BS EN ISO 11666:2018

BSI Standards Publication

Non-destructive testing of welds—Ultrasonic testing—Acceptance levels

National foreword

This British Standard is the UK implementation of EN ISO 11666:2018. It is identical to ISO 11666:2018. It supersedes BS EN ISO 11666:2010, which is withdrawn.

The UK participation in its preparation was entrusted to Technical Committee WEE/46, Non-destructive testing.

A list of organizations represented on this committee can be obtained on request to its secretary.

This publication does not purport to include all the necessary provisions of a contract. Users are responsible for its correct application.

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Non-destructive testing of welds - Ultrasonic testing - Acceptance levels (ISO 11666:2018)

Essais non destructifs des assemblages soudés - Contrôle par ultrasons - Niveaux d'acceptation (ISO 11666:2018)

Zerstörungsfreie Prüfung von Schweißverbindungen - Ultraschallprüfung - Zulässigkeitsgrenzen (ISO 11666:2018)

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European foreword

This document (EN ISO 11666:2018) has been prepared by Technical Committee ISO/TC 44 " Welding and allied processes" in collaboration with Technical Committee CEN/TC 121 “Welding and allied processes”, the secretariat of which is held by DIN.

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of an identical text or by endorsement, at the latest by August 2018, and conflicting national standards shall be withdrawn at the latest by August 2018.

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The text of ISO 11666:2018 has been approved by CEN as EN ISO 11666:2018 without any modification.

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Foreword

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For an explanation on the voluntary nature of standards, the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the World Trade Organization (WTO) principles in the Technical Barriers to Trade (TBT) see the following URL: www.iso.org/iso/foreword.html.

This document was prepared by Technical Committee ISO/TC 44, *Welding and allied processes*, Subcommittee SC 5, *Testing and inspection of welds*.

This second edition cancels and replaces the first edition (ISO 11666:2010), which has been technically revised.

The main changes compared to the previous edition are as follows:

— this document has been editorially revised;

— the normative reference to ISO 5817 has been dated;

— Clause 5 and 6.5 have been described in more detail.

Requests for official interpretations of any aspect of this document should be directed to the Secretariat of ISO/TC 44/SC 5 via your national standards body. A complete listing of these bodies can be found at www.iso.org.

INTERNATIONAL STANDARD **ISO 11666:2018**

Non-destructive testing of welds—Ultrasonic testing—Acceptance levels

1 Scope

This document specifies two ultrasonic acceptance levels known as acceptance level 2 (AL 2) and acceptance level 3 (AL 3) for full penetration welded joints in ferritic steels, which correspond to ISO 5817:2014, quality levels B and C. An acceptance level corresponding to ISO 5817:2014, quality level D is not included in this document, as ultrasonic testing is generally not requested for this weld quality.

These acceptance levels are applicable to testing carried out in accordance with ISO 17640.

This document applies to the testing of full penetration ferritic steel welds, with thicknesses from 8 mm to 100 mm. It can also be used for other types of welds, materials and thicknesses, provided the tests have been performed with necessary consideration of the geometry and acoustic properties of the component, and an adequate sensitivity can be employed to enable the acceptance levels of this document to be applied. The nominal frequency of probes used in this document is between 2 MHz and 5 MHz, unless attenuation or requirements for higher resolution call for other frequencies. It is important to consider the use of these acceptance levels in conjunction with frequencies outside this range carefully.

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements 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.

ISO 5577, *Non-destructive testing — Ultrasonic testing — Vocabulary*

ISO 5817:2014, *Welding — Fusion-welded joints in steel, nickel, titanium and their alloys (beam welding excluded) — Quality levels for imperfections*

ISO 17635, *Non-destructive testing of welds — General rules for metallic materials*

ISO 17640, *Non-destructive testing of welds — Ultrasonic testing — Techniques, testing levels, and assessment*

ISO 23279, *Non-destructive testing of welds — Ultrasonic testing — Characterization of discontinuities in welds*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO 5577 apply.

ISO and IEC maintain terminological databases for use in standardization at the following addresses:

— ISO Online browsing platform: available at https://www.iso.org/obp

— IEC Electropedia: available at http://www.electropedia.org/

4 Determination of discontinuity length

The length of a discontinuity shall be determined by measuring the distance along the length over which the echo amplitude is above the evaluation level, using the fixed-amplitude level technique specified in Annex B.

5 Sensitivity setting and levels

The sensitivity setting shall be performed by one of the following techniques. For sensitivity setting and the subsequent testing, the same technique shall be used.

a) Technique 1: based on 3 mm diameter side-drilled holes.

b) Technique 2: based on distance-gain-size (DGS) curves for flat-bottomed holes (disk-shaped reflectors).

c) Technique 3: using a distance-amplitude-corrected (DAC) curve of a rectangular notch of 1 mm depth and 1 mm width.

d) Technique 4: using the tandem technique with reference to a 6 mm diameter flat-bottomed hole (disk-shaped reflector).

Four levels as defined in ISO 17640 are to be used:

a) reference level;

b) acceptance levels (for two quality levels);

c) recording levels (recording levels are 4 dB below the corresponding acceptance levels);

d) evaluation level.

All levels are linked to the reference reflectors specified in Table A.1.

The sensitivity setting techniques and corresponding levels shall be in accordance with Annex A.

6 Acceptance levels

6.1 General

The relationship between acceptance levels, testing levels and quality levels is given in ISO 17635. See also Table 1.

Table 1 — Ultrasonic pulse-echo technique (UT)

Quality level in accordance with ISO 5817:2014	Testing level in accordance with ISO 17640 [a]	Acceptance level in accordance with this document
B	At least B	2
C	At least A	3
D	At least A	3[b]

[a] When characterization of discontinuities is required, ISO 23279 shall be applied.

[b] UT is not recommended but may be defined in a specification (with the same requirements as quality level C).

The acceptance levels in this document are valid for all testing levels and for all techniques as defined in ISO 17640, including tests with straight-beam probes.

If characterization has been specified in accordance with ISO 23279, planar discontinuities are not acceptable and for non-planar discontinuities, the acceptance levels in this document apply.

If characterization has not been specified, the acceptance levels in this document apply to all discontinuities.

6.2 Indications from longitudinal discontinuities

Table A.1 gives information on the techniques used for evaluation of discontinuities according to ISO 17640 and the related evaluation and acceptance levels. Table A.2 specifies the reference levels for acceptance levels 2 and 3 for technique 2 using angle-beam scanning with transverse waves. Table A.3 specifies the reference levels for acceptance levels 2 and 3 for technique 2 using straight-beam scanning with longitudinal waves.

For techniques 1 (side-drilled holes) and 3 (rectangular notch), see Figures A.1 to A.4.

