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## Non-destructive testing of welds — Ultrasonic testing of welded joints

*Contrôle non destructif des assemblages soudés — Contrôle par  
ultrasons des assemblages soudés*



Reference number  
ISO 17640:2005(E)

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Published in Switzerland

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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.

International Standards are drafted in accordance with the rules given in the ISO/IEC Directives, Part 2.

The main task of technical committees is to prepare International Standards. Draft International Standards adopted by the technical committees are circulated to the member bodies for voting. Publication as an International Standard requires approval by at least 75 % of the member bodies casting a vote.

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights.

ISO 17640 was prepared by Technical Committee ISO/TC 44, *Welding and allied processes*, Subcommittee SC 5, *Testing and inspection of welds*.

## Introduction

This International Standard describes general methods for ultrasonic testing, using standard criteria, of the most commonly used welded joints. It specifies requirements for equipment, surface preparation, inspection performance and reporting. The parameters specified, in particular those for the probes, are compatible with the requirements of EN 1712 and EN 1713, and are suitable for use with other acceptance criteria standards. The inspection techniques are suitable for the detection of weld imperfections specified in typical weld acceptance standards. The methods used for ultrasonic assessment of indications and acceptance criteria shall be specified, for example by reference to application standards.

Requests for official interpretations of any aspect of this International Standard 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](http://www.iso.org).

**NOTE** If the acceptance criteria require a more precise determination of the height and nature of the defect, e.g. when fitness-for-purpose criteria are applied, this may necessitate the use of techniques outside the scope of this International Standard.



# Non-destructive testing of welds — Ultrasonic testing of welded joints

## 1 Scope

This International Standard specifies methods for manual ultrasonic testing of fusion-welded joints in metallic materials, greater than or equal to 8 mm thick, which exhibit low ultrasonic attenuation (especially that due to scatter). This International Standard is primarily intended for full penetration welded joints where both the welded and parent materials are ferritic.

This International Standard specifies four testing levels (A, B, C and D) (see Clause 11), each corresponding to a different probability of detection of imperfections. Rules for the selection of testing levels A, B and C are given in Annex A.

This International Standard may be used for assessment of indications, for acceptance purposes, by either of the following methods:

- a) evaluation based primarily on length and echo amplitude of the signal indication;
- b) evaluation based on characterization and sizing of the indication by probe movement methods.

The techniques described in this International Standard may be specified, for example in an application standard, for use with:

- materials other than those stated,
- partial-penetration welds,
- automated equipment.

In each case, the technique should be verified as having adequate sensitivity.

**NOTE** Where material-dependent ultrasonic values are specified in this International Standard, they are based on steels having an ultrasonic sound velocity of  $(5\,920 \pm 50)$  m/s for longitudinal waves, and  $(3\,255 \pm 30)$  m/s for transverse waves. This is to be taken into account when testing materials with a different velocity.

## 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.

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

ISO 10375, *Non-destructive testing — Ultrasonic inspection — Characterization of search unit and sound field*

ISO 12715, *Ultrasonic non-destructive testing — Reference blocks and test procedures for the characterization of contact search unit beam profiles*

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

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*

### 3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO 17635 and ISO 5577 apply.

### 4 Symbols and abbreviated terms

The symbols and abbreviated terms used in this International Standard are given in Table 1.

**Table 1 — Symbols and abbreviated terms**

Symbol	Term	Unit
$t$	Thickness of parent material (at the thinnest point)	mm
$D_{\text{DSR}}$	Diameter of a disc-shaped reflector	mm
$D_{\text{SDH}}$	Diameter of a side-drilled hole	mm
$l$	Indication length	mm
$h$	Extension of an indication in the depth direction	mm
$x$	Position of an indication in the longitudinal direction	mm
$y$	Position of an indication in the transverse direction	mm
$z$	Position of an indication in the depth direction	mm
$l_z$	Projected length of the indication in the z-direction	mm
$l_x$	Projected length of the indication in the x-direction	mm
$l_y$	Projected length of the indication in the y-direction	mm
$p$	Full skip distance	mm

### 5 Information requirements

#### 5.1 Information required prior to testing

Prior to testing, the following items shall be specified (where applicable):

- method for setting the reference level;
- manufacturing and operation stage(s) at which testing is to be carried out;
- testing level;
- acceptance levels;
- method to be used for evaluation of indications;
- qualification of personnel;



- extent of testing for transverse indications;
- requirements for tandem testing;
- parent material testing prior to and/or after welding;
- requirements for written test procedures.

## 5.2 Additional pre-test information

Prior to testing, the operator shall have access to the following information:

- written test procedure, if required (see 5.3);
- type(s) of parent material and product form (i.e. cast, forged, rolled);
- manufacturing or operation stage, including any heat treatment, at which testing is to be carried out;
- time and extent of any post-weld heat treatment;
- joint preparation and dimensions;
- requirements for surface conditions;
- welding procedure or relevant information on the welding process;
- reporting requirements;
- acceptance levels;
- extent of testing, including requirements for transverse indications, if relevant;
- testing level;
- personnel qualification level;
- procedures for corrective actions when unacceptable indications are revealed.

NOTE Visual testing in accordance with ISO 17637 may be specified prior to any ultrasonic testing. In this case, the result shall also be made available.

## 5.3 Written test procedure

This International Standard will normally satisfy the need for a written test procedure. Where additional written procedures are required, they shall be specified prior to testing, for example by reference to an application standard.

# 6 Requirements for personnel and equipment

## 6.1 Personnel qualifications

Ultrasonic testing of welds and the evaluation of results for final acceptance shall be performed by qualified and capable personnel. It is recommended that personnel are qualified in accordance with ISO 9712 or an equivalent standard at an appropriate level in the relevant industry sector.

## 6.2 Equipment

All ultrasonic testing equipment shall comply with the requirements of ISO 10375 and ISO 12715.

## 6.3 Probe parameters

### 6.3.1 Test frequency

The test frequency shall be within the range 2 MHz to 5 MHz, and selected to comply with the specified acceptance levels.

For the initial test, when the evaluation is carried out according to acceptance levels based on length and amplitude, e.g. EN 1712, the test frequency shall be as low as possible within the above range. Higher test frequencies may be used to improve range resolution, if necessary, when using standards for acceptance levels based on characterization of imperfections, e.g. EN 1713.

NOTE Test frequencies of approximately 1 MHz may be used for testing of long sound paths where the material shows above-average attenuation.

### 6.3.2 Angles of incidence

When testing is carried out with transverse waves and techniques that require the ultrasonic beam to be reflected from an opposite surface, care shall be taken to ensure that the incident angle of the beam, with the opposite reflecting surface, is not less than 35° and preferably not greater than 70°. Where more than one probe angle is used, at least one of the angle probes used shall conform with this requirement. One of the probe angles used shall ensure that the weld fusion faces are tested at, or as near as possible to, normal incidence. When the use of two or more probe angles is specified, the difference between the nominal beam angles shall be 10° or greater.

Angles of incidence at the probe and opposite reflecting surface, when curved, may be determined by drawing a sectional view of the weld or in accordance with the methods given in EN 583-2. Where angles of incidence cannot be determined as specified by this International Standard, the test report shall contain a comprehensive description of the scans used and the extent of any incomplete coverage caused together with an explanation of the difficulties encountered.

### 6.3.3 Adaptation of probes to curved scanning surfaces

The gap between test surface and bottom of the probe shoe shall not be greater than 0,5 mm. For cylindrical or spherical surfaces, this requirement will normally be met when  $D \geq (a^2/2)$ , where  $D$  is the diameter, in millimetres, of the component and  $a$  is the dimension, in millimetres, of the probe shoe in the direction of testing.

