

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

The European Standard EN 1714:1997, with the incorporation of amendments A1:2002 and A2:2003, has the status of a British Standard

ICS 25.160.40

National foreword

This British Standard is the official English language version of EN 1714:1997, including amendments A1:2002 and A2:2003. It supersedes BS 3923-1:1986, which is withdrawn.

The start and finish of text introduced or altered by CEN amendment is indicated in the text by tags **A1** **A1**. Tags indicating change to CEN text carry the number of the amendment. For example, text altered by CEN amendment A1 is indicated by **A1** **A1**.

As agreed by CEN/TC 121/SC 5 resolution 134/2000 and in accordance with amendment A1:2002, the term “examination” has been replaced by “testing” throughout the document.

The UK participation in its preparation was entrusted to Technical Committee WEE/46, Non-destructive testing, which has the responsibility to:

- aid enquirers to understand the text;
- present to the responsible European committee any enquiries on the interpretation, or proposals for change, and keep the UK interests informed;
- monitor related international and European developments and promulgate them in the UK.

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

The first column of Table A.1 has been corrected by Corrigendum No. 1, and information on the back cover has been updated.

Cross-references

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Summary of pages

This document comprises a front cover, an inside front cover, the EN title page, pages 2 to 28, an inside back cover and a back cover.

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Amendments issued since publication

Amd. No.	Date	Comments
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English version

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

(includes amendments A1:2002 and A2:2003)

Contrôle non destructif des assemblages
soudés —

Contrôle par ultrasons des assemblages soudés
(inclut les amendements A1:2002 et A2:2003)

Zerstörungsfreie Prüfung von
Schweißverbindungen —

Ultraschallprüfung von Schweißverbindungen
(enthält Änderungen A1:2002 und A2:2003)

This European Standard was approved by CEN on 1997-08-02. Amendment A1 was approved by CEN on 2002-05-01. Amendment A2 was approved by CEN on 20 November 2003.

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CEN

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

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Ref. No. EN 1714:1997 + A1:2002 + A2:2003 E

Foreword

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

This European Standard shall be given the status of a national standard, either by publication of an identical text or by endorsement, at the latest by February 1998, and conflicting national standards shall be withdrawn at the latest by February 1998.

This document has been prepared under a mandate given to CEN by the European Commission and the European Free Trade Association.

According to the CEN/CENELEC Internal Regulations, the national standards organizations of the following countries are bound to implement this European Standard: Austria, Belgium, Czech Republic, Denmark, Finland, France, Germany, Greece, Iceland, Ireland, Italy, Luxembourg, Netherlands, Norway, Portugal, Spain, Sweden, Switzerland and the United Kingdom.

Foreword to amendment A1

This document EN 1714:1997/A1:2002 has been prepared by Technical Committee CEN/TC 121, Welding, the Secretariat of which is held by DS.

This amendment to the European Standard EN 1714:1997 shall be given the status of a national standard, either by publication of an identical text or by endorsement, at the latest by November 2002, and conflicting national standards shall be withdrawn at the latest by November 2002.

This document has been prepared under a mandate given in CEN by the European Commission and the European Free Trade Association.

This document has been prepared under a mandate given to CEN by the European Commission and the European Free Trade Association, and supports essential requirements of EU Directive(s).

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

Annex A is normative.

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Foreword to amendment A2

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This document has been prepared under a mandate given to CEN by the European Commission and the European Free Trade Association.

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1 Scope

This European Standard specifies methods for the manual ultrasonic testing of fusion welded joints in metallic materials equal to and above 8 mm thick which exhibit low ultrasonic attenuation (especially that due to scatter). It is primarily intended for use on full penetration welded joints where both the welded and parent material are ferritic.

A1 The techniques may also be used:

- on materials other than those stated;
- on partial penetration welds;
- with automated equipment;

if required by specification. **A1**

Where material dependent ultrasonic values are specified in this standard they are based on steels having an ultrasonic sound velocity of 5920 ± 50 m/s for longitudinal waves, and 3255 ± 30 m/s for transverse waves. This is to be taken into account when testing materials with a different velocity.

The standard specifies four testing levels, each corresponding to a different probability of detection of imperfections. Guidance on the selection of testing levels A, B and C is given in Annex A. The requirements of the fourth testing level, which is intended for special applications, are in accordance with the general requirements of this standard and **A1** may only be used when defined by specification. **A1**

A1 This standard, may be used for the assessment of indications, for acceptance purposes, by either of the following methods:

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

The methods used shall be specified. **A1**

2 Normative references

This European Standard incorporates, by dated or undated references, provisions from other publications. These normative references are cited at the appropriate places in the text and the publications are listed as follows. For dated references, subsequent amendments to or revisions of any of these publications apply to this European Standard only when incorporated in it by amendment or revision. For undated references the latest edition of the publication referred to applies.

EN 473, Qualification and certification of NDT personnel — General principles.

prEN 583-1, Non-destructive testing — Ultrasonic examination — Part 1: General principles.

prEN 583-2, Non-destructive testing — Ultrasonic examination — Part 2: Sensitivity and range setting.

prEN 1330-4, Non-destructive testing — Terminology — Part 4: Terms used in ultrasonic testing.

