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Wprowadza
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Zastępuje
–

Badania nieniszczące spoin

Badania ultradźwiękowe techniką głowicy mozaikowej (PAUT)

Kryteria akceptacji

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EUROPEAN STANDARD

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EUROPÄISCHE NORM

EN ISO 19285

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English Version

Non-destructive testing of welds - Phased array ultrasonic testing (PAUT) - Acceptance levels (ISO 19285:2017)

Essais non destructifs des assemblages soudés - Technique ultrasons multi-éléments (PAUT) - Niveaux d'acceptation (ISO 19285:2017)

Zerstörungsfreie Prüfung von Schweißverbindungen - Ultraschallprüfungen mit Phased-Arrays (PAUT) - Zulässigkeitsgrenzen (ISO 19285:2017)

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European foreword

This document (EN ISO 19285:2017) 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of an identical text or by endorsement, at the latest by March 2018, and conflicting national standards shall be withdrawn at the latest by March 2018.

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Non-destructive testing of welds — Phased array ultrasonic testing (PAUT) — Acceptance levels

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Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

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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*.

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.

Non-destructive testing of welds — Phased array ultrasonic testing (PAUT) — Acceptance levels

1 Scope

This document specifies acceptance levels for the phased array ultrasonic testing technique (PAUT) of full penetration welds in ferritic steels of minimum thickness of 6 mm which correspond to the quality levels of ISO 5817.

These acceptance levels are applicable to indications classified in accordance with ISO 13588.

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

ISO 11666, *Non-destructive testing of welds — Ultrasonic testing — Acceptance levels*

ISO 13588, *Non-destructive testing of welds — Ultrasonic testing — Use of automated phased array technology*

ISO 15626, *Non-destructive testing of welds — Time-of-flight diffraction technique (TOFD) — Acceptance levels*

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

3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO 5577 and ISO 13588 apply.

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

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

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

4 Symbols

h	height
h_g	sum of the heights of the individual indications plus the distance between them
l	length
l_g	sum of the lengths of the individual indications plus the distance between them
t	thickness

5 Acceptance levels

For the evaluation, three different acceptance levels are defined. The relation between these acceptance levels and the quality levels as mentioned in ISO 5817 are given in Table 1.

Table 1 — Related levels for phased array ultrasonic testing

Quality level according to ISO 5817	Testing level according to ISO 13588	Acceptance level according to this document
C, D	A	3
B	B	2
By agreement	C	1
Special application	D	By agreement
NOTE Acceptance criteria for acceptance level 1 are only specified for evaluation based on length and height.		

6 Evaluation of indications

Indications detected when applying ISO 13588 shall be evaluated as specified in the test procedure either by:

a) length and height, then Clause 7 and Clause 9 shall be applied;

b) or by length and maximum amplitude, then Clause 8 and Clause 10 shall be applied.

7 Determination of length and height

7.1 General

The size of a discontinuity is determined by its length and height.

7.2 Determination of length

The length of an indication shall be measured as described in ISO 11666, using the focal law which provides the maximum amplitude.

If TOFD is used, the length of an indication shall be measured as described in ISO 15626.

In any other case, testing level D of Table 1 is applicable.

7.3 Determination of height

7.3.1 General

For indications displaying varying height along their length, the height shall be determined at the scan position of maximum extent.

7.3.2 Using diffracted signals

If diffracted signals are observed, they shall be used to determine height. The height is determined using either:

— two diffracted signals observed from the same discontinuity (upper and lower tip);

— one diffracted signal and a surface signal observed from the same discontinuity;

— one diffracted signal and the known wall thickness for root connected discontinuities;

— one diffracted signal in relation to the surface for a surface breaking discontinuity.

If TOFD is used, the height shall be measured as described in ISO 15626.

7.3.3 Using other signals

In case a height cannot be measured using diffracted signals, then the determination can be based on:

— amplitudes using the reference levels as described in ISO 11666. Other sizing techniques may be used (TCG, DGS, 6 dB drop);

— the time-of-flight of reflections (e.g. hollow root, mismatch);

— the time-of-flight of mode converted signals.

8 Determination of length and maximum amplitude

The length of an indication shall be determined by measuring the distance along the weld over which the echo amplitude is above the evaluation level using the fixed amplitude level technique specified in Annex B.

Alternative techniques for measuring indication length may be used when specified.

9 Acceptance criteria based on length and height

9.1 General

When indications are detected, length and height are determined in accordance with 7.2 and 7.3. Indications shall be evaluated according to their acceptance level and the acceptance criteria listed in this clause.

For welds joining two different thicknesses, the thinner of those two is leading for the acceptance criteria.

9.2 Single indications

9.2.1 Acceptance criteria for level 1

Acceptance criteria for level 1 are given in Table 2.

Table 2 — Acceptance criteria for level 1

Thickness range	Maximum allowable length (l_{max}) if $h < h2$ or $h3$			Maximum allowable height ($h1$) when $l > l_{max}$
		Surface breaking	Embedded	
	l_{max}	$h3$	$h2$	$h1$
	mm	mm	mm	mm
6 mm < t ≤ 15 mm	0,75t	1,5	2	1
15 mm < t ≤ 50 mm	0,75t	2	3	1
50 mm < t ≤ 100 mm	40	2,5	4	2
t > 100 mm	50	3	5	2

9.2.2 Acceptance criteria for level 2

Acceptance criteria for level 2 are given in Table 3.

Table 3 — Acceptance criteria for level 2

Thickness range	Maximum allowable length (l_{max}) if $h < h2$ or $h3$			Maximum allowable height ($h1$) when $l > l_{max}$
		Surface breaking	Embedded	
	l_{max}	$h3$	$h2$	$h1$
	mm	mm	mm	mm
6 mm < t ≤ 15 mm	t	2	2	1
15 mm < t ≤ 50 mm	t	2	4	1
50 mm < t ≤ 100 mm	50	3	5	2
t > 100 mm	60	4	6	3

9.2.3 Acceptance criteria for level 3

Acceptance criteria for level 3 are given in Table 4.

Table 4 — Acceptance criteria for level 3

Thickness range	Maximum allowable length (l_{max}) if $h < h2$ or $h3$			Maximum allowable height ($h1$) when $l > l_{max}$
		Surface breaking	Embedded	
	l_{max}	$h3$	$h2$	$h1$
	mm	mm	mm	mm
6 mm < t ≤ 15 mm	1,5t (max. 20)	2	2	1
15 mm < t ≤ 50 mm	1,5t (max. 60)	2,5	4,5	2
50 mm < t ≤ 100 mm	60	4	6	3
t > 100 mm	75	5	8	4

9.3 Cumulative length of indications

9.3.1 General

Point-like indications are not considered to determine total length.