For techniques 2 [flat-bottomed holes (disk-shaped reflectors)] and 4 (tandem technique), see Figures A.5 to A.10.

Any discontinuities providing an amplitude below the acceptance level but with a length (above evaluation level) exceeding t, for the thickness range of 8 mm ≤ t < 15 mm, or $t/2$ or 20 mm, whichever is larger, for all other thickness ranges, shall be subject to further testing. This requires the use of additional beam angle(s), and, if specified, the tandem technique.

The final evaluation shall be based on the maximum echo amplitude and length measured.

6.3 Indications from transverse discontinuities

When detection of transverse discontinuities is specified, the acceptance levels stated in 6.2 apply.

6.4 Grouping of discontinuities

Grouping of discontinuities is based on the length and the separation of individually acceptable discontinuities providing amplitudes above the recording level. The length of a group shall not be used for further grouping.

For evaluation, a group of discontinuities shall be considered as a single one if:

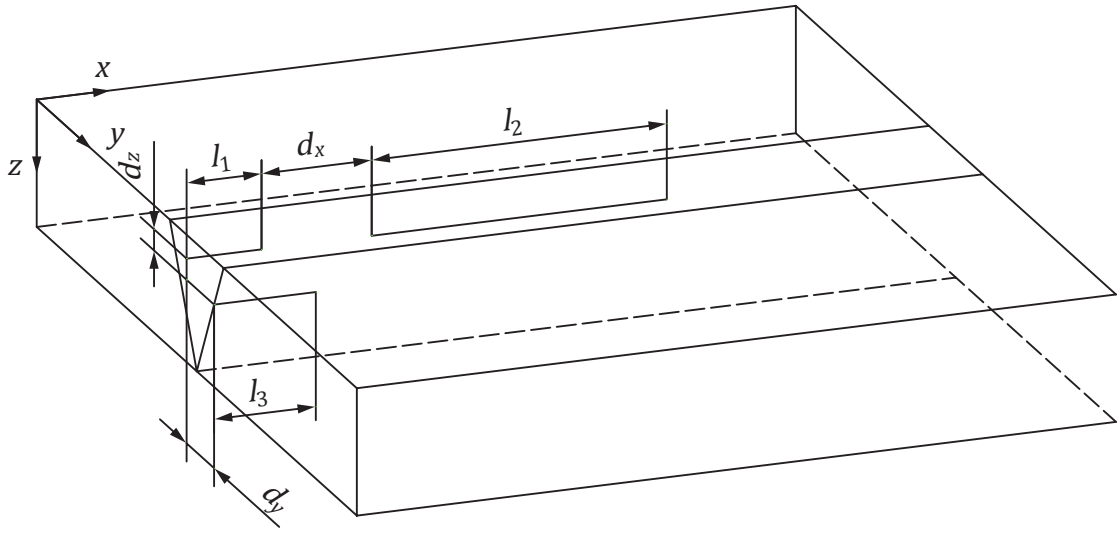
a) the distance, d_x, between two discontinuities is less than twice the length of the longer discontinuity (see Figure 1);

b) the distance, d_y, between two discontinuities is less than half of the thickness but not more than 10 mm; and

c) the distance, d_z, between two discontinuities is less than half of the thickness but not more than 10 mm.

The combined length of the group of two discontinuities is $l_{12} = l_1 + l_2 + d_x$ (see Figure 2).

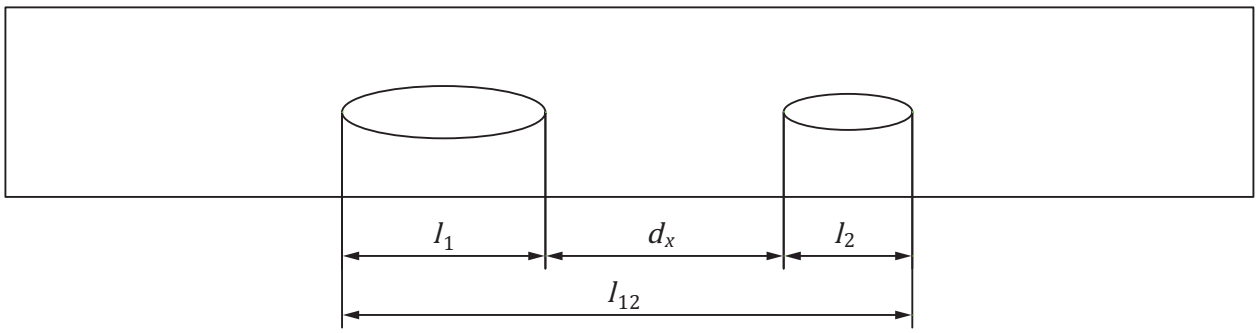
The combined length, l_{12}, and the larger maximum amplitude of the two discontinuities shall then be assessed against the applicable acceptance levels given in Table A.1.



Key

d_x, d_y, d_z	distances in the *x*-, *y*-, and *z*-direction, respectively
l_n	individual discontinuities, where n = 1, …, 3

Figure 1 — Geometric configuration for grouped discontinuities



Key

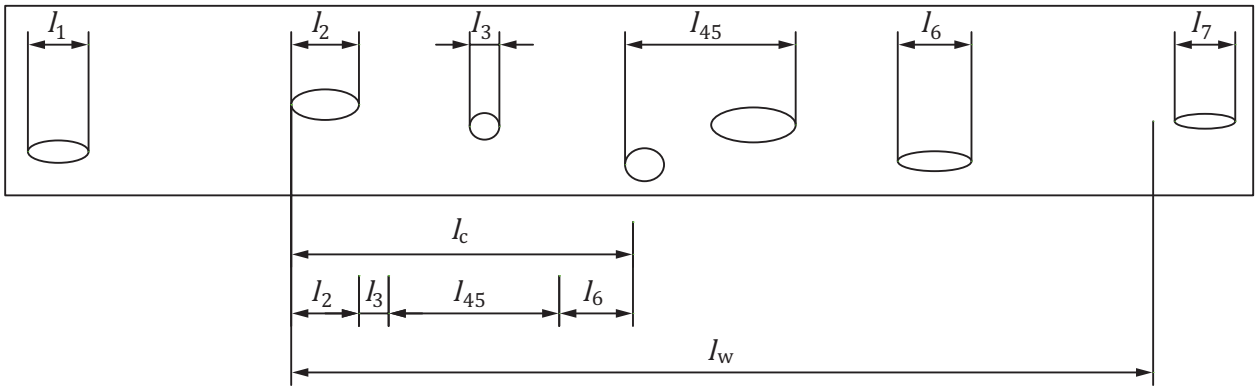
d_x	distance in the x-direction
l_1, l_2	individual discontinuities
l_{12}	combined length

Figure 2 — Length of a group of discontinuities

6.5 Length of acceptable discontinuities

The length of a single acceptable discontinuity above recording level shall be evaluated according to the criteria in this subclause.