A1 EN 1712, Non-destructive examination of welds — Ultrasonic examination of welded joints — Acceptance levels. **A1**

A1 EN 1713, Non-destructive examination of welds — Ultrasonic examination — Characterization of indications in welds. **A1**

EN 12062, Non-destructive testing of welds — General rules for metallic materials.

EN 25817, Arc-welded joints in steel — Guidance on quality levels for imperfections.
(ISO 5817:1992)

3 Definitions and symbols

For the purposes of this standard, the definitions given in prEN 12062 and prEN 1330-4 apply.

For quantities and symbols, see Table 1.

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.

Table 1 — Quantities and symbols

Symbol	Quantity	Unit
t	Thickness of parent material (thinnest part)	mm
D_{DSR}	Diameter of a disc shaped reflector	mm
D_{SDH}	Diameter of a side-drilled hole	mm
l	Length of the indication	mm
h	Extension of the indication in depth direction	mm
x	Position of the indication in the longitudinal direction	mm
y	Position of the indication in the transverse direction	mm
z	Position of the indication in depth	mm
l_z	Projected length of the indication in depth	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

4 General

A1 The purpose of this standard is to describe general methods of ultrasonic testing, using standard criteria, for the most commonly used weld joints. The specific requirements specified by this standard cover the equipment, preparation, performance of the testing and reporting. The parameters specified, in particular those for the probes, are compatible with the requirements of EN 1712 and EN 1713, and are also suitable for use with other acceptance criteria standards. The techniques recommended in this standard are suitable for the detection of those weld imperfections specified in typical weld acceptance standards. Methods to be used for ultrasonic assessment of indications and acceptance criteria shall be defined by specification. **A1**

If the agreed 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 or methods outside the scope of this standard.

5 Information required prior to testing

5.1 **A1** Items to be specified **A1**

- Method for setting the reference level.
- Method to be used for evaluation of indications.
- Acceptance levels.
- Testing level.
- Manufacturing and operation stage(s) at which the testing is to be carried out.
- Qualification of personnel.
- Extent of the testing for transverse indications.
- Requirements for tandem testing.
- Parent metal testing prior to and/or after welding.
- Whether or not a written testing procedure is required.
- Requirements for written testing procedures.

5.2 Specific information required before testing

Before any testing of a welded joint can begin, the operator shall have access to the following essential information:

- written testing procedure, if required (see 5.3);
- type(s) of parent material and product form (i.e. cast, forged, rolled);
- manufacturing or operation stage at which testing is to be made including heat treatment, if any;
- 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.

5.3 Written testing procedure

The definitions and requirements in this standard will normally satisfy the need for a written procedure. Where this is not the case, or where the techniques described in this standard are not applicable to the weld joint to be tested, additional written procedures shall be used, **A1** if required by specification. **A1**

6 Requirements for personnel and equipment

6.1 Personnel qualifications

Personnel performing testing in accordance with this standard shall be qualified to an appropriate level in accordance with EN 473 or equivalent in the relevant industrial sector.

In addition to a general knowledge of ultrasonic weld inspection, they shall also be familiar with testing problems specifically associated with the type of weld joints to be tested.

6.2 Equipment

Any equipment used in conjunction with this standard shall comply with the requirements of relevant European Standards. Prior to the publication of an EN standard related to the subject, the corresponding national standards may be used.

6.3 Probe parameters

6.3.1 Frequency

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

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

Frequencies of approximately 1 MHz may be used for testing at 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 prEN 583-2. Where angles of incidence cannot be determined as specified by this 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 Adaption of probes to curved scanning surfaces

The gap between the 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 the following equation is fulfilled:

$$D \geq 15 a$$

where

D is the diameter of the component (in mm);

a is the dimension of the probe shoe in the direction of testing (in mm).

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

7 Testing volume

The testing volume (see Figure 1) is defined as the zone which includes 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 testing 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 agreed upon. This may, in some cases, require removal of the weld reinforcement.