The cumulative length of all individually acceptable indications above recording level is given as the sum of lengths of both single indications and linearly aligned indications of combined length within a given section of weld length.

9.3.2 For each single set-up

For wall thickness ≤50 mm, the sum of the lengths of the individually acceptable indications measured along the weld over a length of 12t shall be ≤:

— for acceptance level 1: 3,5t with a maximum of 150 mm;

— for acceptance level 2: 4,0t with a maximum of 200 mm;

— for acceptance level 3: 4,5t with a maximum of 225 mm.

For wall thickness >50 mm, the sum of the lengths of the individual indications measured along the weld over the total length of the weld shall be ≤:

— for acceptance level 1: 10 % of the weld length with a maximum of 500 mm;

— for acceptance level 2: 10 % of the weld length with a maximum of 600 mm;

— for acceptance level 3: 10 % of the weld length with a maximum of 700 mm.

9.3.3 Combining set-ups

In addition to 9.3.2, when using two set-ups according to testing level C in ISO 13588 and additional indications are found, the maximum total length for combined indications shall not exceed 1,5 times the maximum length stated in 9.3.2.

9.4 Grouping of indications

Point-like indications are not considered for grouping.

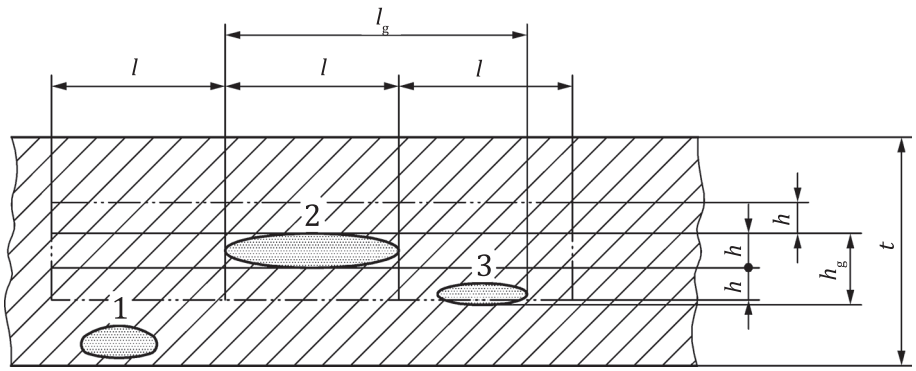
Grouping of indications is based on the size and the separation of individual indications. The length and the size of a group shall not be used for further grouping.

A group of indications shall be considered as a single indication if

— the distance between two individual indications along the weld is less than the length of the longer indication, and

— the distance between two individual indications in thickness direction of the weld is less than the height of the higher indication.

For acceptance or rejection, grouped indications are treated as single indications according to 9.2.



Key

1, 2, 3	simple representation of three indications
h	maximum height of indications 1, 2, 3
l	maximum length of indications 1, 2, 3
h_g	total height of grouped indications
l_g	total length of grouped indications

Figure 1 — Dimensions of grouped indications

For a grouped indication, the total height, h_g, is defined as the sum of the heights of the individual indications plus the distance between them (see Figure 1).

For a grouped indication, the total length, l_g, is defined as the sum of the lengths of the individual indications plus the distance between them (see Figure 1).

Indications 2 and 3 shown in Figure 1 shall be treated as a single indication because their separation in x-direction is smaller than l and their separation in z-direction is smaller than h.

Indication 1 is not included in the group because the separation in the thickness direction is larger than h.

9.5 Point-like indications

Point-like indications have no significant extent in any direction. They may originate from diffraction or reflection.

The maximum number (N) of point-like indications in any 150 mm of weld length shall not exceed the value given by Formula (1):

$$N = 1{,}2t \tag{1}$$

where

N is rounded to the higher integer;

t is the thickness given in millimetres.

10 Acceptance criteria based on length and amplitude

10.1 General

When indications are detected, length and maximum amplitude are determined in accordance with Clause 8. Indications shall be evaluated according to their acceptance level and the acceptance criteria listed in this clause.

For welds joining two different thicknesses, the thinner of those two is leading for the acceptance criteria.

10.2 Longitudinal indications

Table A.1 gives information on the techniques used for the evaluation of indications 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 Figure A.1 to Figure A.4.

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

Any indication with an amplitude below the acceptance level but with a length (above evaluation level) exceeding t, for the thickness range of 6 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 probe angle(s), and, if specified, the tandem technique.

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

10.3 Transverse indications

When detection of transverse indications is specified, the acceptance levels stated in 10.2 apply.

10.4 Grouping of indications

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

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

a) the distance, d_x, is less than twice the length of the longer indication (see Figure 2);

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

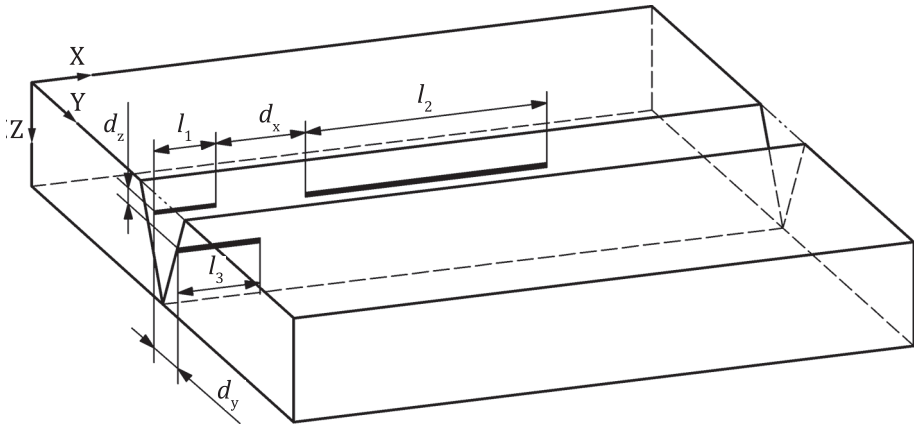
c) the distance, d_z, is less than half of the thickness but not more than 10 mm.

The combined length is as shown in Formula (2):

$$l_{12} = l_1 + l_2 + d_x \tag{2}$$

See Figure 3.