The cumulative length of all individually acceptable discontinuities above recording level is given as the sum of lengths of both single discontinuities and linearly aligned discontinuities of combined length within a given section of weld length (see Figure 3).



Key

l_c cumulative length

$$l_c = l_2 + l_3 + l_{45} + l_6$$

l_w section of weld length (6 × thickness t)

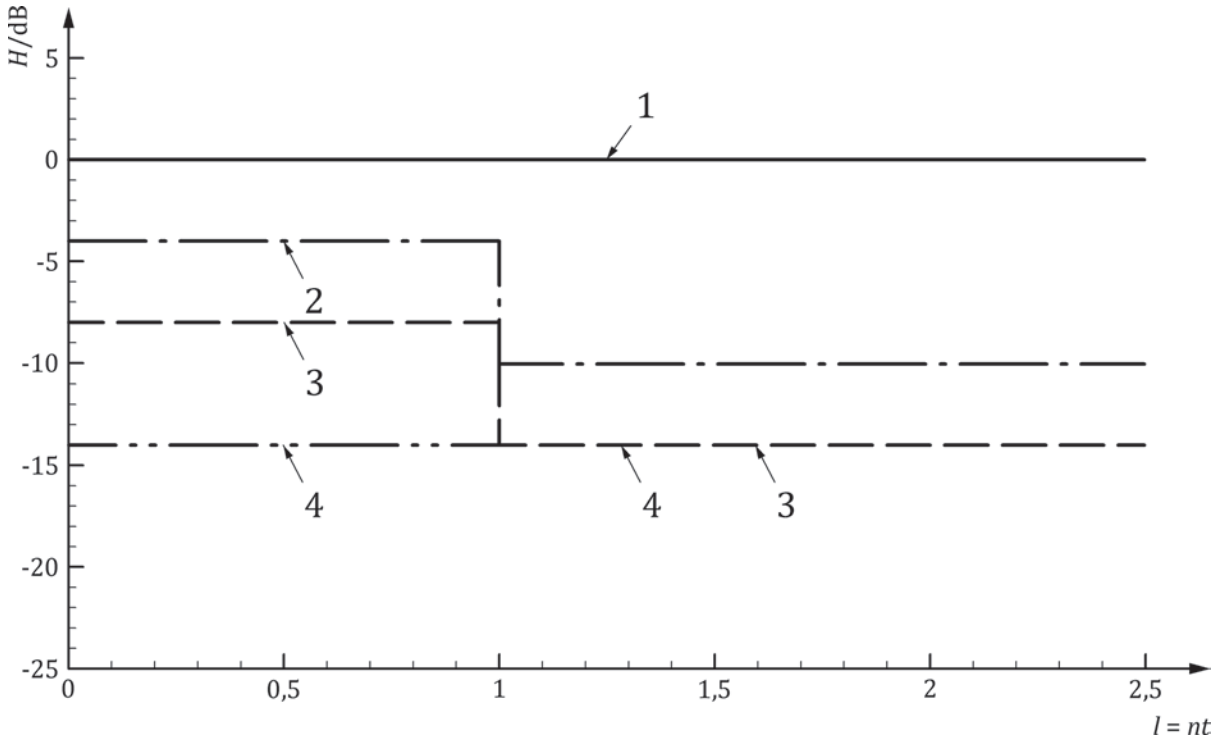
l_n individual discontinuities, where n = 1, …, 7

Figure 3 — Cumulative length of discontinuities

For any section of weld length, $l_w = 6\,t$, the maximum cumulative length, l_c, of all individually acceptable discontinuities above the recording level shall not exceed 20 % of l_w for acceptance level 2, or 30 % of l_w for acceptance level 3.

Annex A
(normative)

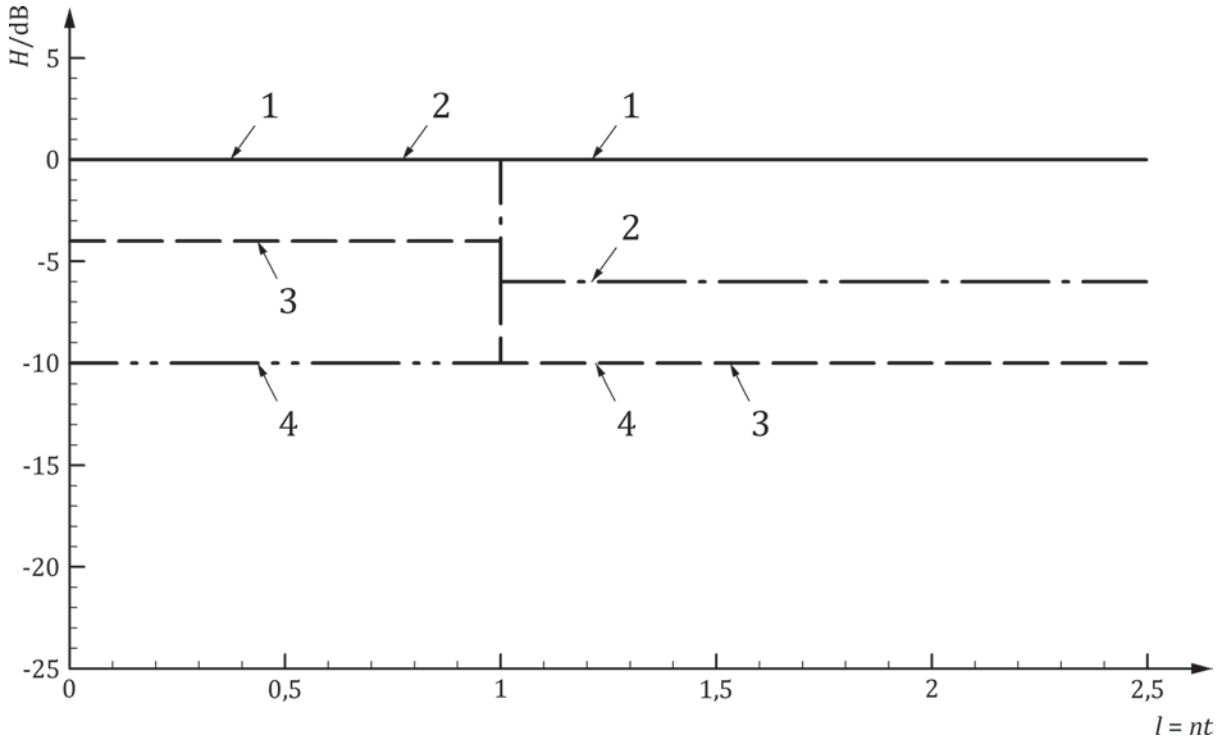
Levels



Key

1 reference level
2 acceptance level 2
3 recording level
4 evaluation level
H amplitude
l length of discontinuities
n multiplier of *t*
t thickness

