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Non-destructive testing of welds — Phased array ultrasonic testing (UT-PA) for thin-walled steel components — Acceptance levels

Essais non destructifs des assemblages soudés — Technique ultrasons multi-éléments (UT-PA) pour les composants en acier à paroi mince — Niveaux d'acceptation

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Foreword

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The procedures used to develop this document and those intended for its further maintenance are described in the ISO/IEC Directives, Part 1. In particular, the different approval criteria needed for the different types of ISO documents should be noted. This document was drafted in accordance with the editorial rules of the ISO/IEC Directives, Part 2 (see www.iso.org/directives).

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

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Official interpretations of ISO/TC 44 documents, where they exist, are available from this page: https://committee.iso.org/sites/tc44/home/interpretation.html.

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Non-destructive testing of welds — Phased array ultrasonic testing (UT-PA) for thin-walled steel components — Acceptance levels

1 Scope

This document specifies acceptance levels for the phased array ultrasonic testing technique (UT-PA) of full-penetration welds in low-alloy and/or fine-grained steels in the wall thickness range from 3,2 mm to 8 mm which correspond to the quality levels of ISO 5817.

These acceptance levels are applicable to indications detected according to ISO 20601.

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 20601, *Non-destructive testing of welds — Ultrasonic testing — Use of automated phased array technology for thin-walled steel components*

ISO 23243, *Non-destructive testing — Ultrasonic testing with arrays — Vocabulary*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO 5577, ISO 20601 and ISO 23243 apply.

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

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

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

4 Symbols

l indication length

l_1, l_2 length of individual indications

l_c corrected length

l_{cu} cumulative length

l_w weld length

t thickness

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5 Sensitivity setting and levels

The setting of the sensitivity shall be performed on a 1,0 mm diameter side-drilled hole as specified in ISO 20601, this is also the reference level. This sensitivity setting shall be used for the subsequent testing.

Three levels as defined in ISO 5577 are to be used:

a) reference level, level defined by the echo amplitude of a defined reference reflector;

b) acceptance level, level defining limits for acceptance regarding echo height, position, classification (if applicable) and number of indications or size of discontinuities;

c) evaluation level, level above or below which indications shall be evaluated or examined further.

All levels are linked to the reference reflector and are specified in Clauses 8 and 9.

6 Acceptance levels

Three different acceptance levels are defined. The relation between these acceptance levels and the quality levels as mentioned in accordance with ISO 5817 are given in Table 1.

Table 1 — Related levels for phased array ultrasonic testing of small wall thickness

Quality level according to ISO 5817	Testing level according to ISO 20601	Acceptance level according to this document
B (stringent)	C	1
C (intermediate)	C	2
D (moderate)	C	3
Special application	D	By agreement

7 Evaluation of indications

Indications detected when applying ISO 20601 and having an amplitude above the evaluation level (reference level -12 dB) shall be evaluated according to the specified acceptance level by using the indication length and maximum amplitude. Unless specified otherwise, indications from the object geometry, such as weld reinforcement, are considered not relevant.

For two-sided testing, Clause 8 shall be applied. For single-sided testing, Clause 9 shall be applied.

The length of an indication shall be determined by measuring the length along the weld using the 6 dB drop method. Only for unfocused sound beams in lateral direction, a length correction may be applied according to Formula (1).

$$l_c = l_s \times \frac{D_0 - 2d}{D_0} \tag{1}$$

where

l_c is the corrected length;

l_s is the length measured along the surface;

D_0 is the outside diameter;

d is the depth of indication.

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When reporting of indications below the acceptance level is specified, the details for reporting shall also be specified.

8 Acceptance criteria for two-sided testing

8.1 General

When indications are detected, length and maximum amplitude shall be determined in accordance with Clause 7.