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

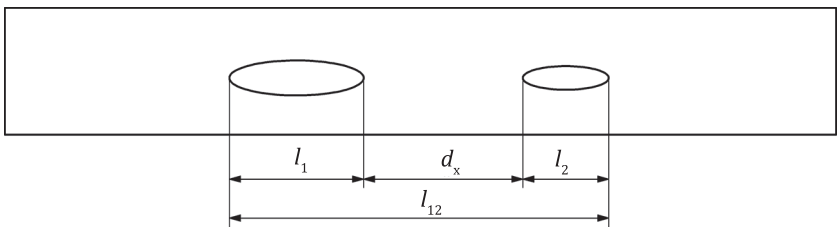


Key

d_x, d_y, d_z distances in the *x*-, *y*- and *z*-directions, respectively

l_n length of individual indications, where n = 1…3

Figure 2 — Simple representation of grouped indications in a sketch of a weld



Key

d_x distance in the *x*-direction

l_1, l_2 length of individual indications

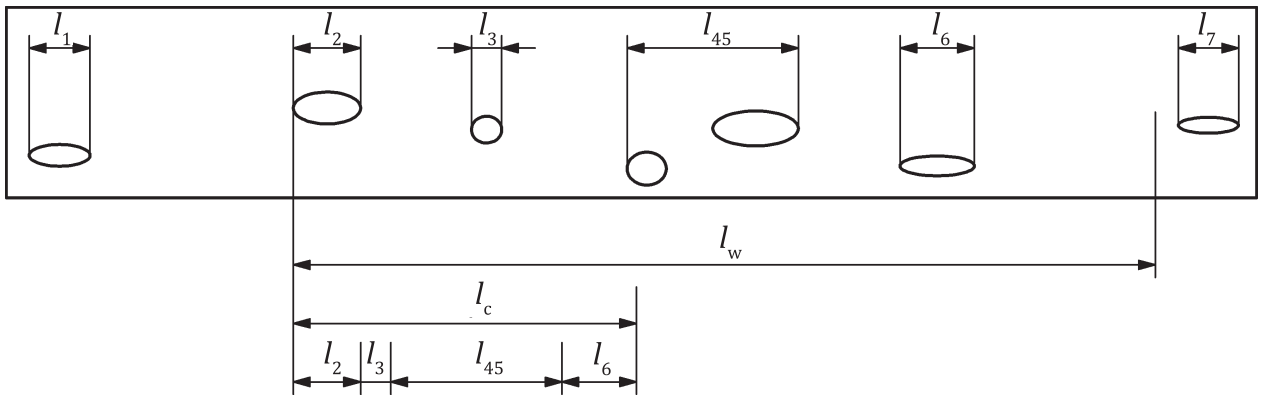
l_{12} combined length

Figure 3 — Length of a group of indications

10.5 Cumulative length of indications

10.5.1 General

The cumulative length of all individually acceptable indications above recording level is calculated within a specified section of weld length, l_w, as the sum of lengths of both single indications and linearly aligned indications (see Figure 4).



Key

l_c cumulative length

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

l_w weld length

l_n length of individual indications, where $n = 1 \ldots 7$

Figure 4 — Cumulative length of indications

10.5.2 For each single set-up

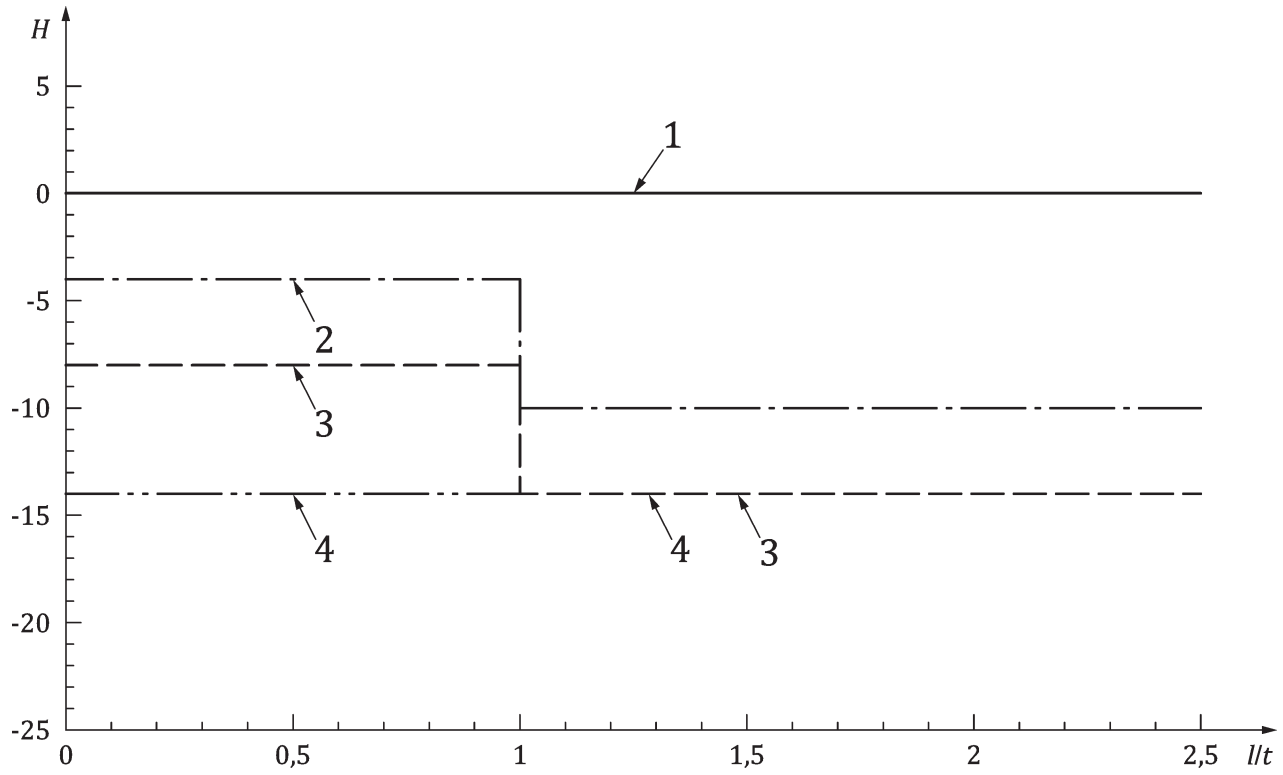
For any section of weld length, $l_w = 6t$, the maximum cumulative length, l_c, of all individually acceptable indications above the recording level shall not exceed 20 % of l_w for acceptance level 2 or 30 % of l_w for acceptance level 3.

10.5.3 Combined set-up

In addition to 10.5.2, when using two set-ups according to testing level C in ISO 13588 and additional indications are found, the maximum total length for combined indications shall not exceed 1,5 times the maximum length stated in 10.5.2.