If this requirement cannot be met, the probe shoe shall be adapted to the surface and the sensitivity and range shall be set accordingly.

### 6.3.4 Coupling media

The coupling media shall be in accordance with EN 583-1.

## 7 Test volume

The test volume (see Figure 1) is defined as the zone which includes the weld and parent material for at least 10 mm on each side of the weld, or the width of the heat-affected zone, whichever is greater.

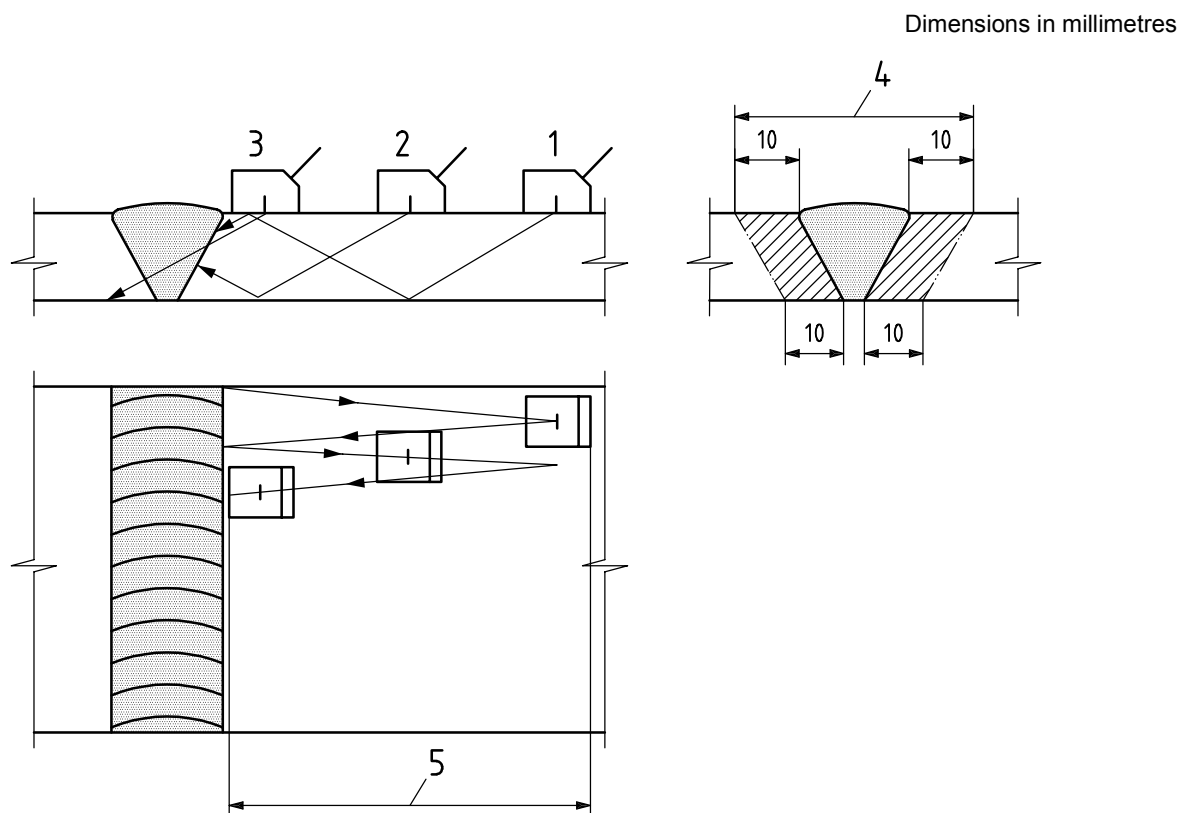
In all cases, scanning shall cover the whole test volume. If individual sections of this volume cannot be covered in at least one scanning direction, or if the angles of incidence with the opposite surface do not meet the requirements of 6.3.2, alternative or supplementary ultrasonic techniques or other non-destructive methods shall be specified. This may require removal of the weld reinforcement.

Alternative or supplementary techniques may require testing using dual-element angle beam probes, creeping wave probes and additional ultrasonic techniques. Other non-destructive methods may include liquid penetrant, magnetic particle and radiographic testing. In selecting alternative or supplementary methods, due consideration should be given to the type of weld and probable orientation of any imperfections to be detected.

## 8 Preparation of scanning surfaces

The width of the scanning surfaces should be sufficient to enable full coverage of the test volume by scanning from one surface (see Figure 1). The width of the scanning surfaces may be smaller if full coverage of the test volume can be achieved by scanning from both the upper and the lower surfaces of the joint.

The scanning surfaces shall be even and free from foreign matter likely to interfere with probe coupling (e.g. rust, loose scale, weld spatter, notches, grooves). The maximum permitted gap between the probe and the scanning surface from which the evaluation of indications is to be carried out shall be 0,5 mm. Any unevenness in the test surface which exceeds 0,5 mm shall be dressed in order to ensure these requirements.



### Key

- 1 angle probe position 1
- 2 angle probe position 2
- 3 angle probe position 3
- 4 width of test volume
- 5 scanning surface

**Figure 1 — Example of test volume to be covered when scanning for longitudinal indications**

Scanning surfaces and surfaces from which the sound beam is reflected may be assumed to be satisfactory if the surface roughness, *Ra*, is not greater than 6,3 µm for machined surfaces, or not greater than 12,5 µm for shot-blasted surfaces.

Local variations in surface contour, e.g. along the edge of the weld, which result in a gap beneath the probe of up to 1 mm, are only permitted if at least one additional probe angle is employed from the affected side at the weld. This additional scanning is necessary to compensate for the reduced weld coverage that occurs with such a gap.

9 Parent material testing

The parent material in the scanning zone area shall be tested with straight beam probes prior to or after welding, unless it can be demonstrated (e.g. by previous testing during the fabrication process) that testing of the weld using an angle probe will not be influenced by the presence of imperfections or high attenuation in the parent material.

If imperfections are found in the parent material, their influence on the subsequent weld testing using an angle probe shall be assessed and, if necessary, the weld testing techniques shall be adjusted. When ultrasonic testing of the weld is seriously affected by the presence of imperfections in the parent material, other test methods (e.g. radiography) shall be considered.

10 Range and sensitivity setting

10.1 General

The range and sensitivity shall be set prior to each test in accordance with this International Standard and EN 583-2. Checks to confirm these settings shall be performed at least every 4 h and on completion of testing. Checks shall also be carried out whenever a system parameter is changed or changes in the equivalent settings are suspected.

If deviations in range or sensitivity are found during these checks, corrections shall be made in accordance with Table 2.

Table 2 — Sensitivity and range corrections

Sensitivity		
1	Deviations ≤ 4 dB	The setting shall be corrected before testing is continued.
2	Reduction of the sensitivity > 4 dB	The setting shall be corrected and all tests carried out with the equipment over the previous period shall be repeated.
3	Increase in sensitivity > 4 dB	The setting shall be corrected and all recorded indications shall be re-examined.
Range		
1	Deviations ≤ 2 % of the range	The setting shall be corrected before testing is continued.
2	Deviations > 2 % of the range	The setting shall be corrected and all tests carried out with the equipment over the previous period shall be repeated.

10.2 Reference level

The reference level for sizing of imperfections shall be set using one of the following methods:

- Method 1: The reference level is set using a distance-amplitude-corrected curve (DAC curve) for a side-drilled hole of diameter *D*<sub>SDH</sub> = 3 mm.

- Method 2: The reference levels using the distance-gain-size (DGS) system based on a disc-shaped reflector (DSR) for transverse waves are set in accordance with Table 3 and for longitudinal waves in accordance with Table 4.
- Method 3: The reference level is set using a DAC curve for a 1 mm deep rectangular notch.