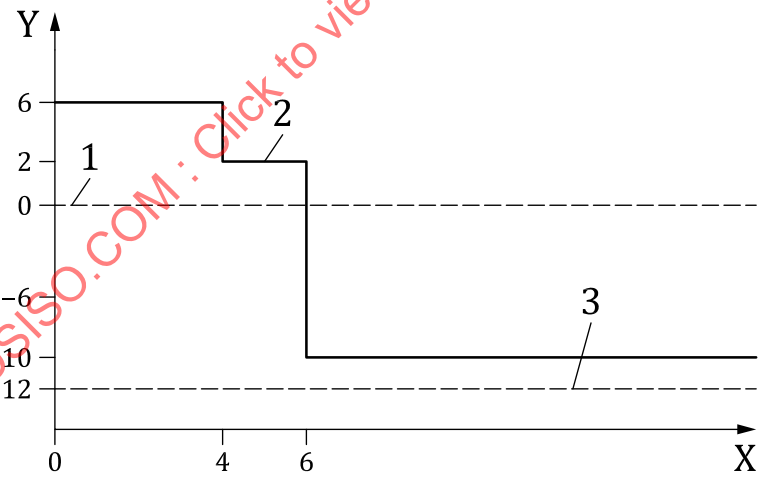
Indications shall be evaluated according to their acceptance level and the acceptance criteria listed in this clause.

All indications with an amplitude greater than the reference level -12 dB shall be evaluated for acceptance by using the criteria given in 8.2, 8.3 and 8.4.

8.2 Longitudinal indications

Table 2 — Criteria for acceptance level 1

Indication length, l mm	**Evaluation level** dB relative to the reference level	**Maximum allowable amplitude** dB relative to the reference level
$l \leq 4$	-12	+6
$4 < l \leq 6$	-12	+2
$l > 6$	-12	-10



Key

X indication length, in mm
Y amplitude, in dB
1 reference level
2 acceptance level 1
3 evaluation level

Figure 1 — Criteria for acceptance level 1

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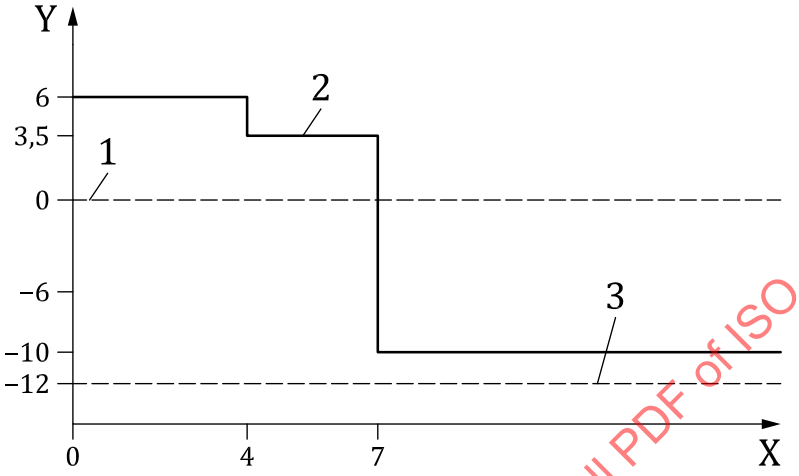
Table 3 — Criteria for acceptance level 2

Indication length, *l* mm	**Evaluation level** dB relative to the reference level	**Maximum allowable amplitude** dB relative to the reference level
$l \leq 4$	-12	+6
$4 < l \leq 7$	-12	+3,5
$l > 7$	-12	-10



Key

X indication length, in mm
Y amplitude, in dB
1 reference level
2 acceptance level 2
3 evaluation level

Figure 2 — Criteria for acceptance level 2

Table 4 — Criteria for acceptance level 3

Indication length, *l* mm	**Evaluation level** dB relative to the reference level	**Maximum allowable amplitude** dB relative to the reference level
$l \leq 4$	-12	+6
$4 < l \leq 8$	-12	+5
$l > 8$	-12	-10