Annex A
(normative)

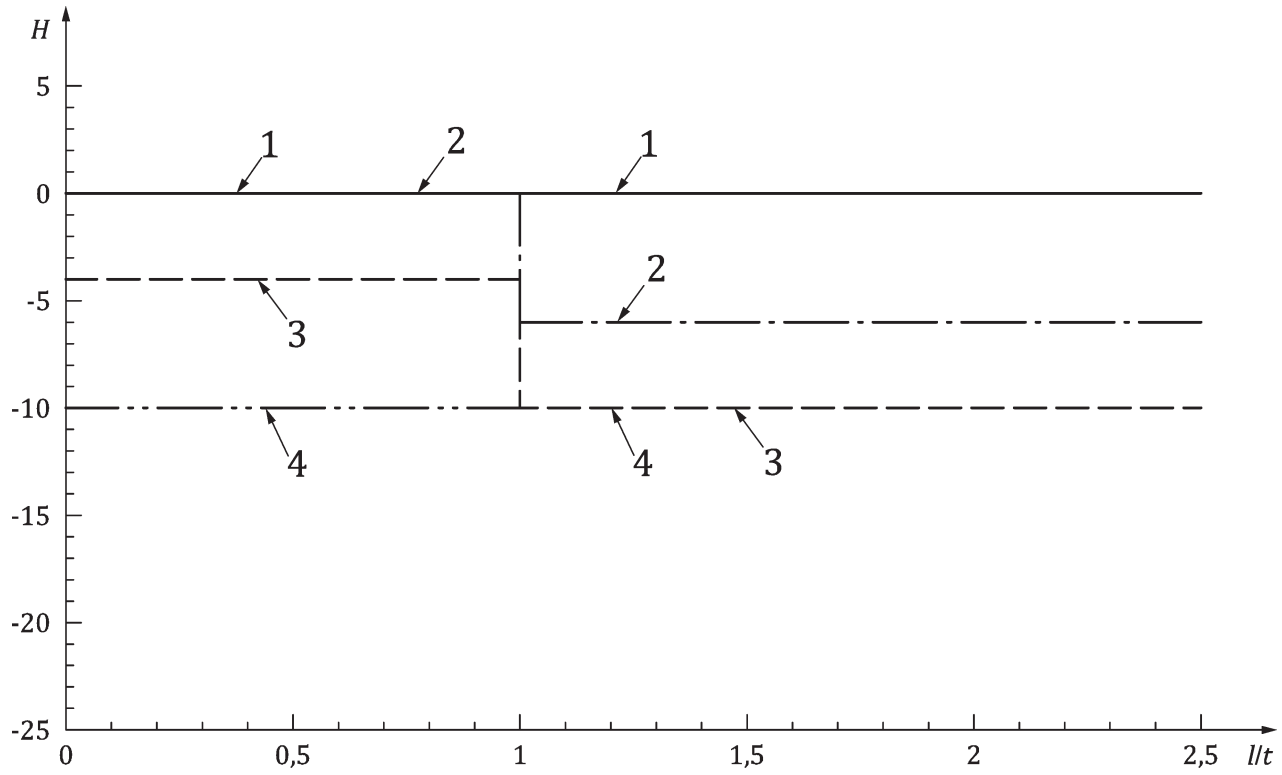
Levels



Key

1 reference level
2 acceptance level 2
3 recording level
4 evaluation level
H amplitude in dB
l indication length
t thickness

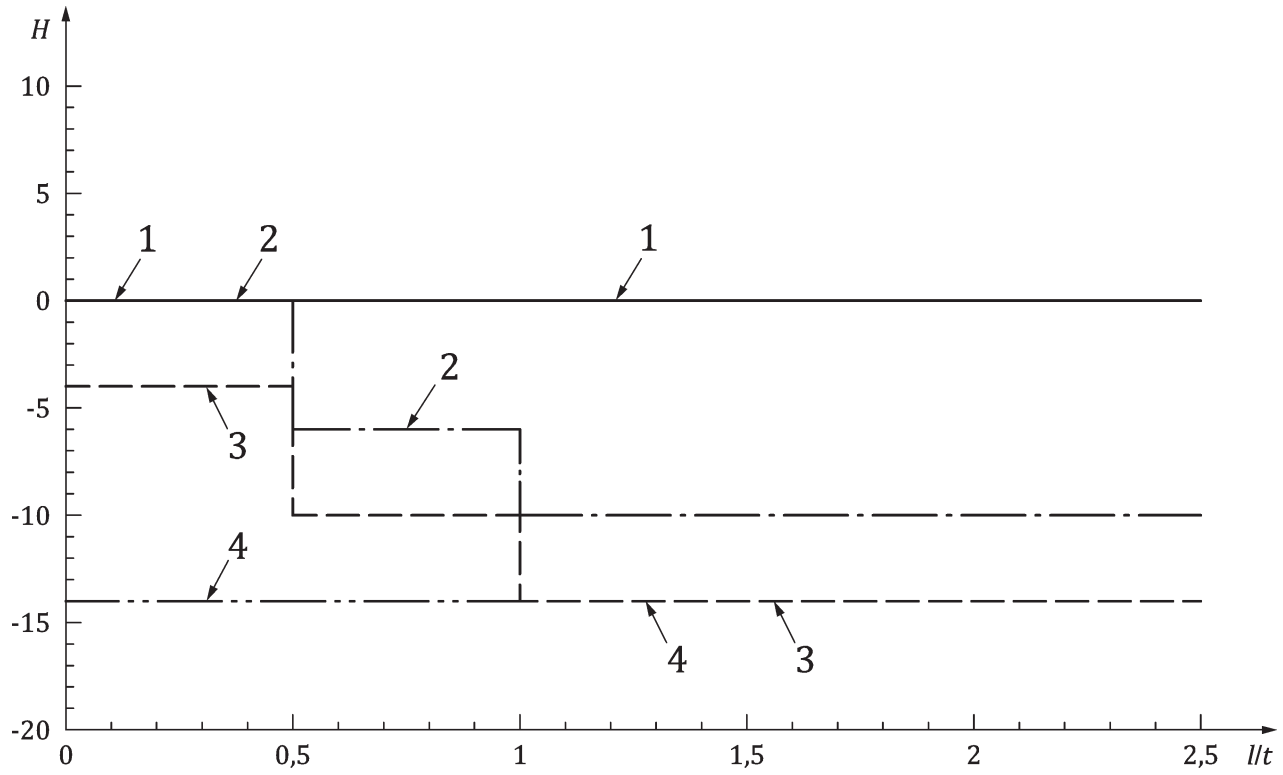
Figure A.1 — Levels for techniques 1 and 3 for thicknesses 6 mm to 15 mm — Acceptance level 2