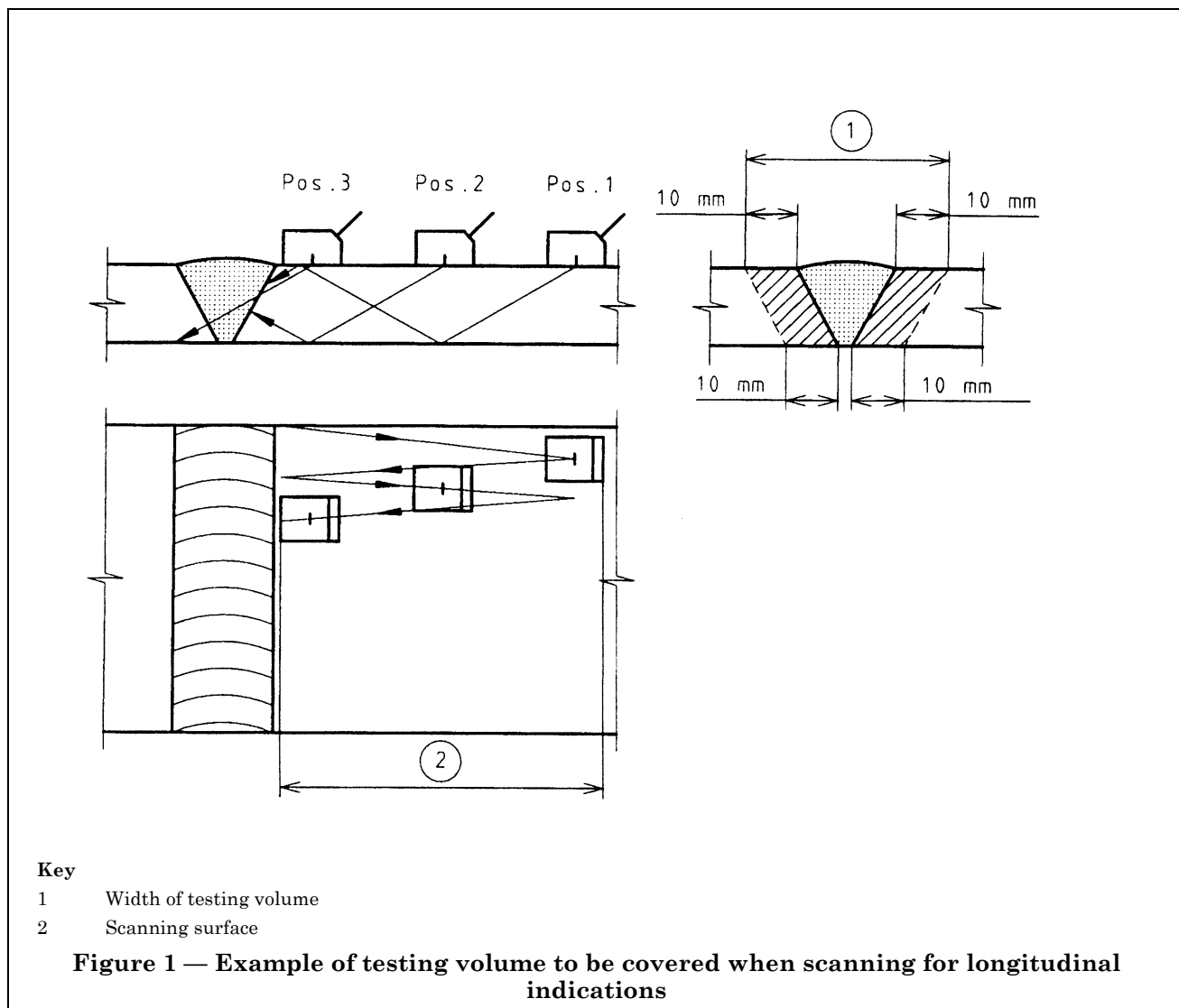
Supplementary methods may require testing using twin crystal angle beam probes, creeping wave probes, further ultrasonic techniques or any other suitable method, for example, liquid penetrant, magnetic particle, radiographic testing. In selecting alternative or supplementary methods, due consideration should be given to the type of weld and probable orientation of any imperfections to be detected.

8 Preparation of scanning surfaces

Scanning surfaces shall be wide enough to permit the testing volume (see Figure 1) to be fully covered. Alternatively, the width of the scanning surfaces may be smaller if equivalent coverage of the testing volume can be achieved by scanning from both the upper and the lower surface of the joint.

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). Waviness of the test surface shall not result in a gap between the probe and test surfaces greater than 0,5 mm. These requirements shall be ensured by dressing if necessary. 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, can only be 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 will occur with a gap of this dimension.

In all cases, the maximum permitted gap on areas of the test surface from which the evaluation of indications is to be carried out shall be 0,5 mm. Scanning surfaces and surfaces from which the sound beam is reflected may be assumed to be satisfactory if the surface roughness, R_a , is not greater than 6,3 µm for machined surfaces, or not greater than 12,5 µm for shotblasted surfaces.



9 Parent metal testing

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

Where imperfections are found their influence on the proposed angle beam test shall be assessed and, if necessary, the techniques adjusted correspondingly. When satisfactory coverage by ultrasonic testing is seriously affected, by agreement, other inspection methods (e.g. radiography) shall be considered.

10 Range and sensitivity setting

10.1 General

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

If deviations are found during these checks the corrections given in Table 2 shall be carried out.

Table 2 — Sensitivity and range corrections

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

10.2 Reference level

One of the following methods for setting reference levels shall be used:

- *Method 1*: The reference level is a distance-amplitude-curve (DAC-curve) for a $\varnothing 3$ mm side drilled hole;
- *Method 2*: The reference levels for transverse and longitudinal waves using the distance gain size (DGS) system based on a disc shaped reflector (DSR) are given in Table 3 and Table 4 respectively;
- *Method 3*: The reference level is equal to a DAC curve for a 1 mm deep rectangular notch.
- *Tandem testing*: $D_{\text{DSR}} = 6$ 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 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 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

10.3 Evaluation levels

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

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

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 prEN 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 shall be considered and further preparation of the scanning surfaces shall be carried out, if applicable.