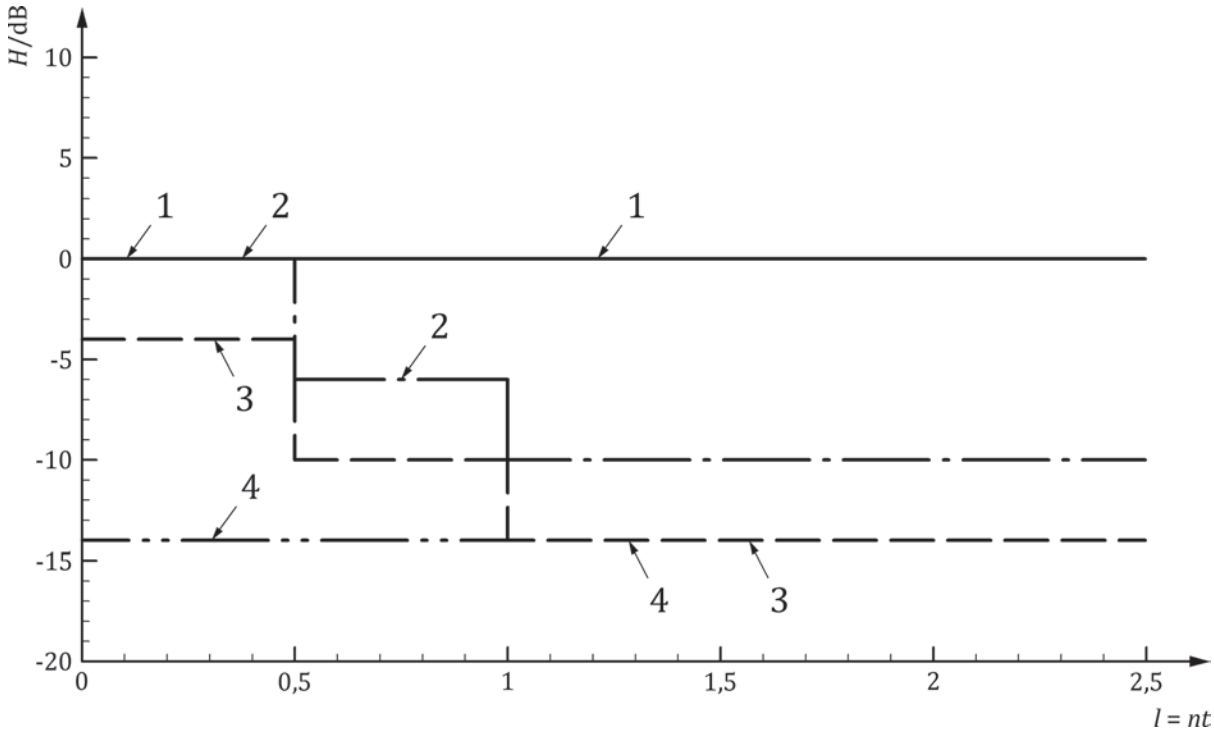
Figure A.1 — Levels for techniques 1 and 3 for thicknesses 8 mm to 15 mm — Acceptance level 2



Key

1 reference level
2 acceptance level 3
3 recording level
4 evaluation level
H amplitude
l length of discontinuities
n multiplier of *t*
t thickness

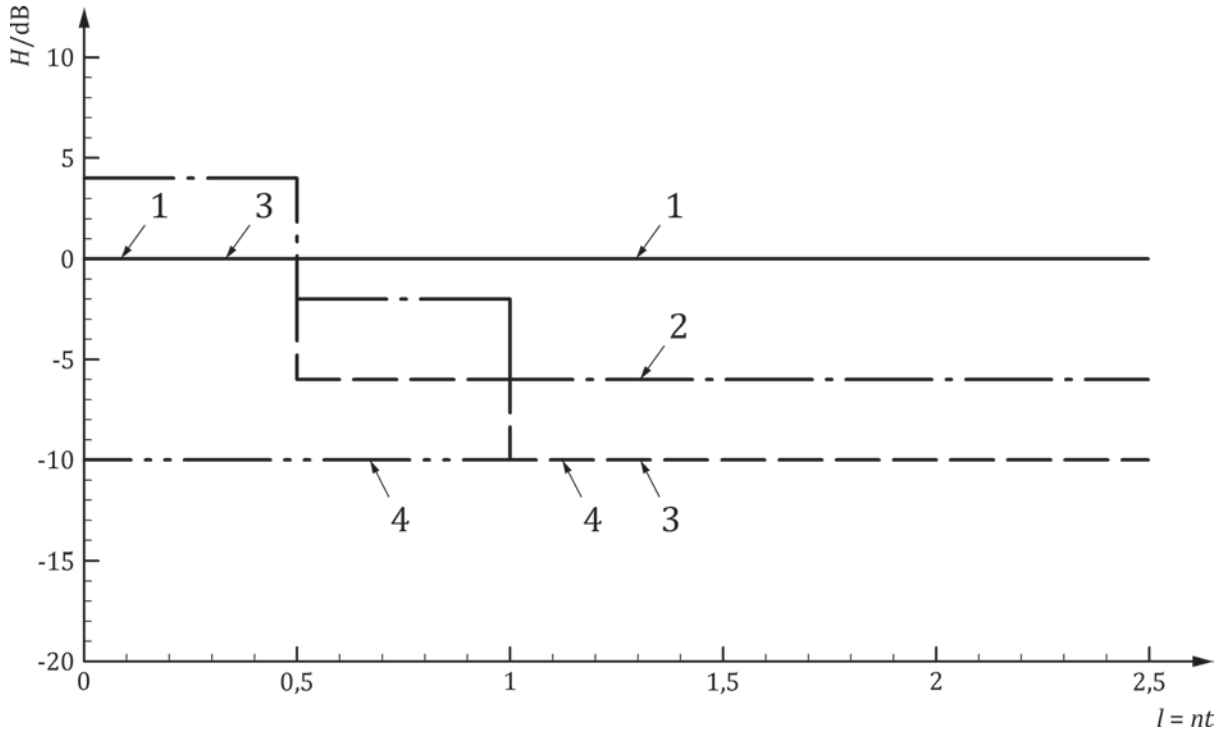
Figure A.2 — Levels for techniques 1 and 3 for thicknesses 8 mm to 15 mm — Acceptance level 3



Key

1 reference level
2 acceptance level 2
3 recording level
4 evaluation level
H amplitude
l length of discontinuities
n multiplier of *t*
t thickness