Key

1 reference level
2 acceptance level 3
3 recording level
4 evaluation level
H amplitude in dB
l indication length
t thickness

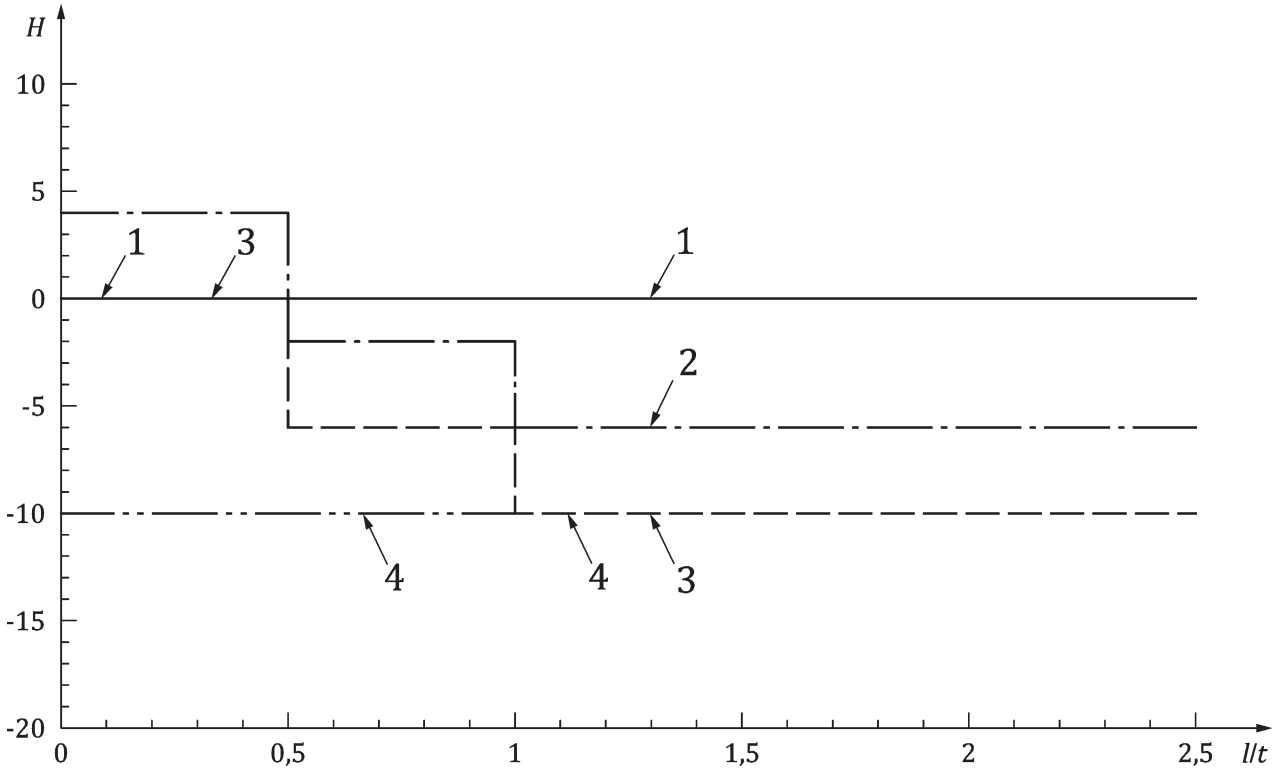
Figure A.2 — Levels for techniques 1 and 3 for thicknesses 6 mm to 15 mm — Acceptance level 3



Key

1 reference level
2 acceptance level 2
3 recording level
4 evaluation level
H amplitude in dB
l indication length
t thickness

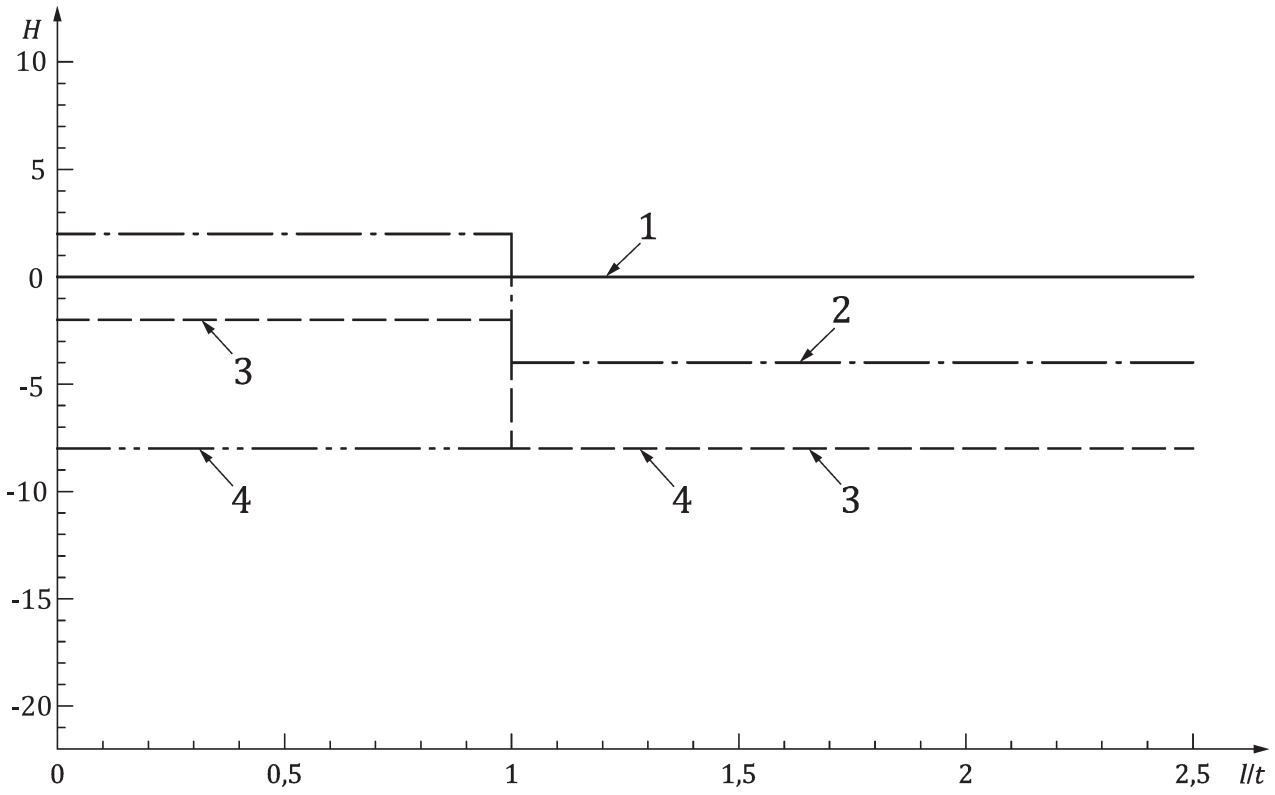
Figure A.3 — Levels for technique 1 for thicknesses 15 mm to 100 mm — Acceptance level 2