When there are no apparent reasons for high correction values, the attenuation, at various locations on the test object, shall be measured 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 subject to **A₁** specification. **A₁**

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 standard specifies four testing levels (A, B, C and D).

From testing level A to testing level C an increasing probability of detection will be achieved by an increasing testing coverage e.g. number of scans, surface dressing. The testing level D may be agreed for special application using a written procedure which shall take into account the general requirements of this standard.

In general the testing levels are related to quality levels (e.g. EN 25817). The appropriate testing level may be specified by standards for testing of welds (e.g. EN 12062), product standards or other documents.

When EN 12062 is specified the recommended testing levels are as given in Table 5.

Table 5 — Recommended testing levels

Testing level	Quality level in EN 25817
A	C
B	B
C	By agreement
D	Special application

Specific requirements for testing levels A to C are given for various types of joints 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 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 prEN 583-1 with the addition of the following clauses.

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.

12.3 Testing for imperfections perpendicular to the testing surface

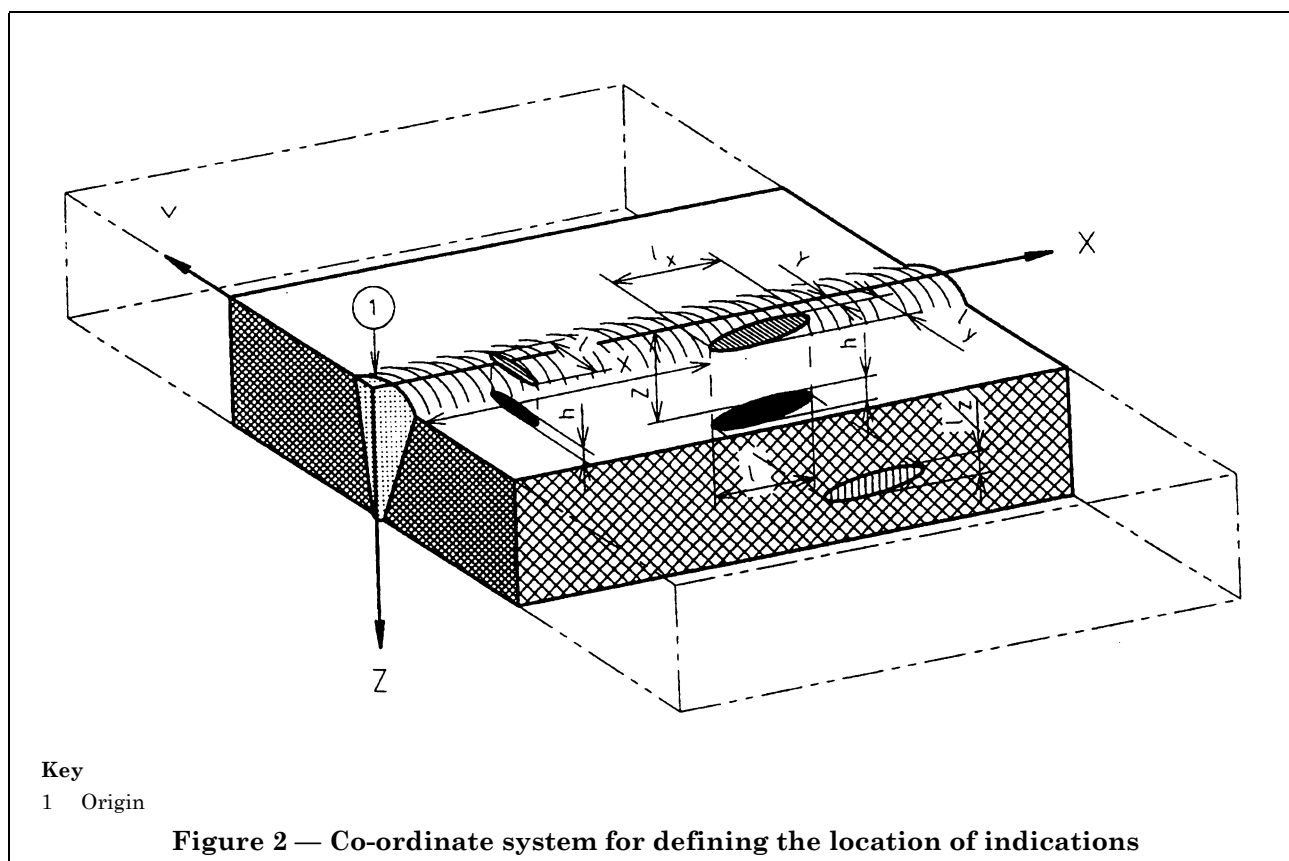
Subsurface planar imperfections perpendicular to the testing surface are difficult to detect with single angle probe techniques. For such imperfections specific testing techniques should be considered, particularly for welds in thicker materials. Use of these testing techniques shall be $\sqrt{A_1}$ defined by specification. $\sqrt{A_1}$

12.4 Location of indications

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

Where 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 relevant indications above the evaluation level shall be assessed in accordance with Clauses 12.5.2, 12.5.3 and 12.5.4.