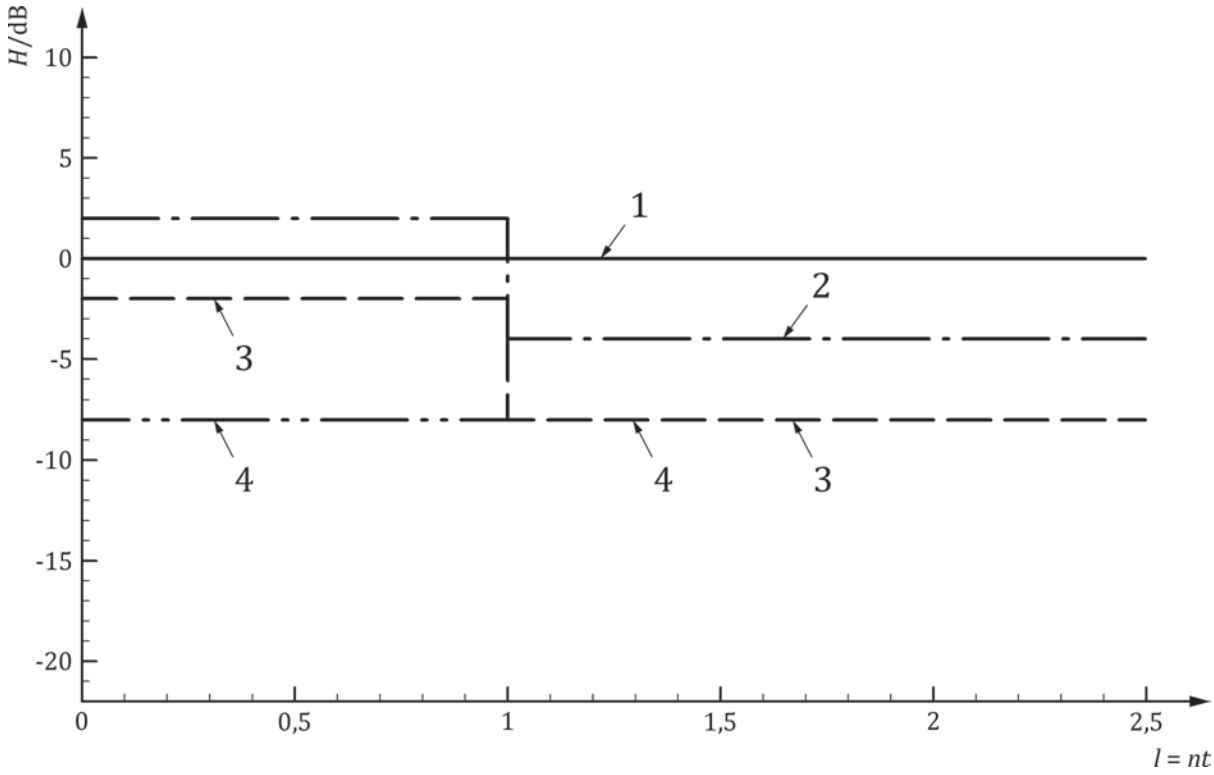
Figure A.3 — Levels for technique 1 for thicknesses 15 mm to 100 mm — Acceptance level 2



Key

1 reference level
2 acceptance level 3
3 recording level
4 evaluation level
H amplitude
l length of discontinuities
n multiplier of *t*
t thickness

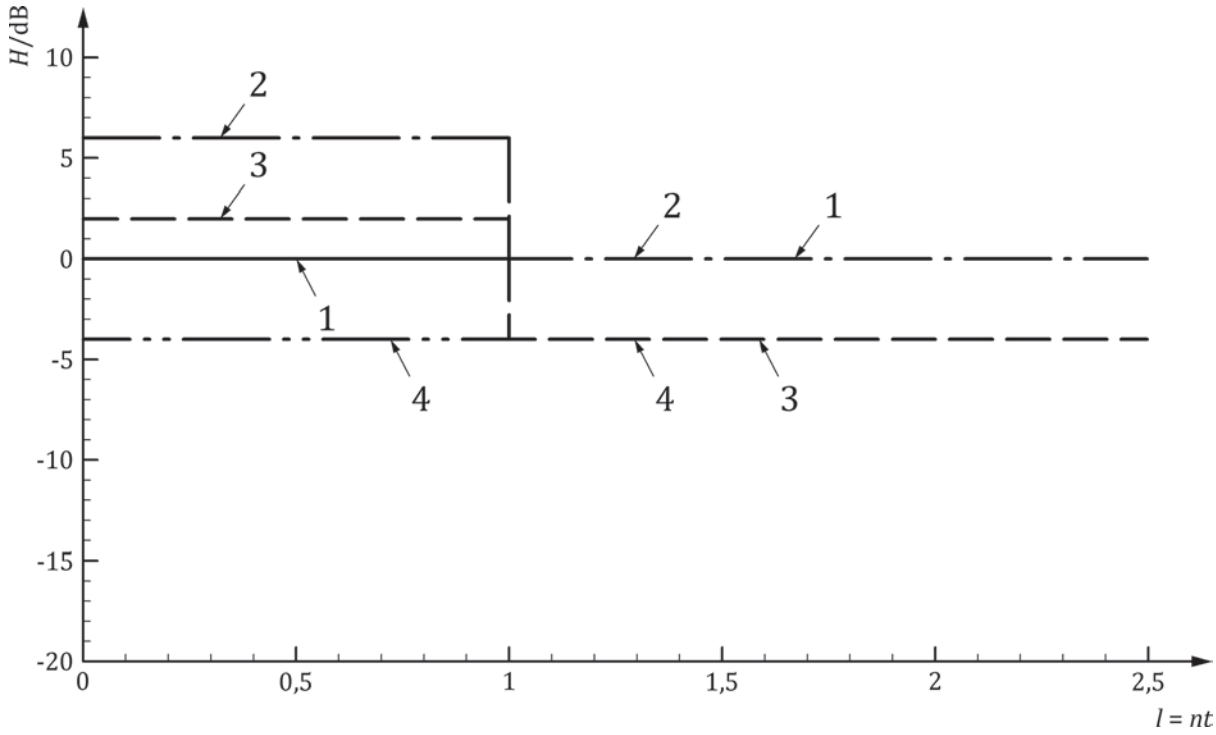
Figure A.4 — Levels for technique 1 for thicknesses 15 mm to 100 mm — Acceptance level 3



Key

1 reference level
2 acceptance level 2
3 recording level
4 evaluation level
H amplitude
l length of discontinuities
n multiplier of t
t thickness