Key

1 reference level
2 acceptance level 3
3 recording level
4 evaluation level
H amplitude in dB
l indication length
t thickness

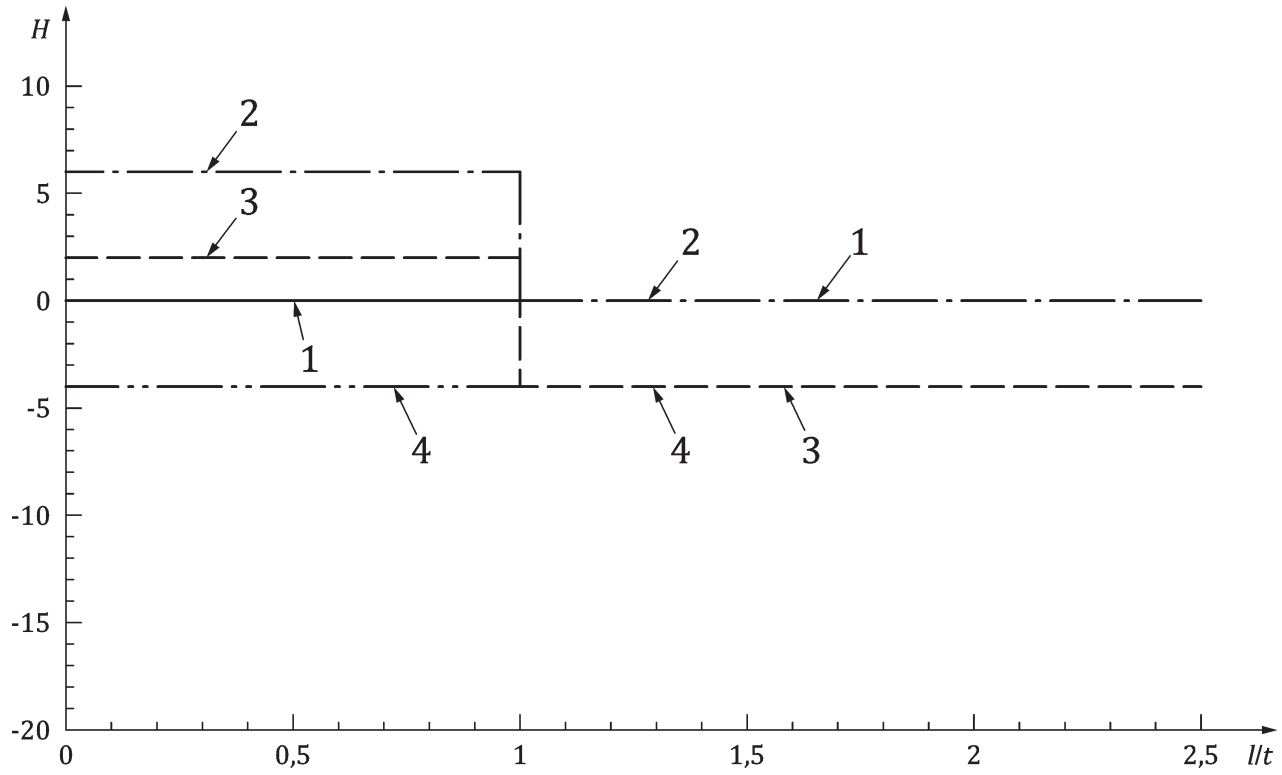
Figure A.4 — Levels for technique 1 for thicknesses 15 mm to 100 mm — Acceptance level 3



Key

1 reference level
2 acceptance level 2
3 recording level
4 evaluation level
H amplitude in dB
l indication length
t thickness

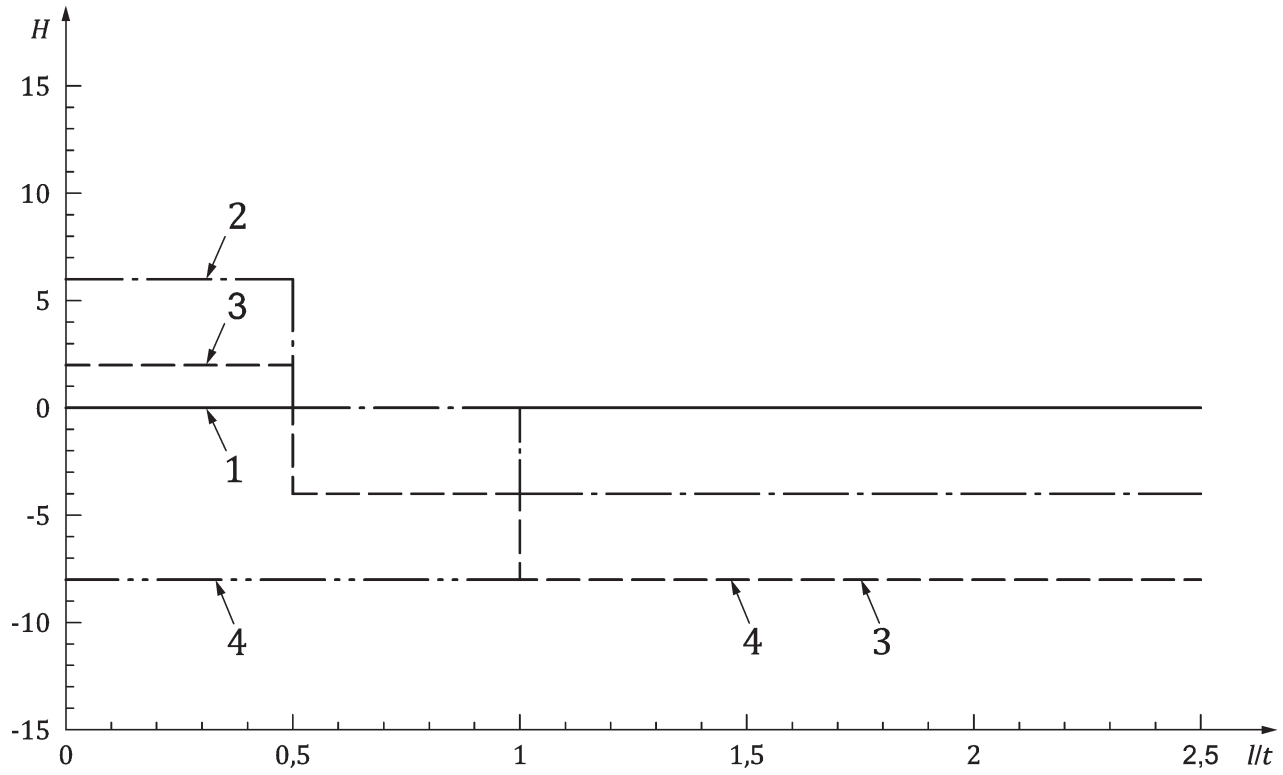
Figure A.5 — Levels for technique 2 for thicknesses 6 mm to 15 mm — Acceptance level 2