12.5.2 Maximum echo amplitude

The echo amplitude shall be maximized by probe movement and recorded in relation to the agreed reference level.

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 levels standard or the 6 dB drop tip location technique, unless otherwise agreed.

12.5.4 Indication height

Indication height measurement shall be carried out $\sqrt{A_1}$ if required by specification. $\sqrt{A_1}$ If applicable, 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 and above, the indication height is recorded. However, other higher threshold heights for recording may be $\sqrt{A_1}$ defined $\sqrt{A_1}$ upon.

12.5.5 Characterization of imperfections

Imperfections shall be characterized $\sqrt{A_1}$ if required by specification $\sqrt{A_1}$, or when necessary to meet the requirements of the specified acceptance levels.

13 Test report

13.1 General

The test report shall include a reference to this standard and give, as a minimum, the following information.

13.2 General data

- a) identification of the object under testing:
 - 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) contract requirements, e.g. specifications, guidelines, special agreements etc.;
- c) place and date of testing;
- d) identification of testing organizations and identification and certification of operator;
- e) identification of inspection authority.

13.3 Information relating to equipment

- a) maker and type of ultrasonic instrument with identification number, if required;
- b) maker, 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) couplant 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 co-ordinate system used, as specified in **12.4**;
- e) identification of probe positions, as specified in Annex A 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 for acceptance levels;
- k) deviations from this standard, or contract requirements.

13.5 Results of the testing

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

- a) co-ordinates 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 evaluation, according to specified acceptance levels.

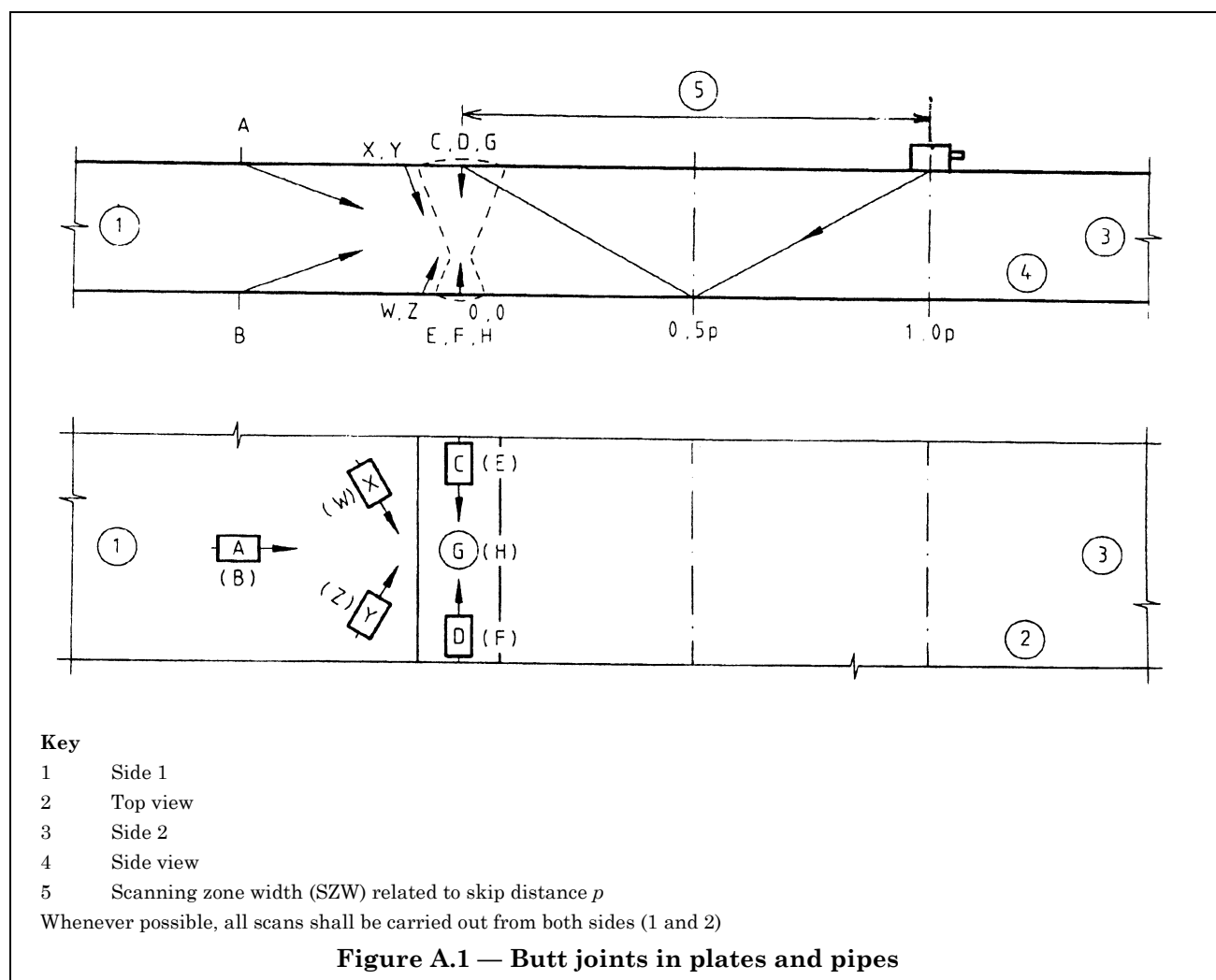
Annex A (normative)

Testing levels for various types of welded joints

See Figure A.1 to Figure A.7 and Table A.1 to Table A.7

Key for 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.