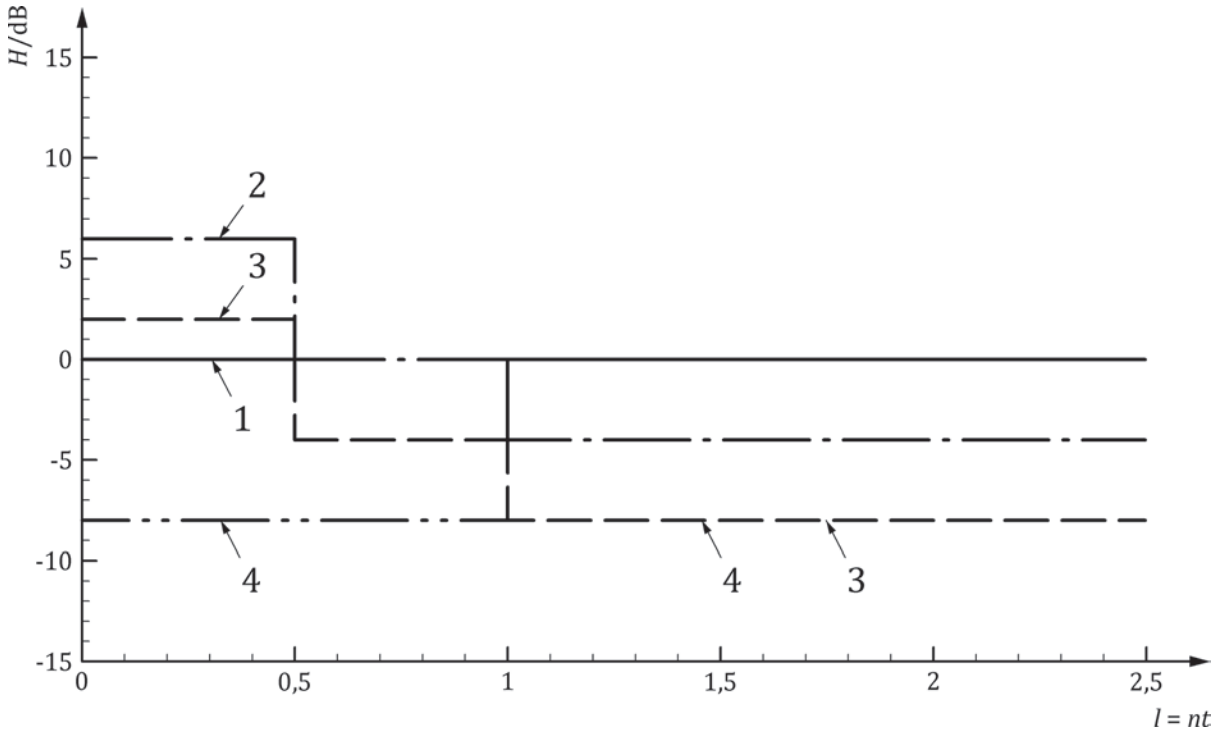
Figure A.5 — Levels for technique 2 for thicknesses 8 mm to 15 mm — Acceptance level 2



Key

1 reference level
2 acceptance level 3
3 recording level
4 evaluation level
H amplitude
l length of discontinuities
n multiplier of *t*
t thickness

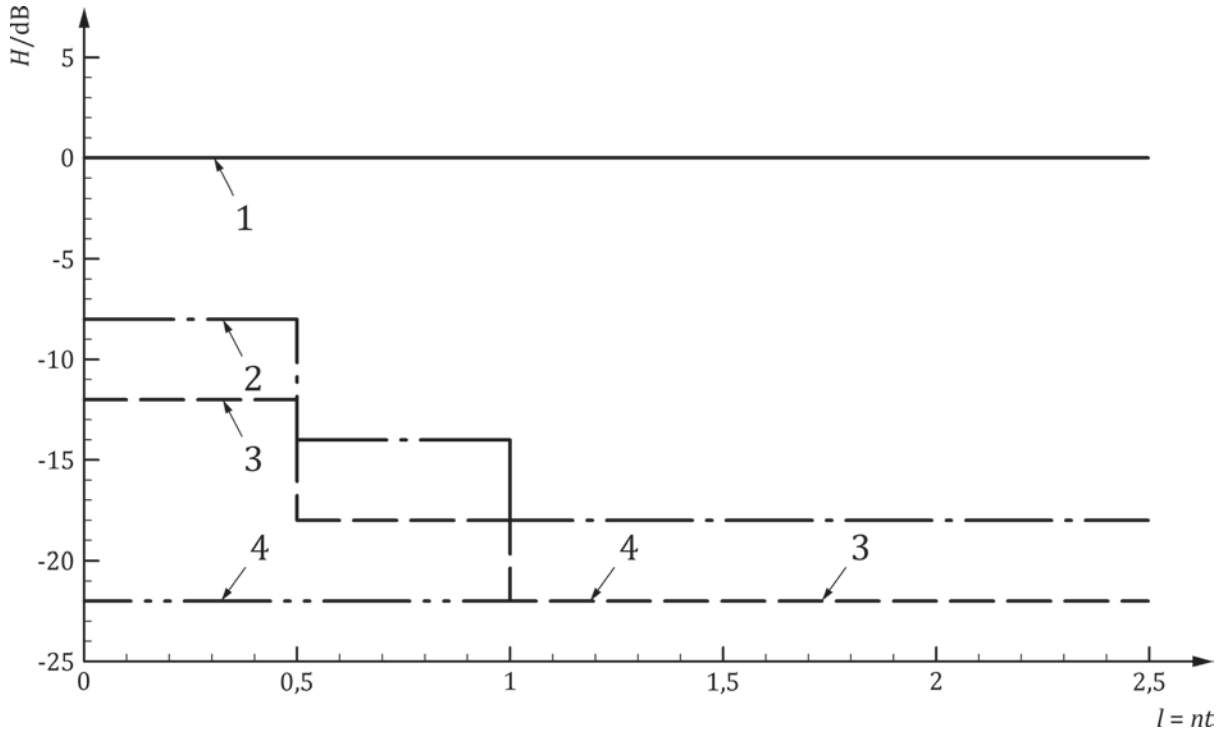
Figure A.6 — Levels for technique 2 for thicknesses 8 mm to 15 mm — Acceptance level 3



Key

1 reference level
2 acceptance level 2
3 recording level
4 evaluation level
H amplitude
l length of discontinuities
n multiplier of *t*
t thickness