For tandem testing, the reference level shall be set using  $D_{\text{DSR}} = 6$  mm (for all thicknesses).

### 10.3 Evaluation levels

All indications equal to or exceeding the following shall be evaluated:

- Methods 1 and 3: Reference level  $-10$  dB (33 % of the DAC).
- Method 2: Reference level  $-4$  dB, in accordance with Tables 3 and 4, respectively.
- Tandem test:  $D_{\text{DSR}} = 6$  mm (for all thicknesses).

**Table 3 — Reference levels for angle beam scanning with transverse waves for method 2 (DGS)**

Nominal probe frequency MHz	Thickness of parent material $t$ mm		
	$8 \leq t < 15$	$15 \leq t < 40$	$40 \leq t \leq 100$
1,5 to 2,5	—	$D_{\text{DSR}} = 2$ mm	$D_{\text{DSR}} = 3$ mm
3 to 5	$D_{\text{DSR}} = 1$ mm	$D_{\text{DSR}} = 1,5$ mm	—

**Table 4 — Reference levels for longitudinal waves for method 2 (DGS)**

Nominal probe frequency MHz	Thickness of parent material $t$ mm		
	$8 \leq t < 15$	$15 \leq t < 40$	$40 \leq t \leq 100$
1,5 to 2,5	—	$D_{\text{DSR}} = 2$ mm	$D_{\text{DSR}} = 3$ mm
3 to 5	$D_{\text{DSR}} = 2$ mm	$D_{\text{DSR}} = 2$ mm	$D_{\text{DSR}} = 3$ mm

### 10.4 Transfer correction

When separate blocks are used for establishing reference levels, a measurement shall be made of the transfer differences, between test object and block at a representative number of locations. Suitable techniques are described in EN 583-2.

If the differences are less than 2 dB, correction is not required.

If the differences are greater than 2 dB but smaller than 12 dB, they shall be compensated for.

If transfer losses exceed 12 dB, the reason(s) shall be considered and further preparation of the scanning surfaces shall be carried out, if applicable.

When there are no apparent reasons for high transfer correction values, the attenuation shall be measured at various locations on the test object and, where it is found to vary significantly, corrective actions considered.

## 10.5 Signal-to-noise ratio

During testing of the weld, the noise level, excluding spurious surface indications, shall remain at least 12 dB below the evaluation level. This requirement may be relaxed but shall be specified prior to testing, for example by reference to an application standard.

## 11 Testing levels

Quality requirements for welded joints are mainly associated with the material, welding process and service conditions. To accommodate all of these requirements, this International Standard specifies four testing levels (A, B, C and D).

From testing level A to testing level C, an increased probability of detection will be achieved by an increased test coverage, e.g. number of scans, surface dressing. Testing level D may be used for special applications, using a written procedure which shall take into account the general requirements of this International Standard.

In general, the testing levels are related to quality levels (e.g. ISO 5817). The appropriate testing level may be specified by standards for testing of welds (e.g. ISO 17635), application/product standards or other documents.

When ISO 17635 is specified, the testing levels given in Table 5 are recommended.

**Table 5 — Recommended testing levels**

Testing level	Quality level in ISO 5817
A	C
B	B
C	No recommended level — shall be specified
D	Special application

Specific requirements for testing levels A to C for various types of joints are given in Annex A. It should be noted that the joint types shown are ideal examples only and, where actual weld conditions or accessibility do not conform exactly with those shown, the testing technique shall be modified to satisfy the general requirements of this International Standard and the specific testing level required. For these cases, a written test procedure shall be prepared.

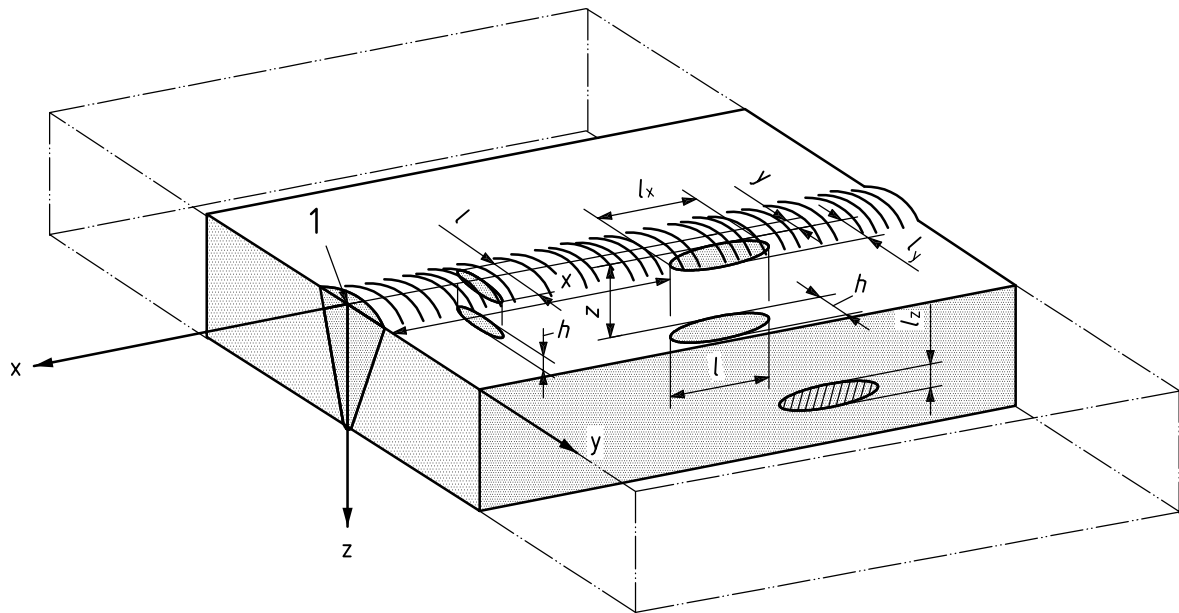
## 12 Testing technique

### 12.1 General

Ultrasonic testing shall be performed in accordance with EN 583-1 and 12.2 to 12.4.

### 12.2 Manual scan path

During angle probe scanning (as illustrated in Figure 1), a slight swivelling movement up to an angle of 10° on either side of the nominal beam direction may be applied to the probe.

**Key**

1 origin

**Figure 2 — Coordinate system for defining the location of indications****12.3 Testing for imperfections perpendicular to the test surface**

Subsurface planar imperfections oriented perpendicular to the test surface are difficult to detect with single angle probe techniques. For such imperfections, alternative or supplementary testing techniques should be considered, particularly for welds in thicker materials. Use of these testing techniques shall be specified for example by reference to an application standard.

**12.4 Location of indications**

The location of all indications shall be defined by reference to a coordinate system, e.g. as shown in Figure 2. A point on the test surface shall be selected as the origin for these measurements.

When ultrasonic testing is carried out from more than one surface, reference points shall be established on each surface. In this case, care shall be taken to establish a positional relationship between all reference points used so that the absolute location of all indications can be established from any nominated reference point.

In the case of circumferential welds, this may require the establishment of the inner and outer reference points prior to assembly for welding.

**12.5 Evaluation of indications****12.5.1 General**

All indications above the evaluation level shall be assessed in accordance with 12.5.2 to 12.5.4.

**12.5.2 Maximum echo amplitude**

The echo amplitude shall be maximized by probe movement and recorded in relation to the reference level (see 10.2).

### 12.5.3 Indication length

The length of the indication, in either the longitudinal or transverse direction, shall, where possible, be determined using the technique specified in the acceptance level standard or the 6 dB drop tip location technique, unless otherwise specified.