Key

1 reference level
2 acceptance level 3
3 recording level
4 evaluation level
H amplitude in dB
l indication length
t thickness

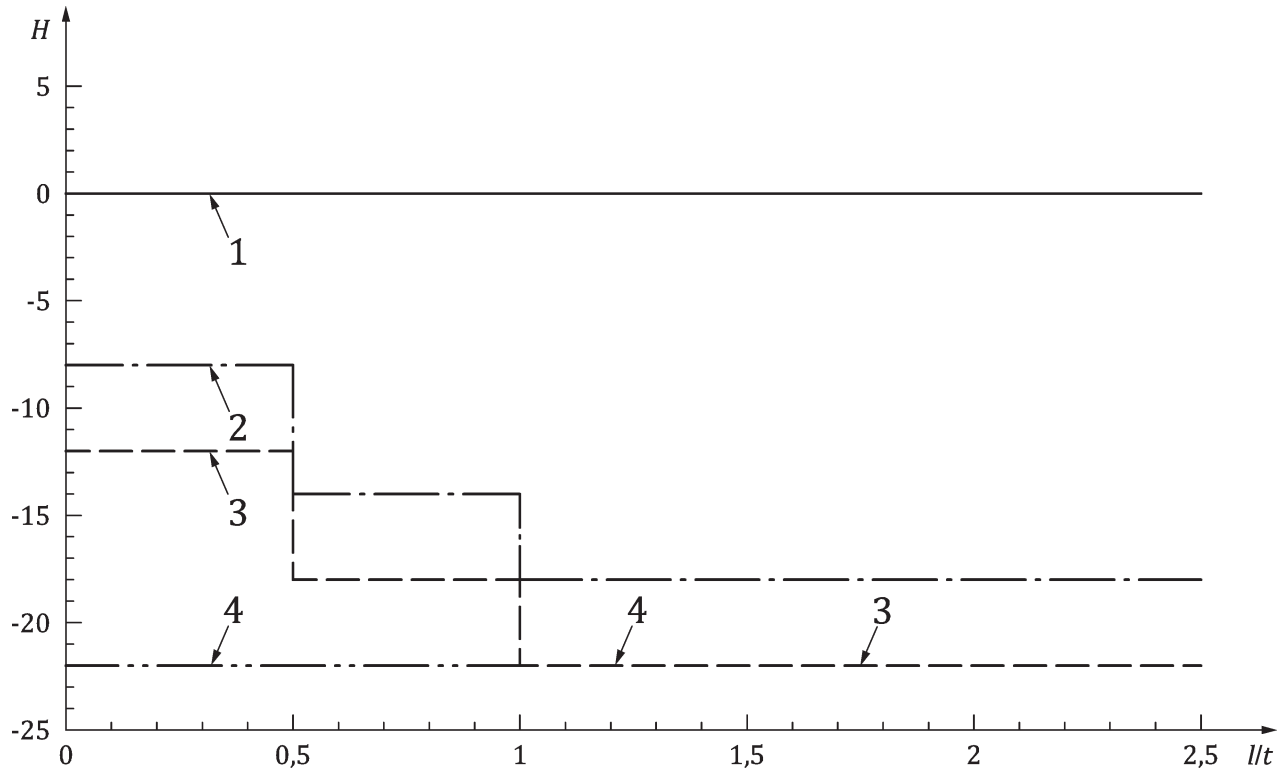
Figure A.6 — Levels for technique 2 for thicknesses 6 mm to 15 mm — Acceptance level 3



Key

1 reference level
2 acceptance level 2
3 recording level
4 evaluation level
H amplitude in dB
l indication length
t thickness

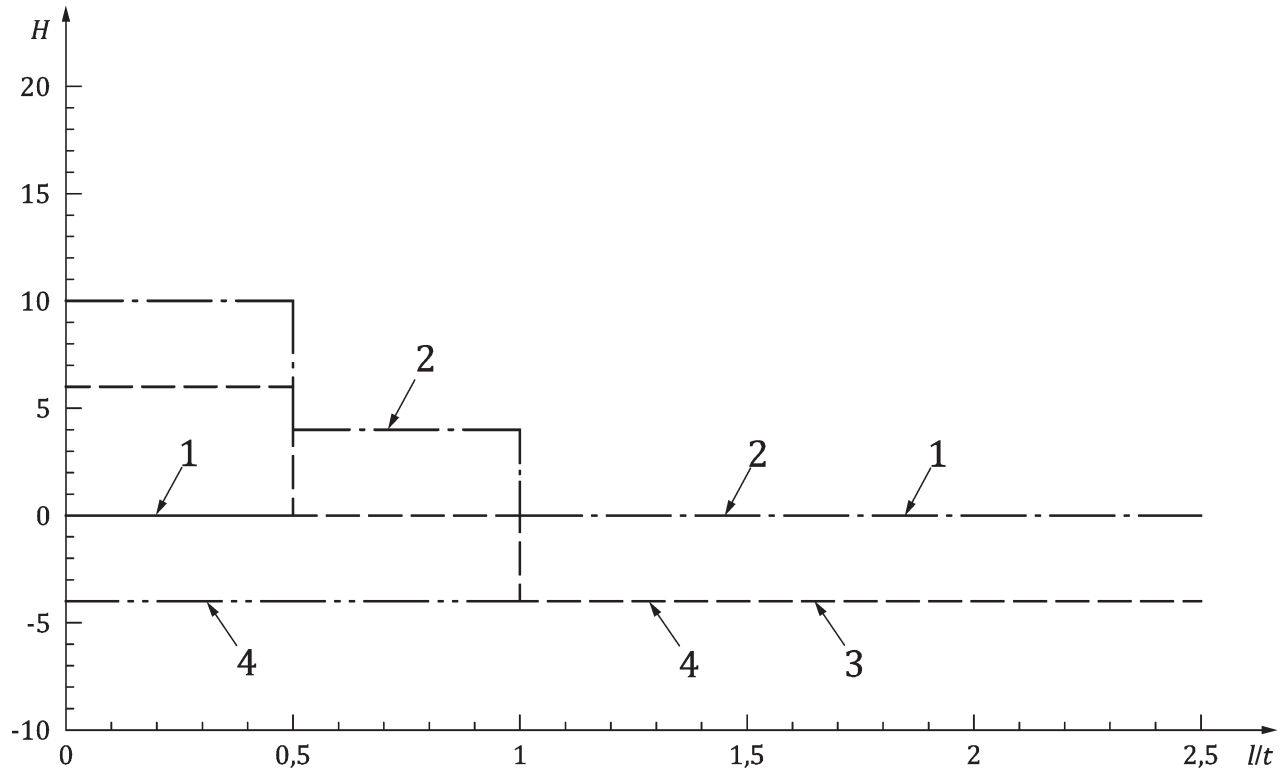
Figure A.7 — Levels for technique 2 for thicknesses 15 mm to 100 mm — Acceptance level 2