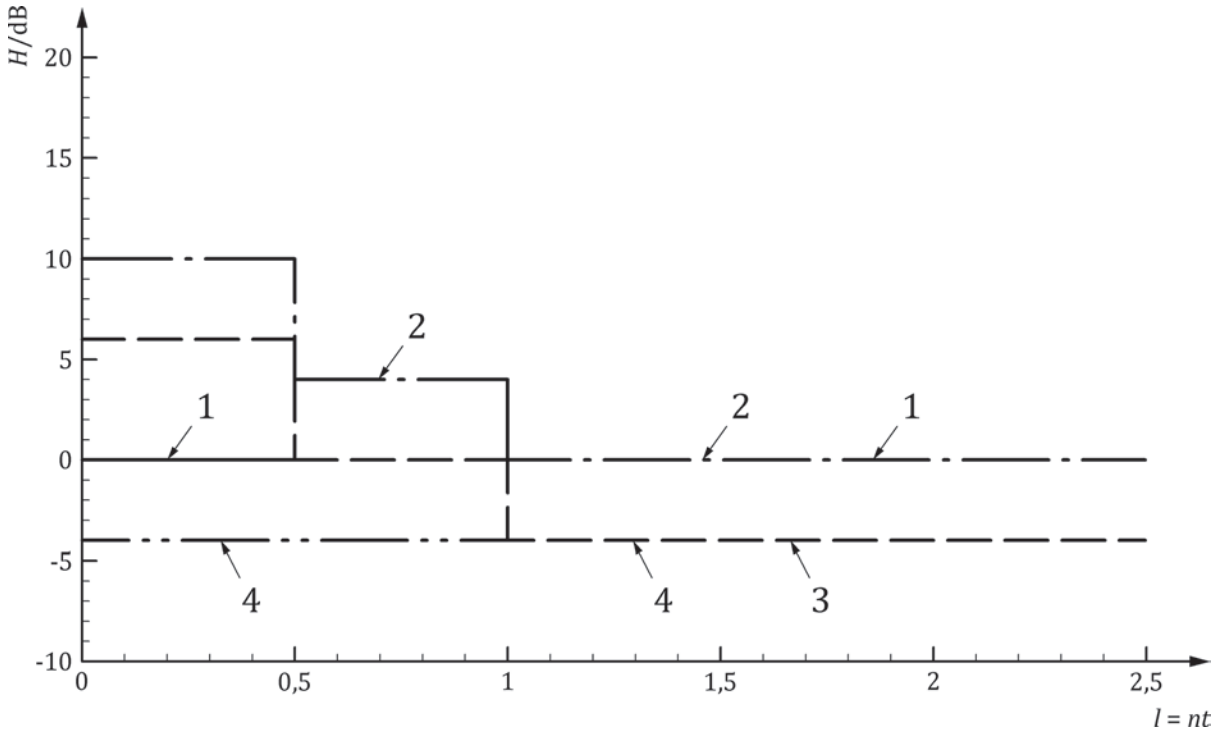
Figure A.7 — Levels for technique 2 for thicknesses 15 mm to 100 mm — Acceptance level 2



Key

1 reference level
2 acceptance level 2
3 recording level
4 evaluation level
H amplitude
l length of discontinuities
n multiplier of *t*
t thickness

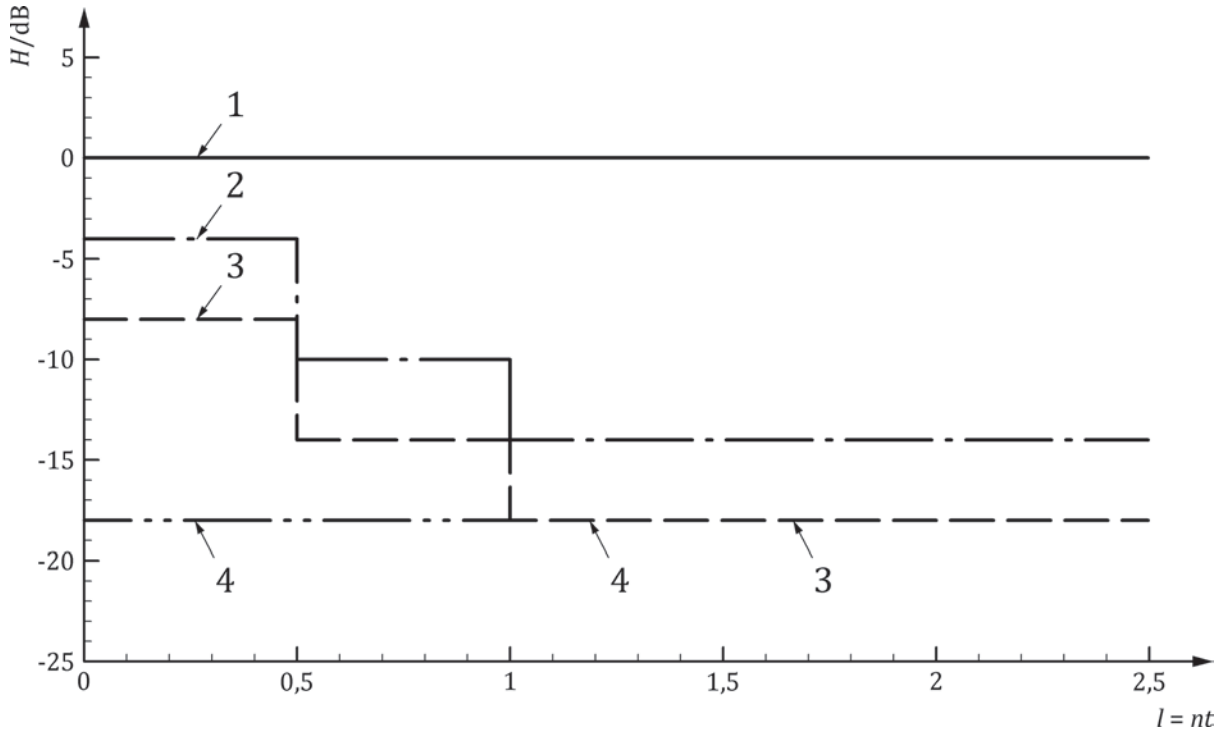
Figure A.8 — Levels for technique 4 for thicknesses 15 mm to 100 mm — Acceptance level 2



Key

1 reference level
2 acceptance level 3
3 recording level
4 evaluation level
H amplitude
l length discontinuities
n multiplier of *t*
t thickness

Figure A.9 — Levels for technique 2 for thicknesses 15 mm to 100 mm — Acceptance level 3



Key

1 reference level
2 acceptance level 3
3 recording level
4 evaluation level
H amplitude
l length of discontinuities
n multiplier of t
t thickness

Figure A.10 — Levels for technique 4 for thicknesses 15 mm to 100 mm — Acceptance level 3

Table A.1 — Acceptance levels 2 (AL 2) and 3 (AL 3) for techniques 1, 2, 3 and 4

Technique	**Evaluation level**		**Acceptance level 2 (AL 2)**		**Acceptance level 3 (AL 3)**	
(according to ISO 17640)	for AL 2	for AL 3	8 mm ≤ t < 15 mm	15 mm ≤ t < 100 mm	8 mm ≤ t < 15 mm	15 mm ≤ t < 100 mm
1 (side-drilled holes)	H_0 − 14 dB	H_0 − 10 dB	For $l \le t$: H_0 − 4 dB For $l > t$: H_0 − 10 dB	For $l \le 0{,}5\ t$: H_0 For 0,5 $t < l \le t$: H_0 − 6 dB For $l > t$: H_0 − 10 dB	For $l \le t$: H_0 For $l > t$: H_0 − 6 dB	For $l \le 0{,}5\ t$: H_0 + 4 dB For 0,5 $t < l \le t$: H_0 − 2 dB For $l > t$: H_0 − 6 dB
NOTE 1 Recording levels are 4 dB below the corresponding acceptance levels. NOTE 2 H_0 is the reference level.						