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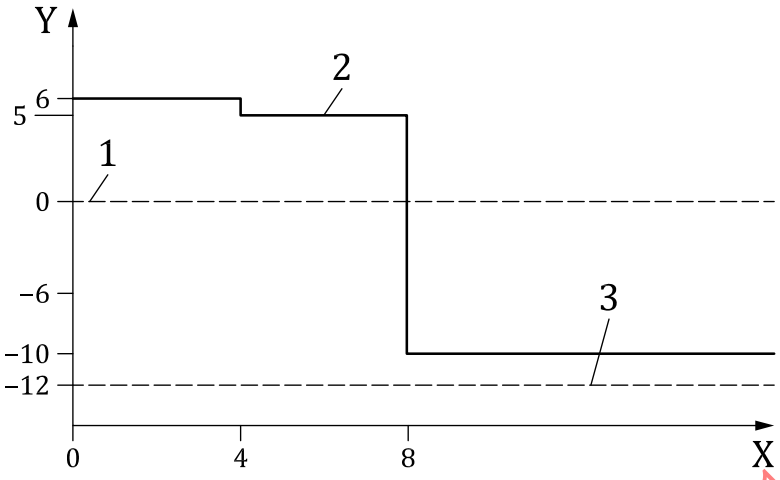


Key

X indication length, in mm
Y amplitude, in dB
1 reference level
2 acceptance level 3
3 evaluation level

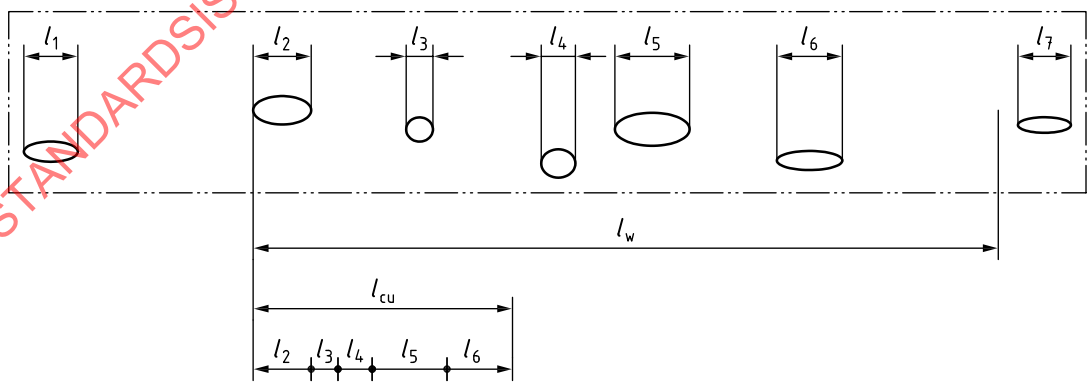
Figure 3 — Criteria for acceptance level 3

8.3 Transverse indications

When detection of transverse indications is specified, these indications are only acceptable if amplitude and length can be determined and meet the acceptance levels stated in 8.2.

8.4 Cumulative length of indications

The cumulative length of all individually acceptable indications above the evaluation level shall be 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_{cu} cumulative length, $l_{cu} = l_2 + l_3 + l_4 + l_5 + l_6$
l_w weld length
l_n length of individual indications, where $n = 1…7$

Figure 4 — Cumulative length of indications

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For wall thickness *t*, the sum of the lengths of the individual indications measured along the weld over a length of 12 *t* shall be:

a) ≤3,5 *t* for acceptance level 1;

b) ≤4,0 *t* for acceptance level 2;

c) ≤4,5 *t* for acceptance level 3.

9 Acceptance criteria for single-sided testing

9.1 General

When indications are detected, length and maximum amplitude shall be determined in accordance with Clause 7.

Indications shall be evaluated according to their acceptance level and the acceptance criteria listed in this clause.