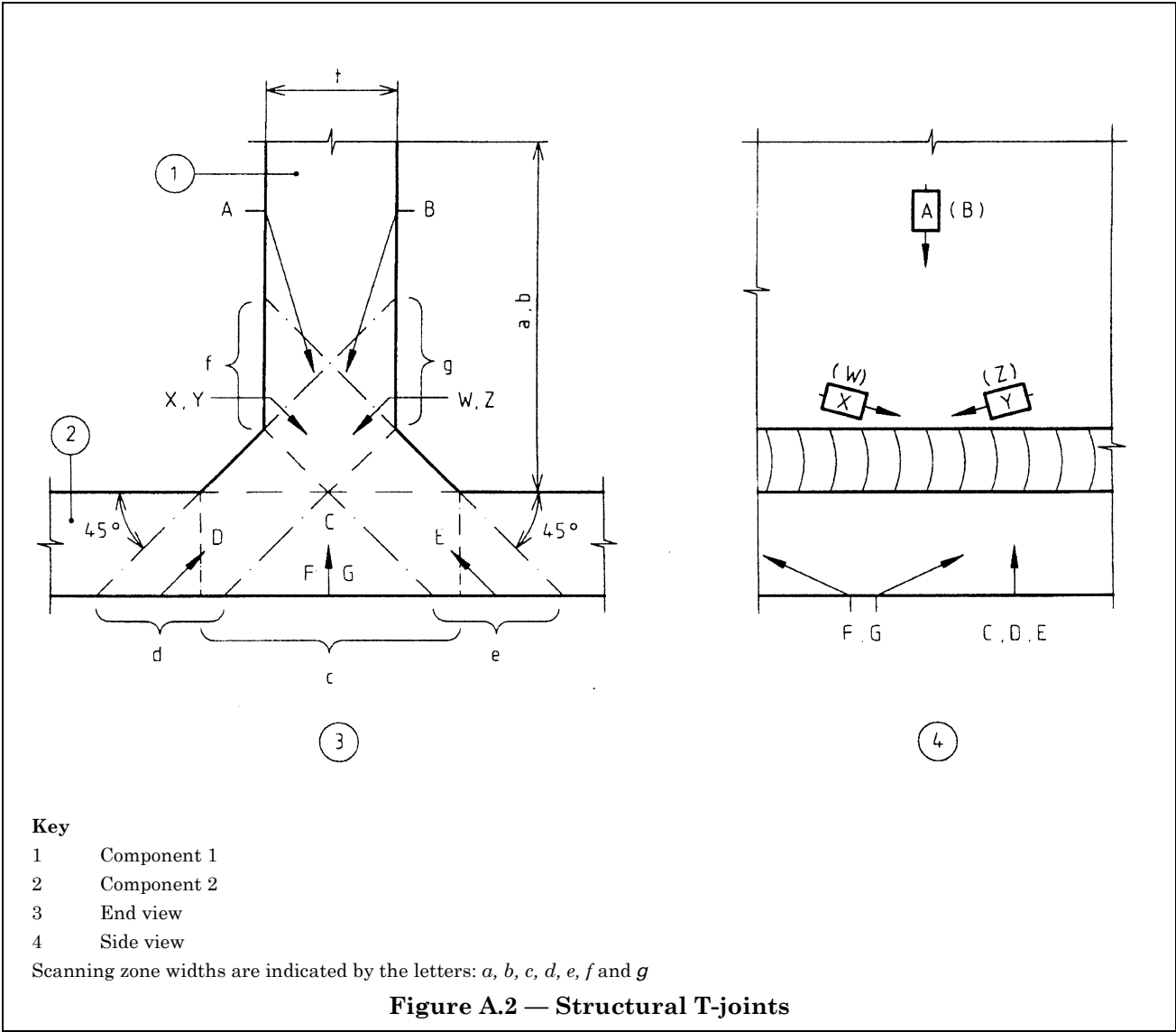


Table A.1 — Butt joints in plates and pipes

Testing level	Thickness of the parent material	Longitudinal indications						Transverse indications				
		Required number of:				Total number of scans	Notes	Required number of:			Total number of scans	Notes
		probe angles	probe positions	Scanning zone width	probe positions			probe angles	probe positions			
mm		L-scan		N-scan		T-scans						
A	$8 \leq t < 15$	1	A or B	1,25p	—	—	2	1)	1	(X and Y) or (W and Z)	4	3)
	$15 \leq t < 40$	1	A or B	1,25p	—	—	2	1)	1	(X and Y) or (W and Z)	4	3)
	$8 \leq t < 15$	1	A or B	1,25p	—	—	2	5)	1	(X and Y) or (W and Z)	4	3)
B	$15 \leq t < 40$	2 ⁶⁾	A or B	1,25p	—	—	4	2) 5)	1	(X and Y) or (W and Z)	4	3)
	$40 \leq t < 60$	2	A or B	1,25p	—	—	4	2)	2	(X and Y) or (W and Z)	8	3)
	$60 \leq t \leq 100$	2	A or B	1,25p	—	—	4	2)	2	(C and D) or (E and F)	4	3) 4)
C	$8 \leq t < 15$	1	A or B	1,25p	G or H	3	4)	1	(C and D) or (E and F)	2	4)	
	$15 \leq t \leq 40$	2	A or B	1,25p	G or H	5	2) 4)	2	(C and D) or (E and F)	4	4)	
	> 40	2	A or B	1,25p	G or H	5	2) 4)	2	(C and D) or (E and F)	4	4)	

¹⁾ May be limited by agreement to one scan from one side.

²⁾ Additional testing by tandem technique by special agreement.

³⁾ Required only by special agreement.

⁴⁾ The surface of the weld cap shall comply with the requirement in Clause 8. This may require dressing of the weld cap. However, for single sided circumferential pipe welds the outside cap only is to be dressed.

⁵⁾ If only accessible from one side, two angles shall be used.

⁶⁾ In the range of $15 < t \leq 25$ one angle is sufficient provided the frequency is below 3 MHz.

1) May be limited by agreement to one scan from one side.

2) Additional testing by tandem technique by special agreement.

3) Required only by special agreement.