### 12.5.4 Indication height

Indication height measurement shall only be carried out if specified, for example by reference to an application standard. If the height of the indications is to be measured, the following method shall be used.

Where possible, for imperfections which generate more than one distinct peak in the received signal when scanned in the through-thickness direction, the height,  $h$ , shall be measured by a probe movement technique. It is recommended that, when an indication has a measured height of 3 mm or above, the indication height is recorded. However, other higher threshold heights for recording may be specified.

### 12.5.5 Characterization of imperfections

Imperfections shall only be characterized if specified, for example by reference to an application standard, or to meet the requirements of the specified acceptance levels.

Indications shall be considered to be either longitudinal or transverse, depending on the direction of their major dimension with respect to the weld axis,  $x$ , in accordance with Figure 2.

## 13 Test report

### 13.1 General

The test report shall include a reference to this International Standard and give, as a minimum, the information listed in 13.2 to 13.5.

### 13.2 General data

a) Identification of the object under test:

- material and product form,
- dimensions,
- location of weld/welded joint tested,
- sketch showing geometrical configuration (if necessary),
- reference to the welding procedure, specification and heat treatment,
- state of manufacture,
- surface conditions,
- temperature of the object, if outside the range 0 °C to 40 °C;

b) any additional requirements;

c) place and date of testing;

d) identification of testing organizations and identification and certification of operator;

e) identification of testing authority.



### 13.3 Information relating to equipment

- a) Make and type of ultrasonic instrument, with identification number, if required;
- b) make, type, nominal frequency and actual angle of incidence of probes used, with identification number, if required;
- c) identification of reference blocks used, with a sketch, if necessary;
- d) coupling medium.

### 13.4 Information relating to testing technique

- a) Testing level(s) and reference to written procedure when used;
- b) extent of testing;
- c) location of the scanning areas;
- d) reference points and details of the coordinate system used, as specified in 12.4;
- e) identification of probe positions as specified in Annex A, either in writing or by use of a sketch;
- f) time base range;
- g) method and values used for sensitivity setting (gain setting for reference levels and values used for transfer corrections);
- h) reference levels;
- i) result of the parent material testing;
- j) standard used for acceptance levels;
- k) deviations from this International Standard or additional requirements.

### 13.5 Results of testing

Tabular summary (or sketches) providing the following information for recorded indications:

- a) coordinates of the indication, as specified in 12.4, with details of associated probes and corresponding probe positions;
- b) maximum echo amplitude as specified in 12.5.2 and information, if required, on the type and size of indication;
- c) lengths of indications as specified in 12.5.3;
- d) results of the evaluation according to specified acceptance levels.

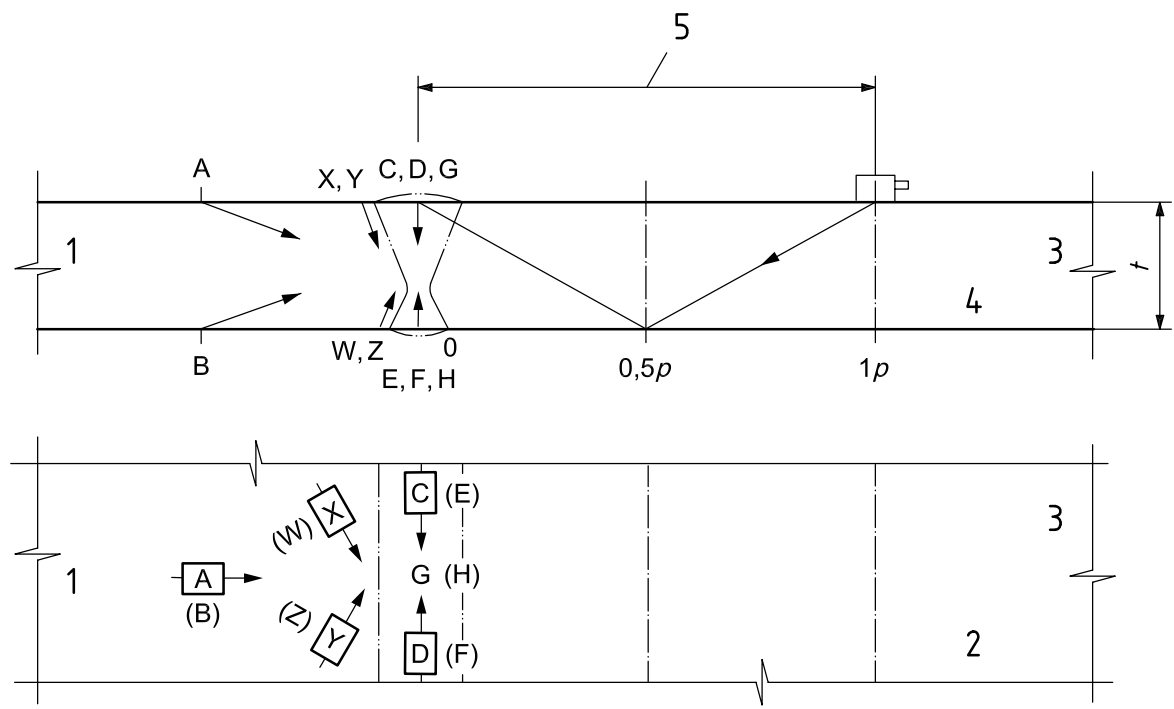
Annex A  
(normative)

Testing levels for various types of welded joint

The testing levels for the joints given in Figures A.1 to A.7 are given in Tables A.1 to A.7, respectively.

Key to tables

- L-scan scan for longitudinal indications using angle beam probes
- N-scan scan using straight beam probe
- T-scan scan for transverse indications using angle beam probes
- $p$  full skip distance
- SZW scanning zone width



Key

- 1 side 1
- 2 top view
- 3 side 2
- 4 side view
- 5 scanning zone width (SZW) related to skip distance,  $p$

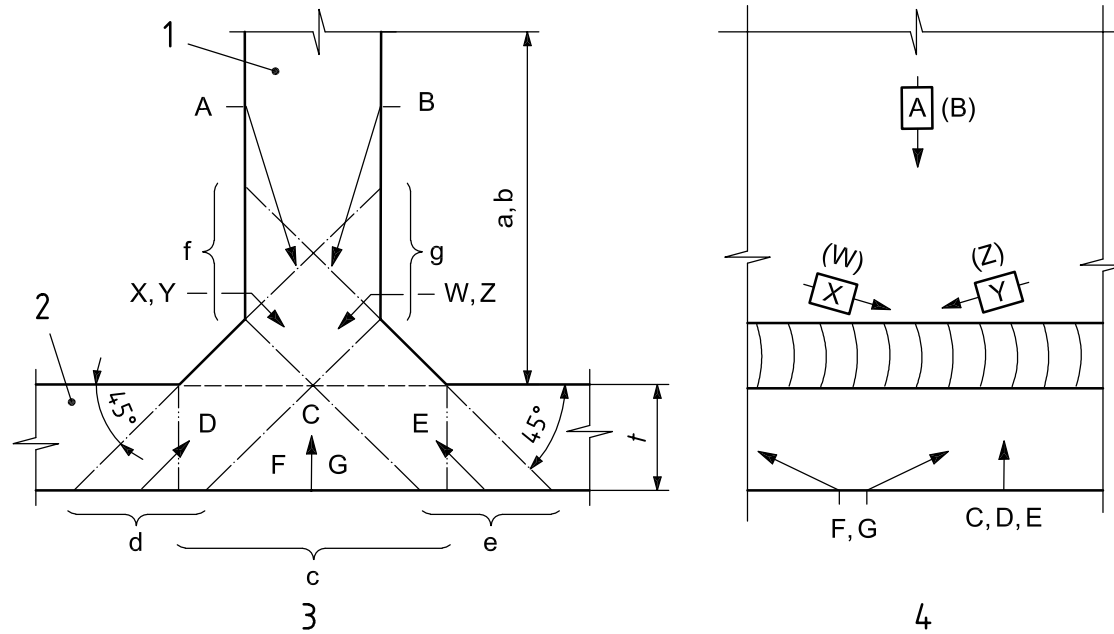
A, B, C, D, E, F, G, H, W, X, Y, Z: probe positions

Whenever possible, all scans shall be carried out from both sides (1 and 2).