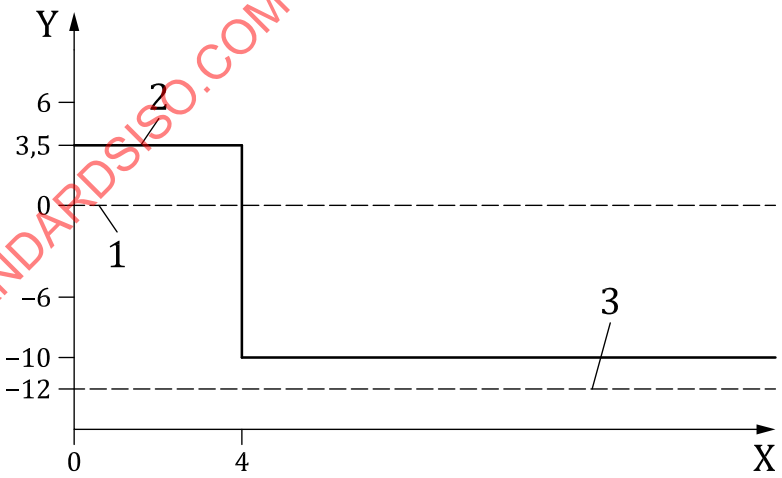
All indications with an amplitude greater than the reference level -12 dB shall be evaluated for acceptance by using the criteria given in 9.2, 9.3 and 9.4.

For single-sided testing no acceptance criteria are defined for acceptance level 1 (stringent).

9.2 Longitudinal indications

Table 5 — Criteria for acceptance level 2 for single-sided testing

Indication length, *l* mm	**Evaluation level** dB relative to the reference level	**Maximum allowable amplitude** dB relative to the reference level
l ≤ 4	-12	+3,5
l > 4	-12	-10



Key

X indication length, in mm

Y amplitude, in dB

1 reference level

2 acceptance level 2

3 evaluation level

Figure 5 — Criteria for acceptance level 2 for single-sided testing

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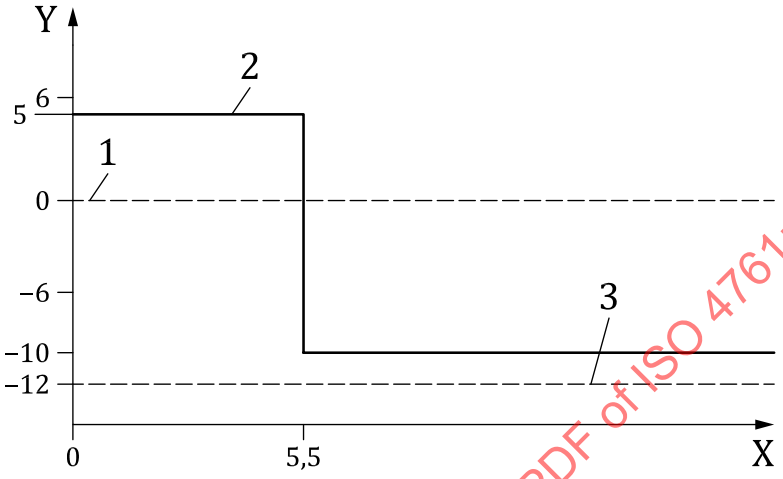
Table 6 — Criteria for acceptance level 3 for single-sided testing

Indication length *l* mm	Evaluation level dB relative to the reference level	Maximum allowable amplitude dB relative to the reference level
$l \leq 5{,}5$	-12	+5
$l > 5{,}5$	-12	-10



Key

Y amplitude, in dB
X indication length, in mm
1 reference level
2 acceptance level 3
3 evaluation level

Figure 6 — Criteria for acceptance level 3 for single-sided testing

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9.3 Transverse indications

When detection of transverse indications is specified, these indications are only acceptable if amplitude and length can be determined and meet the acceptance levels stated in 9.2.

9.4 Cumulative length of indications

The cumulative length of all individually acceptable indications above the evaluation level shall be 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).

For wall thickness *t*, the sum of the lengths of the individual indications measured along the weld over a length of 12 *t* shall be:

a) ≤4,0 *t* for acceptance level 2;

b) ≤4,5 *t* for acceptance level 3.

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