4) The surface of the weld cap shall comply with the requirement in Clause 8. This may require dressing of the weld cap. However, for single sided circumferential pipe welds the outside cap only is to be dressed.

5) If only accessible from one side, two angles shall be used.

6) In the range of $15 < t \leq 25$ one angle is sufficient provided the frequency is below 3 MHz.

A1



Table A.2 — Structural T-joints

Testing level	Thickness of the parent material mm	Longitudinal indications					Transverse indications					
		Required number of:					Total number of scans	Required number of:				
		probe angles	probe positions	Scanning zone width (SZW)	probe positions	SZW		probe angles	probe positions	SZW	Total number of scans	Notes
A	$8 \leq t < 15$	1	A or B	1,25p	or C ³⁾	—	1	—	—	—	1)	
	$15 \leq t < 40$	1	A or B	1,25p	C ³⁾	c	2	—	—	—	1)	
	$8 \leq t < 15$	1	A or B	1,25p	C ³⁾	—	2	1	F and G	c	2)	
	$15 \leq t < 40$	1	A and B	1,25p	C ³⁾	c	3	1	(F and G) or (X and Y) or (W and Z)	c	2)	
B	$40 \leq t \leq 100$	2	A and B	0,75p	C ³⁾	c	5	1	(F and G) or (X and Y) or (W and Z)	c	2)	
	$8 \leq t < 15$	1	(A and B)	1,25p	C ³⁾	c	3	2	F and G	c	2)	
	$15 \leq t < 40$	2	(A and B) and (D and E)	1,25p	C ³⁾	c	7	1	(F and G) and (X and Y) or (W and Z)	c	2)	
	$40 \leq t \leq 100$	2	(A and B) and (D and E)	0,75p	C ³⁾	c	7	2	(F and G) and (X and Y) or (W and Z)	c	2)	
C	$8 \leq t < 15$	1	(A and B)	1,25p	C ³⁾	c	3	2	F and G	c	2)	
	$15 \leq t < 40$	2	(A and B) and (D and E)	1,25p	C ³⁾	c	7	1	(F and G) and (X and Y) or (W and Z)	c	2)	
	$40 \leq t \leq 100$	2	(A and B) and (D and E)	0,75p	C ³⁾	c	7	2	(F and G) and (X and Y) or (W and Z)	c	2)	
	> 100	3	(A and B) and (D and E)	0,75p	C ³⁾	c	9	2	(F and G) and (X and Y) or (W and Z)	c	2)	
		1	(D and E)	d + e	(D and E)	d + e			(X and Y) or (W and Z)	f + g		
¹⁾ Not applicable. ²⁾ Shall be carried out by special agreement only. ³⁾ To be substituted by tandem technique from A or B if C is not possible.												