Figure A.1 — Butt joints in plates and pipes

Table A.1 — Butt joints in plates and pipes

Testing level	Thickness of parent material <i>t</i> mm	Longitudinal indications					Transverse indications				
		Required probe			Total number of scans	NOTE	Required probe		Total number of scans	NOTE	
		angles (number)	positions	SZWs			positions	angles (number)			positions
A	$8 \leq t < 15$	1	A or B	1,25 <i>p</i>	—	2	a	1	(X and Y) or (W and Z)	4	c
	$15 \leq t \leq 40$	1	A or B	1,25 <i>p</i>	—	2	a	1	(X and Y) or (W and Z)	4	c
	$8 \leq t < 15$	1	A or B	1,25 <i>p</i>	—	2	e	1	(X and Y) or (W and Z)	4	c
B	$15 \leq t < 40$	2 <sup>f</sup>	A or B	1,25 <i>p</i>	—	4	b, e	1	(X and Y) or (W and Z)	4	c
	$40 \leq t < 60$	2	A or B	1,25 <i>p</i>	—	4	b	2	(X and Y) or (W and Z)	8	c
	$60 \leq t \leq 100$	2	A or B	1,25 <i>p</i>	—	4	b	2	(C and D) or (E and F)	4	c, d
	$8 \leq t < 15$	1	A or B	1,25 <i>p</i>	G or H	3	d	1	(C and D) or (E and F)	2	d
C	$15 \leq t \leq 40$	2	A or B	1,25 <i>p</i>	G or H	5	b, d	2	(C and D) or (E and F)	4	d
	$t > 40$	2	A and B	1,25 <i>p</i>	G and H	10	b, d	2	(C and D) or (E and F)	4	d
a	May be limited to one scan from one side.										
b	Additional testing by tandem technique shall only be carried out if specified.										
c	Only if specified.										
d	The surface of the weld cap shall comply with Clause 8. This may require dressing of the weld cap. However, for single-sided circumferential pipe welds, the outside cap only need be dressed.										
e	If only accessible from one side, two angles shall be used.										
f	In the range $15 \text{ mm} < t \leq 25 \text{ mm}$ , one angle is sufficient provided the frequency is below 3 MHz.										



**Key**

- 1 component 1
- 2 component 2
- 3 end view
- 4 side view

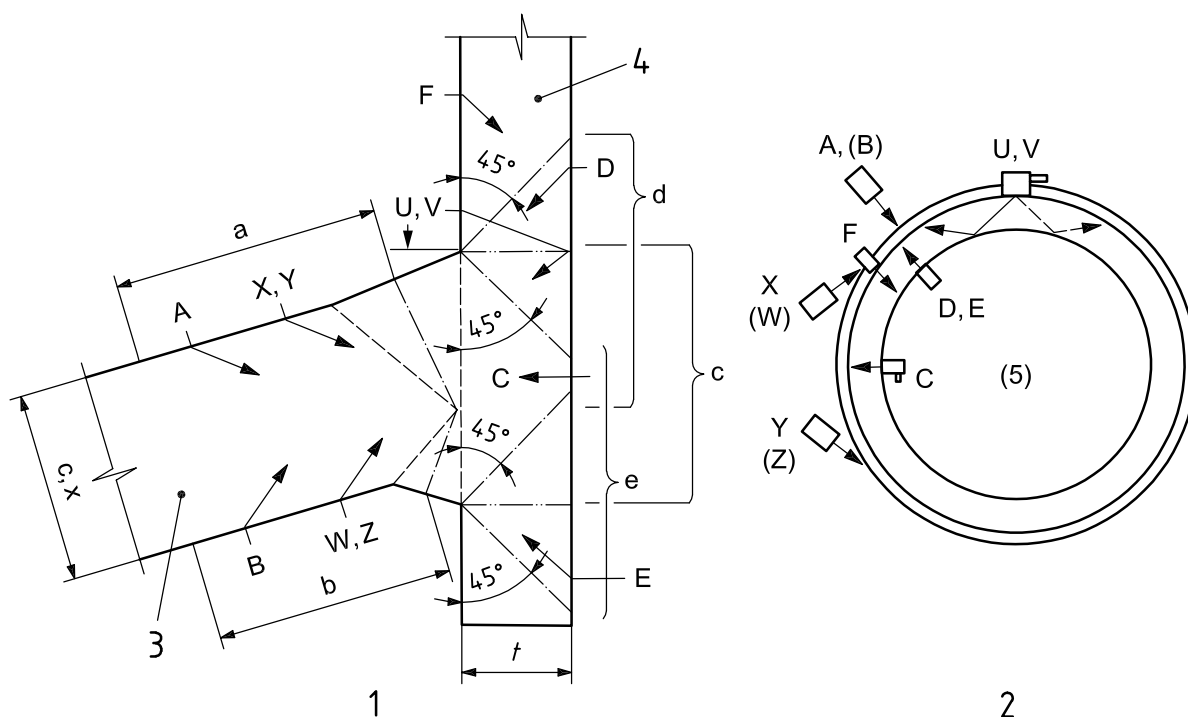
A, B, C, D, E, F, G, W, X, Y, Z: probe positions

Scanning zone widths are indicated by the letters a, b, c, d, e, f and g.

**Figure A.2 — Structural T-joints**

Table A.2 — Structural T-joints

Testing level	Thickness of parent material $t$ mm	Longitudinal indications						Transverse indications				NOTE
		Required probe				Total number of scans	Required probe			Total No. of scans		
		angles (number)	positions	SZWs	positions <sup>c</sup>		SZWs	angles (number)	positions		SZWs	
L-scans		N-scans		T-scans								
A	$8 \leq t < 15$	1	A or B	1,25 $p$	or C	—	—	—	—	a		
	$15 \leq t \leq 40$	1	A or B	1,25 $p$	C	c	—	—	—	a		
	$8 \leq t < 15$	1	A or B	1,25 $p$	C	—	—	F and G	c	2	b	
B	$15 \leq t < 40$	1	A and B	1,25 $p$	C	c	—	(F and G) or (X and Y) or (W and Z)	c f + g	2	b	
	$40 \leq t \leq 100$	2	A and B	0,75 $p$	C	c	—	(F and G) or (X and Y) or (W and Z)	c f + g	2	b	
	$8 \leq t < 15$	1	A and B	1,25 $p$	C	c	—	F and G	c	4	b	
C	$15 \leq t < 40$	2 1	(A and B) and (D et E)	1,25 $p$ d + e	C	c	—	(F and G) and (X and Y) or (W and Z)	c f + g	4	b	
	$40 \leq t \leq 100$	2 1	(A and B) and (D and E)	0,75 $p$ d + e	C	c	—	(F and G) and (X and Y) or (W and Z)	c f + g	8	b	
	$t > 100$	3 1	(A and B) and (D and E)	0,75 $p$ d + e	C	c	—	(F and G) and (X and Y) or (W and Z)	c f + g	8	b	
	<sup>a</sup> Not applicable.											
	<sup>b</sup> Only if specified.											
<sup>c</sup> To be substituted by tandem technique at position A or B if C is not possible.												