Technique (according to ISO 17640)	Evaluation level		Acceptance level 2 (AL 2)		Acceptance level 3 (AL 3)	
	for AL 2	for AL 3	8 mm ≤ t < 15 mm	15 mm ≤ t < 100 mm	8 mm ≤ t < 15 mm	15 mm ≤ t < 100 mm
2 [flat-bottomed holes (disk-shaped reflectors)]	H_0 – 8 dB in accordance with Table A.2 or A.3	H_0 – 4 dB in accordance with Table A.2 or A.3	For $l \le t$: H_0 + 2 dB For $l > t$: H_0 – 4 dB	For $l \le 0{,}5\ t$: H_0 + 6 dB For $0{,}5\ t < l \le t$: H_0 For $l > t$: H_0 – 4 dB	For $l \le t$: H_0 + 6 dB For $l > t$: H_0	For $l \le 0{,}5\ t$: H_0 + 10 dB For $0{,}5\ t < l \le t$: H_0 + 4 dB For $l > t$: H_0
3 (rectangular notch)	H_0 – 14 dB	H_0 – 10 dB	For $l \le t$: H_0 – 4 dB For $l > t$: H_0 – 10 dB	—	For $l \le t$: H_0 For $l > t$: H_0 – 6 dB	—
4 (tandem technique)	H_0 – 22 dB	H_0 – 18 dB	—	For $l \le 0{,}5\ t$: H_0 – 8 dB For $0{,}5\ t < l \le t$: H_0 – 14 dB For $l > t$: H_0 – 18 dB	—	For $l \le 0{,}5\ t$: H_0 – 4 dB For $0{,}5\ t < l \le t$: H_0 – 10 dB For $l > t$: H_0 – 14 dB

NOTE 1 Recording levels are 4 dB below the corresponding acceptance levels.

NOTE 2 H_0 is the reference level.

Table A.2 — Reference levels for acceptance levels 2 (AL 2) and 3 (AL 3) for technique 2 using angle-beam scanning with transverse waves

Nominal probe frequency MHz	Thickness of parent material, t					
	8 mm ≤ t < 15 mm		15 mm ≤ t < 40 mm		40 mm ≤ t < 100 mm	
	AL 2	AL 3	AL 2	AL 3	AL 2	AL 3
1,5 to 2,5	—	—	D_{DSR} = 2,5 mm	D_{DSR} = 2,5 mm	D_{DSR} = 3,0 mm	D_{DSR} = 3,0 mm
3,0 to 5,0	D_{DSR} = 1,5 mm	D_{DSR} = 1,5 mm	D_{DSR} = 2,0 mm	D_{DSR} = 2,0 mm	D_{DSR} = 3,0 mm	D_{DSR} = 3,0 mm

NOTE D_{DSR} is the diameter of the disk-shaped reflector.

Table A.3 — Reference levels for acceptance levels 2 (AL 2) and 3 (AL 3) for technique 2 using straight-beam scanning with longitudinal waves

Nominal probe frequency MHz	Thickness of parent material, t					
	8 mm ≤ t < 15 mm		15 mm ≤ t < 40 mm		40 mm ≤ t < 100 mm	
	AL 2	AL 3	AL 2	AL3	AL 2	AL 3
1,5 to 2,5	—	—	D_{DSR} = 2,5 mm	D_{DSR} = 2,5 mm	D_{DSR} = 3,0 mm	D_{DSR} = 3,0 mm
3,0 to 5,0	D_{DSR} = 2,0 mm	D_{DSR} = 2,0 mm	D_{DSR} = 2,0 mm	D_{DSR} = 2,0 mm	D_{DSR} = 3,0 mm	D_{DSR} = 3,0 mm

NOTE D_{DSR} is the diameter of the disk-shaped reflector.

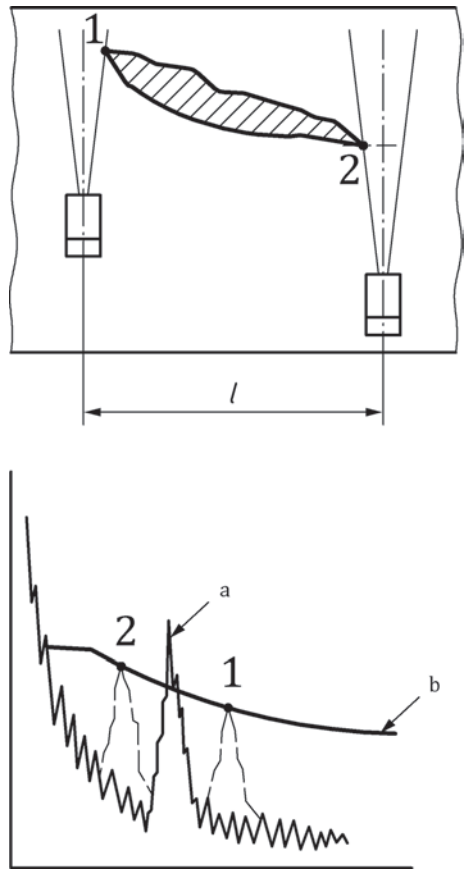
Annex B
(normative)

Fixed-amplitude level technique

The technique determines the lateral dimensions of a discontinuity over which the echo is equal to or greater than the evaluation level.

To make a measurement, the beam is scanned over the discontinuities, and the probe position and beam path range, at which the echo has fallen to the evaluation level, are noted (see Figure B.1).

The lateral dimension, *l*, is then determined by the distance between the positions 1 and 2.



Key

l measured lateral dimension of discontinuity

1, 2 positions where the indication amplitudes are equal to the evaluation level

a Maximum echo.

b Evaluation level.

Figure B.1 — Fixed-amplitude-level technique using the beam axis

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