Key

1 reference level
2 acceptance level 2
3 recording level
4 evaluation level
H amplitude in dB
l indication length
t thickness

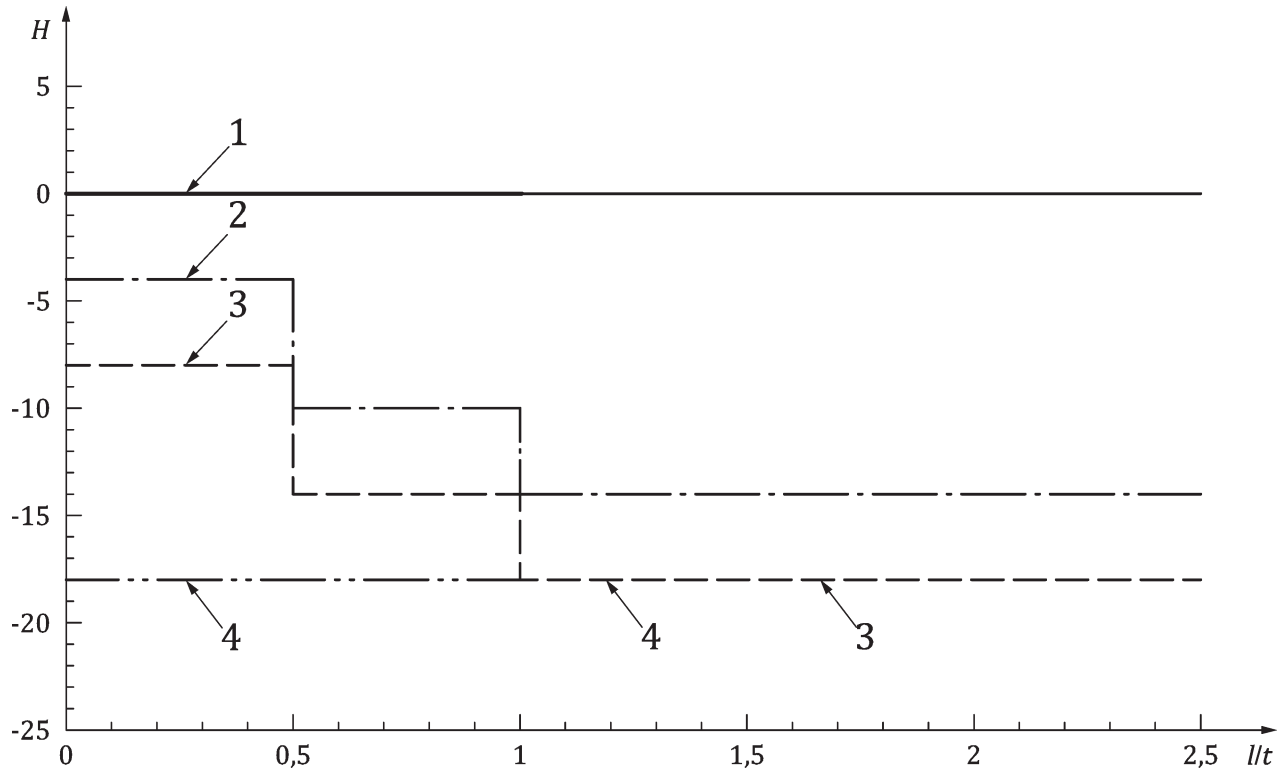
Figure A.8 — Levels for technique 4 for thicknesses 15 mm to 100 mm — Acceptance level 2



Key

1 reference level
2 acceptance level 3
3 recording level
4 evaluation level
H amplitude in dB
l indication length
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 in dB
l indication length
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 and 3 for techniques 1, 2, 3 and 4

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

Nominal probe frequency (MHz)	**Thickness of parent material, t**					
	6 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 and 3 for technique 2 using straight-beam scanning with longitudinal waves

Nominal probe frequency (MHz)	**Thickness of parent material,** t					
	6 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.						

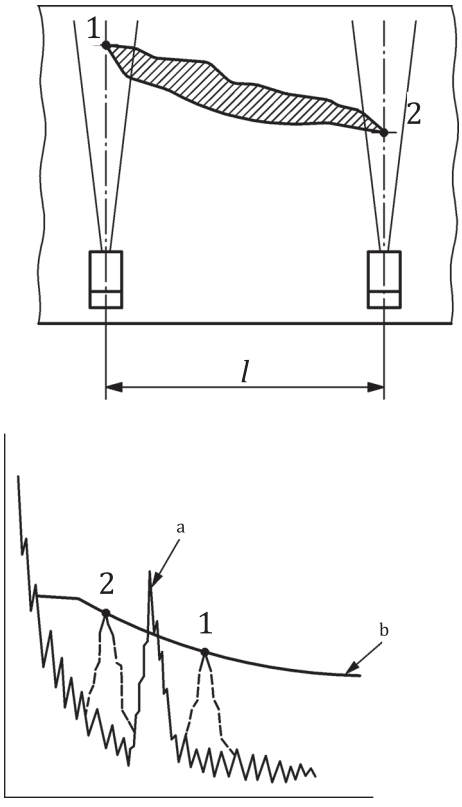
Annex B
(normative)

Fixed amplitude level technique

The technique measures the lateral dimensions of an indication over which the echo is equal to or greater than the evaluation level.

To make a measurement, the beam is scanned over the indications, and the probe position and beam path range, at which the echo has fallen to the evaluation level, are noted (positions 1 and 2 in 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 indication

1, 2 positions where 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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