**Key**

- 1 cross-section
- 2 top view
- 3 component 1: cylindrical shell/flat plate
- 4 component 2: nozzle

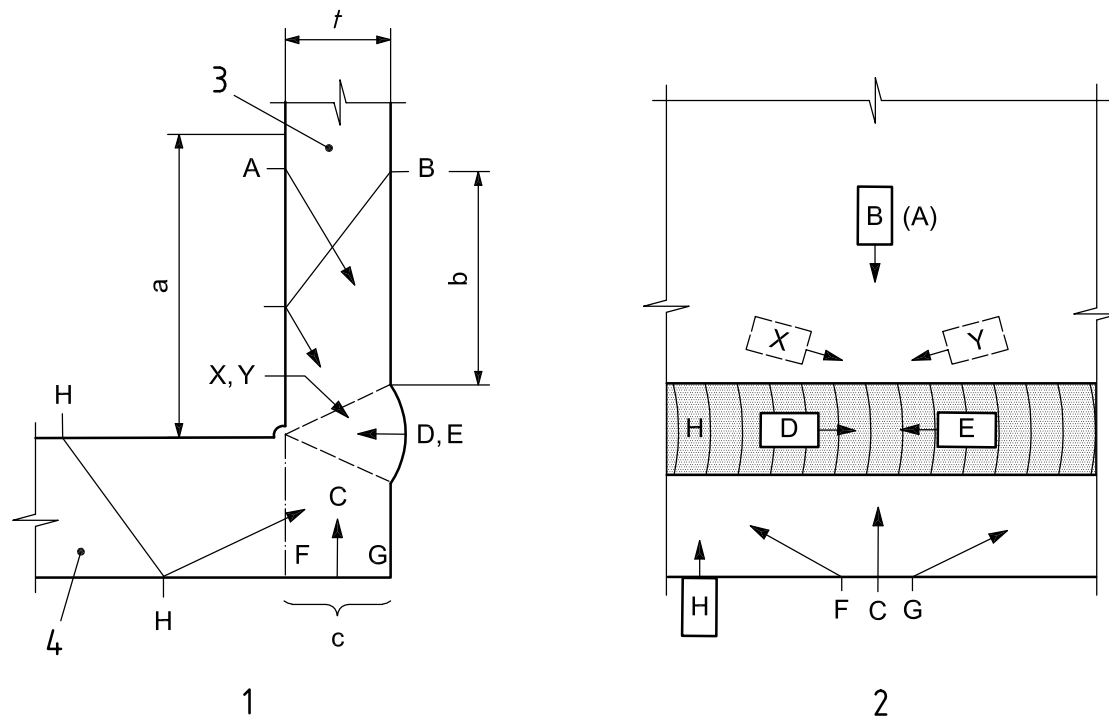
A, B, C, D, E, F, U, V, W, X, Y, Z: probe positions

Scanning zone widths are indicated by the letters a, b, c, d, e and x.

**Figure A.3 — Set-through nozzle joints**

Table A.3 — Set-through nozzle joints

Testing level	Thickness of parent material $t$ mm	Longitudinal indications						Transverse indications				
		Required probe						Total number of scans	Required probe		Total number of scans	NOTE
		angles (number)	positions	SZWs	positions	SZWs	angles (number)		positions			
										L-scans		
A	$8 \leq t < 15$	1	A	1,25 $p$	or C	c	1	—	—	—	a	
	$15 \leq t \leq 40$	1	A or F or D	1,25 $p_d$	C	c	2	—	—	—	a	
B	$8 \leq t < 15$	1	A or D	1,25 $p_d$	C	c	2	1	(U and V) or (X and Y) or (W and Z)	2	b	
	$15 \leq t < 40$	1	A or (D and E)	1,25 $p_{d+e}$	C	c	2 or 3	1	(U and V) or (X and Y) or (W and Z)	2	b	
	$40 \leq t < 60$	1	(A or B) and (D and E)	1,25 $p_{d+e}$	C	c	4	1	(X and Y) and (W and Z)	4	b	
	$60 \leq t \leq 100$	2 1	(A and B) and (D and E)	0,5 $p_{d+e}$	C	c	7	2	(X and Y) and (W and Z)	8	b	
C	$8 \leq t < 15$	1	(A or B) and (D or E)	1,25 $p_{d+e}$	C	c	3	1	(U and V) or (X and Y) and (W and Z)	2 or 4	b	
	$15 \leq t \leq 40$	2	(A or B) and (D or E)	0,5 $p_{d+e}$	C	c	5	2	(X and Y) and (W and Z)	8	b	
	$t > 40$	2	(A and B) and (D and E)	0,5 $p_{d+e}$	C	c	9	2	(X and Y) and (W and Z)	8	b	
a Not applicable.												
b Only if specified.												



**Key**

- 1 cross-section
- 2 end view
- 3 component 1
- 4 component 2

A, B, C, D, E, F, G, H, X, Y: probe positions

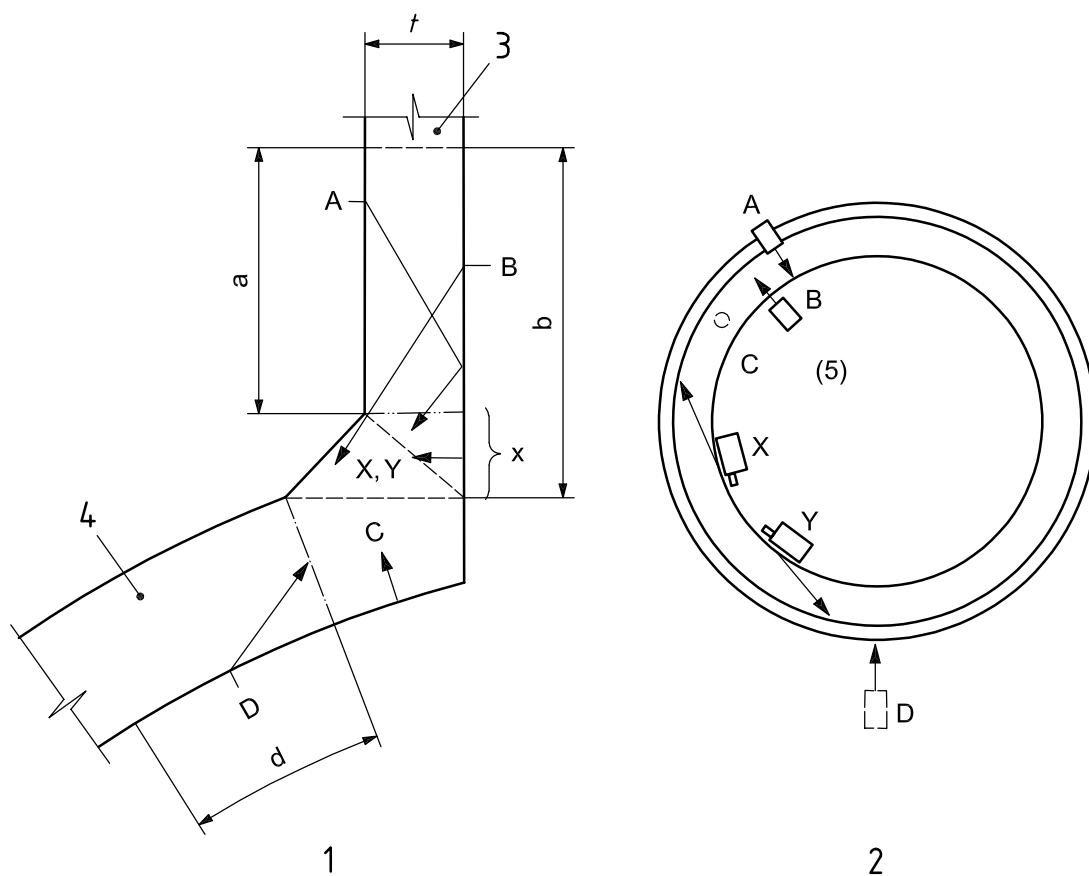
Scanning zone widths are indicated by the letters a, b and c.

