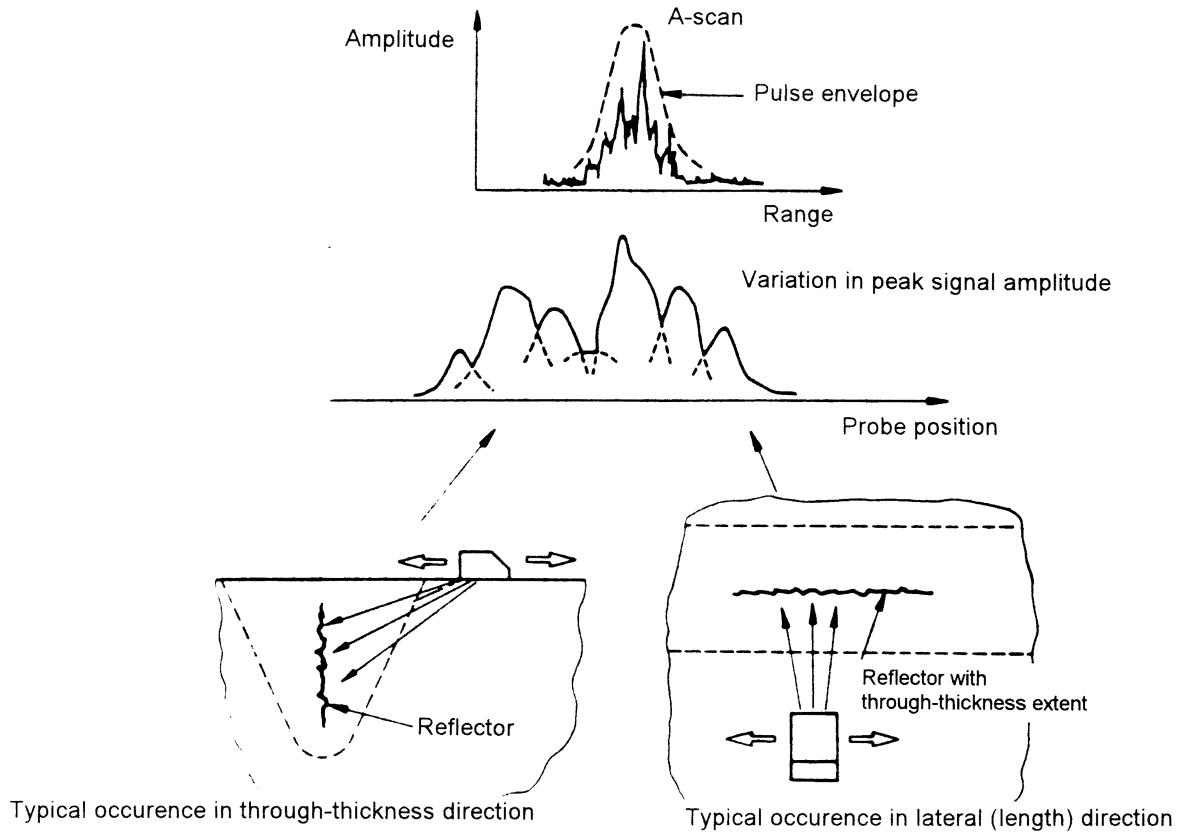

Figure C.3b — Pattern 3b ultrasonic response

Figure C.3

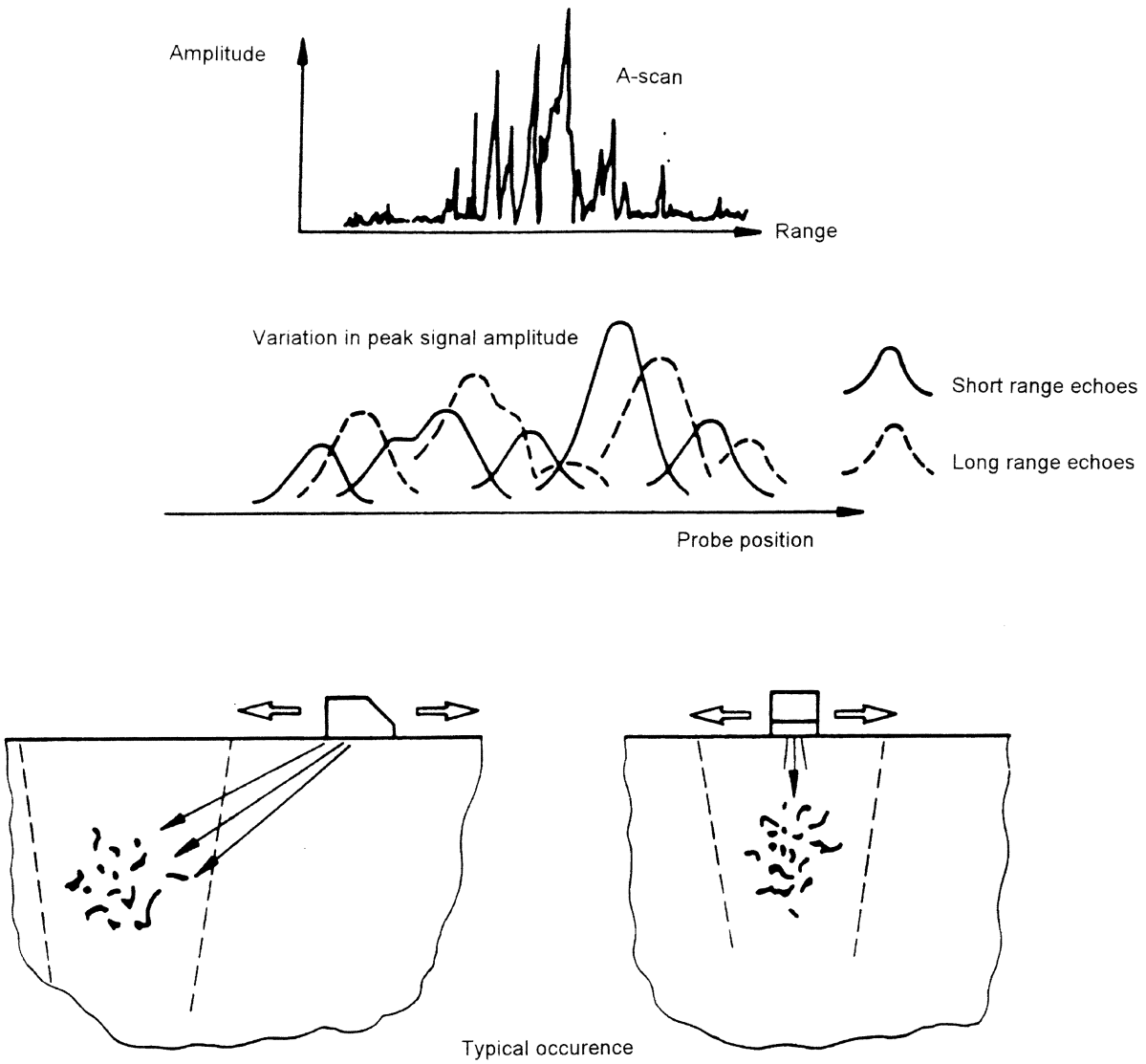

Figure C.4 — Pattern 4 ultrasonic response

[A1] Annex ZA (informative)
Clauses of this European Standard addressing essential requirements or other provisions of EU directives

This European Standard has been prepared under a mandate given to CEN by the European Commission and the European Free Trade Association and supports essential requirements of Directive 97/23/EC of the European Parliament and the Council of 29 May 1997 on the approximation of the laws of the Member States concerning pressure equipment.

WARNING Other requirements and other EU Directives may be applicable to the product(s) falling within the scope of this standard.

The following clauses of this standard as detailed in Table ZA.1 and Table ZA.2, are likely to support requirements of the Directives 97/23/EC and 87/404/EEC.

Compliance with these clauses of this standard provides one with means of conforming to the specific essential requirements of the Directives concerned and associated EFTA regulations.

Table ZA.1 — Correspondence between this European Standard and Directive 97/23/EC

Clauses/subclauses of this European Standard	Essential requirements of Directive 97/23/EC	Qualifying remarks/notes
All	Annex I, **3.1.2**	Non-destructive tests

Table ZA.2 — Correspondence between this European Standard and Directive 87/404/EEC

Clauses/subclauses of this European Standard	Essential requirements of Directive 87/404/EEC	Qualifying remarks/notes
All	Annex I, **3.2**	Welds on pressurized parts

[A1]

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