**Figure A.4 — Structural L-joints**



Table A.4 — Structural L-joints

Testing level	Thickness of parent material <i>t</i> mm	Longitudinal indications						Transverse indications				
		Required probe						Total number of scans	Required probe		Total number of scans	NOTE
		angles (number)	positions	SZWs	positions	SZWs	angles (number)		positions			
										T-scans		
A	$8 \leq t < 15$	1	A or B or H	1,25 <i>p</i>	or C	c	1	—	—	—	a	
	$15 \leq t \leq 40$	1	A or B or H	1,25 <i>p</i>	C	c	2	—	—	—	a	
	$8 \leq t < 15$	1	A or B or H	1,25 <i>p</i>	or C	c	1	1	(F and G) or (X and Y)	2	b	
	$15 \leq t < 40$	2	A or B or H	1,25 <i>p</i>	C	c	3	2	(F and G) or (X and Y)	4	b	
B	$40 \leq t \leq 100$	2	(H or A) and B	0,75 <i>p</i>	C	c	5	2	D and E	4	b, c	
	$8 \leq t < 15$	1	(H or A) and B	1,25 <i>p</i>	C	c	3	1	D and E	2	b, c	
	$15 \leq t < 40$	2	(H or A) and B	1,25 <i>p</i>	C	c	5	1	D and E	2	b, c	
	$40 \leq t \leq 100$	3	(H or A) and B	0,75 <i>p</i>	C	c	7	2	D and E	4	b, c	
C	$t > 100$	3	(H or A) and B	0,5 <i>p</i>	C	c	7	2	D and E	4	b, c	
	a Not applicable.											
	b Only if specified.											
	c The surface of the weld cap shall comply with Clause 8. This may require dressing of the weld cap.											



# Key

- 1 cross-section
- 2 top view
- 3 component 1: nozzle
- 4 component 2: shell
- 5 normal probe

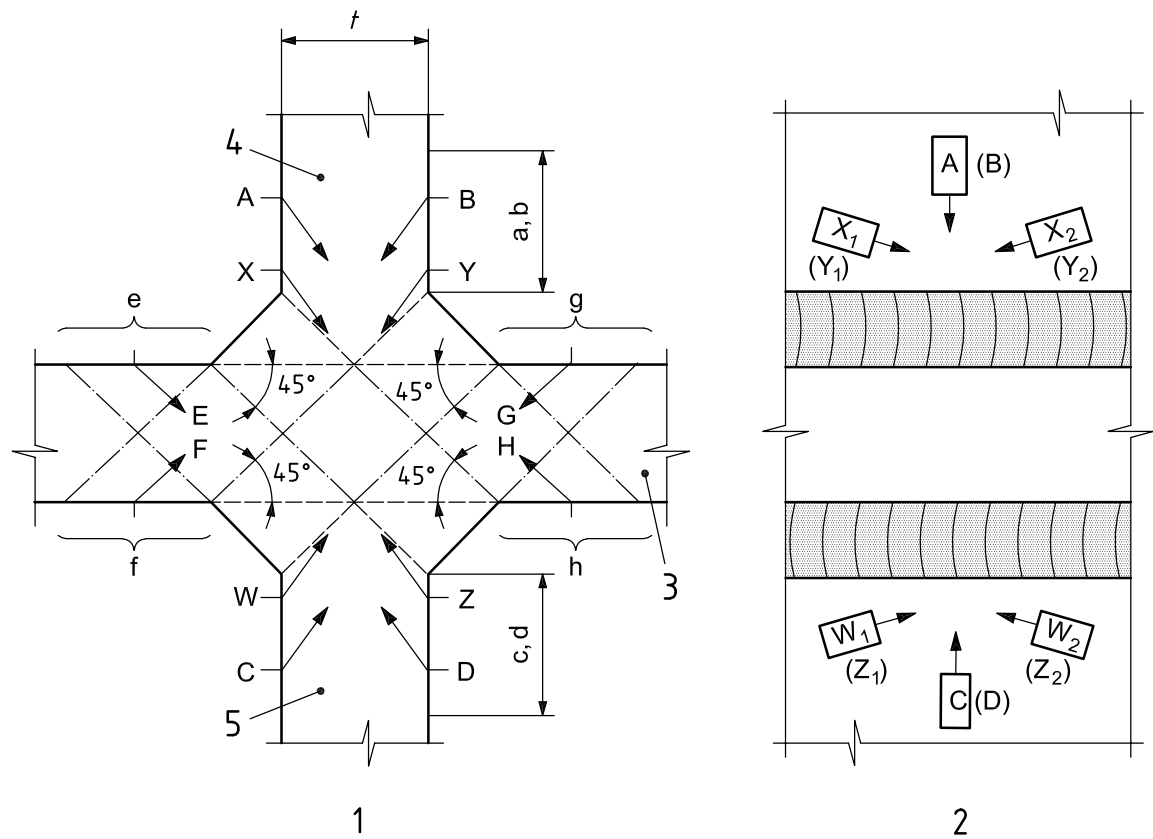
A, B, C, D, X, Y: probe positions

Scanning zone widths are indicated by the letters a, b, c, d and x.

**Figure A.5 — Set-on nozzle joints**

Table A.5 — Set-on nozzle joints

Testing level	Thickness of parent material $t$ mm	Longitudinal indications						Transverse indications			NOTE	
		Required probe						Total number of scans	Required probe positions			Total number of scans
		angles (number)	positions	SZWs	positions	SZWs	Total number of scans					
A	$8 \leq t < 15$	1	A or B	1,25 <sub>p</sub> 0,50 <sub>p</sub>	—	—	1	—	—	—	a	
	$15 \leq t \leq 40$	1	A or B	1,25 <sub>p</sub> 0,50 <sub>p</sub>	C	c	2	—	—	—	a	
B	$8 \leq t < 15$	2	A or B	1,25 <sub>p</sub> 0,50 <sub>p</sub>	—	—	2	1	X and Y	2	b, c	
	$15 \leq t < 40$	2	A or B	1,25 <sub>p</sub> 0,50 <sub>p</sub>	C	c	3	1	X and Y	2	b, c	
	$40 \leq t < 60$	2	A and (B or D)	1,25 <sub>p</sub> 0,50 <sub>p</sub>	C	c	5	2	X and Y	4	b, c	
	$60 \leq t \leq 100$	2	A and (B or D)	1,25 <sub>p</sub> 0,50 <sub>p</sub>	C	c	5	2	X and Y	4	b, c	
C	$8 \leq t < 15$	3	A or B	1,25 <sub>p</sub> 0,50 <sub>p</sub>	C	c	4	1	X and Y	2	b, c	
	$15 \leq t < 40$	3	A or B	1,25 <sub>p</sub> 0,50 <sub>p</sub>	C	c	4	1	X and Y	2	b, c	
	$40 \leq t < 60$	3	A and B	1,25 <sub>p</sub> 0,50 <sub>p</sub>	C	c	7	2	X and Y	4	b, c	
	$60 \leq t \leq 100$	3	A and B	1,25 <sub>p</sub> 0,50 <sub>p</sub>	C	c	7	2	X and Y	4	b, c	
a Not applicable.												
b Only if specified.												
c The surface of the weld cap shall comply with Clause 8. This may require dressing of the weld cap.												



Key

- 1 cross-section
- 2 side view
- 3 component 1
- 4 component 2
- 5 component 3

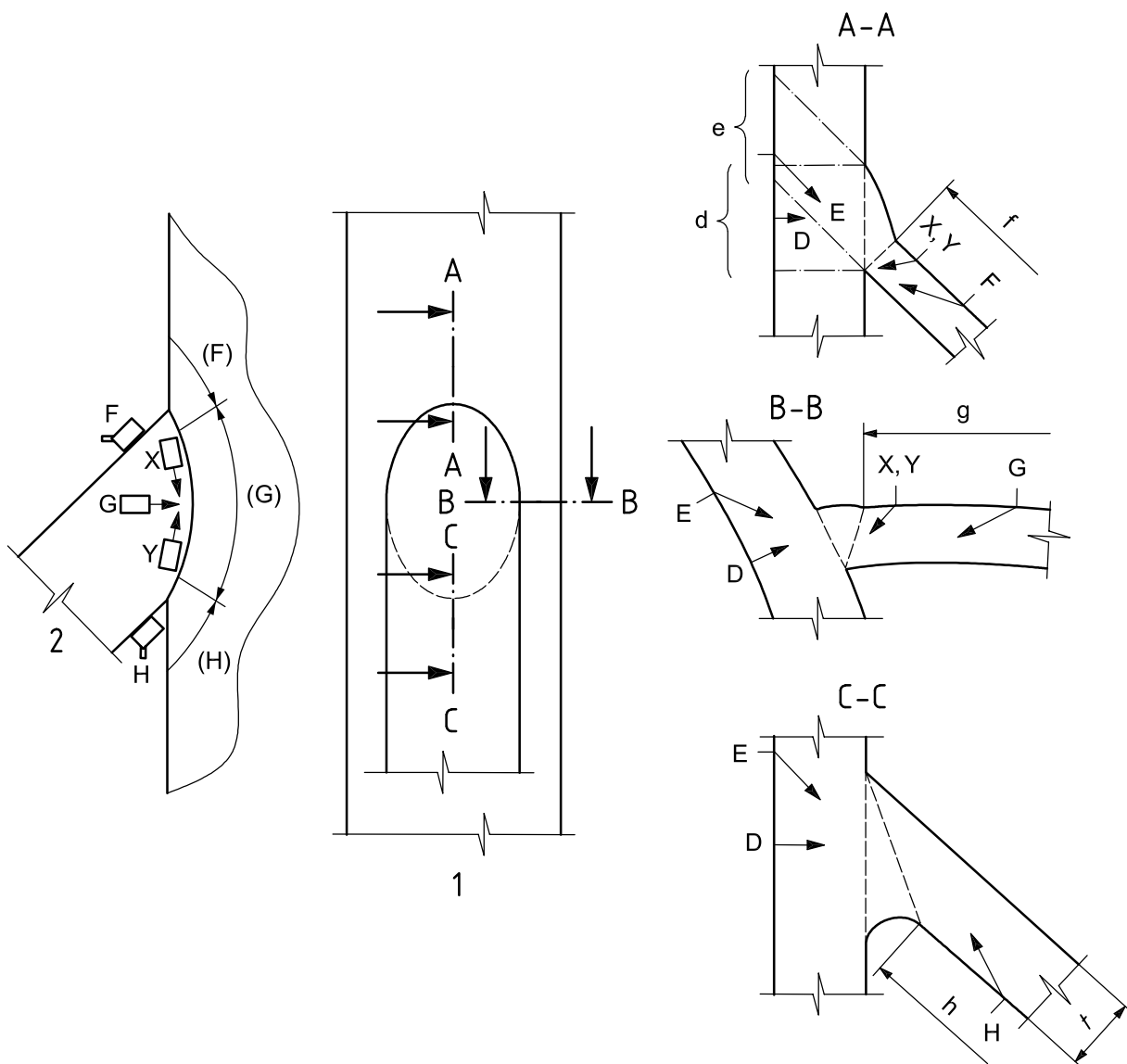
A, B, C, D, E, F, G, H, W, X, Y, Z: probe positions

Scanning zone widths are indicated by the letters a, b, c, d, e, f, g and h.

Figure A.6 — Cruciform joints

Table A.6 — Cruciform joints

Testing level	Thickness of parent material $t$ mm	Longitudinal indications				Transverse indications				
		Required probe		Total number of scans	NOTE	Required probe		Total number of scans	NOTE	
		angles (number)	positions			angles (number)	positions			
										L-scans
A	$8 \leq t < 15$	1	(A and C) or (B and D)	1,25 $p$	2	—	—	—	a	
	$15 \leq t < 40$	1	A and B and C and D	0,75 $p$	4	c	—	—	a	
	$40 \leq t \leq 100$	2	A and B and C and D	0,75 $p$	8	c	—	—	a	
B	$8 \leq t < 15$	1	A and B and C and D	1,25 $p$	4	—	1	(X1 and Y1 and W1 and Z1) and (X2 and Y2 and W2 and Z2)	8	b
	$15 \leq t < 40$	2	A and B and C and D	0,75 $p$	8	c	1	(X1 and Y1 and W1 and Z1) and (X2 and Y2 and W2 and Z2)	8	b
	$40 \leq t \leq 100$	2 1	(A and B and C and D) and (E and F and G and H)	0,75 $p$ e to h	12	c, d	2	(X1 and Y1 and W1 and Z1) and (X2 and Y2 and W2 and Z2)	16	b
C	$40 \leq t \leq 100$	2 1	(A and B and C and D) and (E and F and G and H)	0,75 $p$ e to h	12	—	2	(X1 and Y1 and W1 and Z1) and (X2 and Y2 and W2 and Z2)	b	b
a Not applicable.										
b Only if specified.										
c If a more sensitive level is required, a tandem technique shall be used.										
d But then E and F and G and H shall be omitted.										



# Key

- 1 component 1: main pipe
- 2 component 2: branch pipe
- D, E, F, G, H, X, Y: probe positions

Scanning zone widths are indicated by the letters d, e, f, g and h.

**Figure A.7 — Node joints in tubular structures**

Table A.7 — Node joints in tubular structures

Testing level	Thickness of parent material <i>t</i> mm	Longitudinal indications						Transverse indications					
		Required probe						Total number of scans	Required probe		Total number of scans	Notes	
		angles (number)	positions	SZWs	positions	SZWs	angles (number)		positions				
		L-scans			N-scans			T-scans					
A	$8 \leq t < 15$	2	F and G and H	1,25 <i>p</i>	—	—	—	6	—	—	—	a, b	
	$15 \leq t < 40$	3	F and G and H	1,25 <i>p</i>	—	—	—	9	—	—	—	a, b	
	$40 \leq t \leq 100$	3	F and G and H	1,25 <i>p</i>	—	—	—	9	—	—	—	a, b	
B	$8 \leq t < 15$	2	F and G and H	1,25 <i>p</i>	D	d	d	7	1	X and Y	2	a, c	
	$15 \leq t < 40$	3	F and G and H	1,25 <i>p</i>	D	d	d	10	2	X and Y	4	a, c	
	$40 \leq t \leq 100$	3 1	(F and G and H) and E	1,25 <i>p</i> e	D	d	d	11	2	X and Y	4	a, c	
C		Not applicable											
a	Node joint testing shall usually be level D and shall be specified.												
b	Not applicable.												
c	If the bore of component 1 is not accessible (probe position D and E), testing level B cannot be achieved.												

## Bibliography

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- [3] ISO 17637, *Non-destructive testing of welds — Visual testing of fusion-welded joints*
- [4] EN 1712, *Non-destructive examination of welds — Ultrasonic examination of welded joints — Acceptance levels*
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