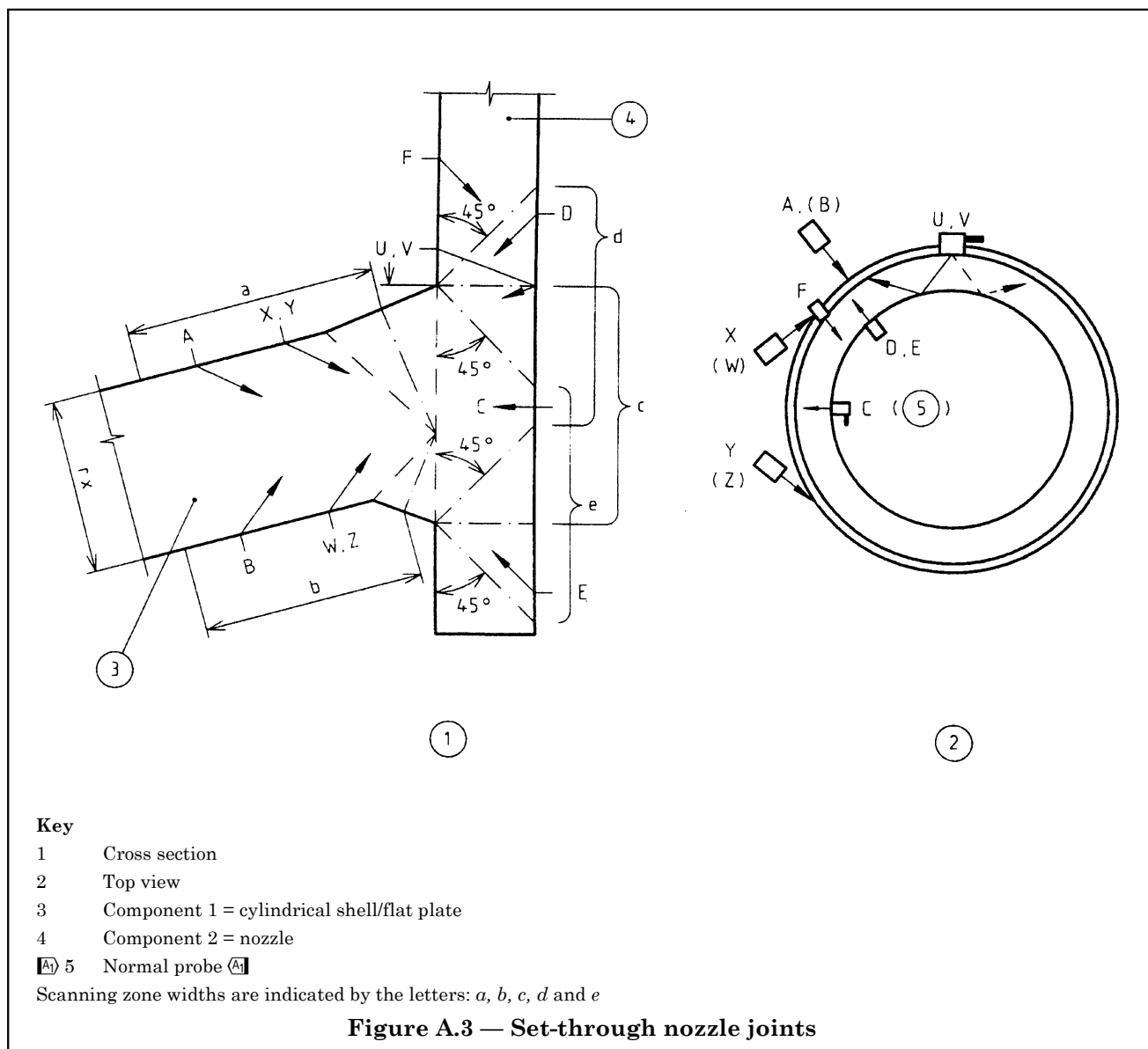


Table A.3 — Set-through nozzle joints

Testing level	Thickness of the parent material	Longitudinal indications						Transverse indications				Notes
		Required number of:						Required number of:		Total number of scans		
		probe angles	probe positions	Scanning zone width (SZW)	probe positions	SZW	Total number of scans	probe angles	probe positions			
mm		L-scan		N-scan		T-scans						
A	$8 \leq t < 15$	1	A	1,25p	or C	c	1	—	—	—	1)	
	$15 \leq t \leq 40$	1	A or F or D	1,25p <i>d</i>	C	c	2	—	—	—	1)	
	$8 \leq t < 15$	1	A or D	1,25p <i>d</i>	C	c	2	1	(U and V) or (X and Y) or (W and Z)	2	2)	
	$15 \leq t < 40$	1	A or (D and E)	1,25p <i>d + e</i>	C	c	2 or 3	1	(U and V) or (X and Y) or (W and Z)	2	2)	
B	$40 \leq t < 60$	1	(A or B) and (D and E)	1,25p <i>d + e</i>	C	c	4	1	(X and Y) and (W and Z)	4	2)	
	$60 \leq t \leq 100$	2	(A and B) and (D and E)	0,5p <i>d + e</i>	C	c	7	2	(X and Y) and (W and Z)	8	2)	
	$8 \leq t < 15$	1	(A or B) and (D or E)	1,25p <i>d or e</i>	C	c	3	1	(U and V) or (X and Y and W and Z)	2 or 4	2)	
	$15 \leq t \leq 40$	2	(A or B) and (D or E)	0,5p <i>d or e</i>	C	c	5	2	(X and Y) and (W and Z)	8	2)	
C	> 40	2	(A and B) and (D and E)	0,5p <i>d + e</i>	C	c	9	2	(X and Y) and (W and Z)	8	2)	
1) Not applicable. 2) Shall be carried out by special agreement only.												

A1

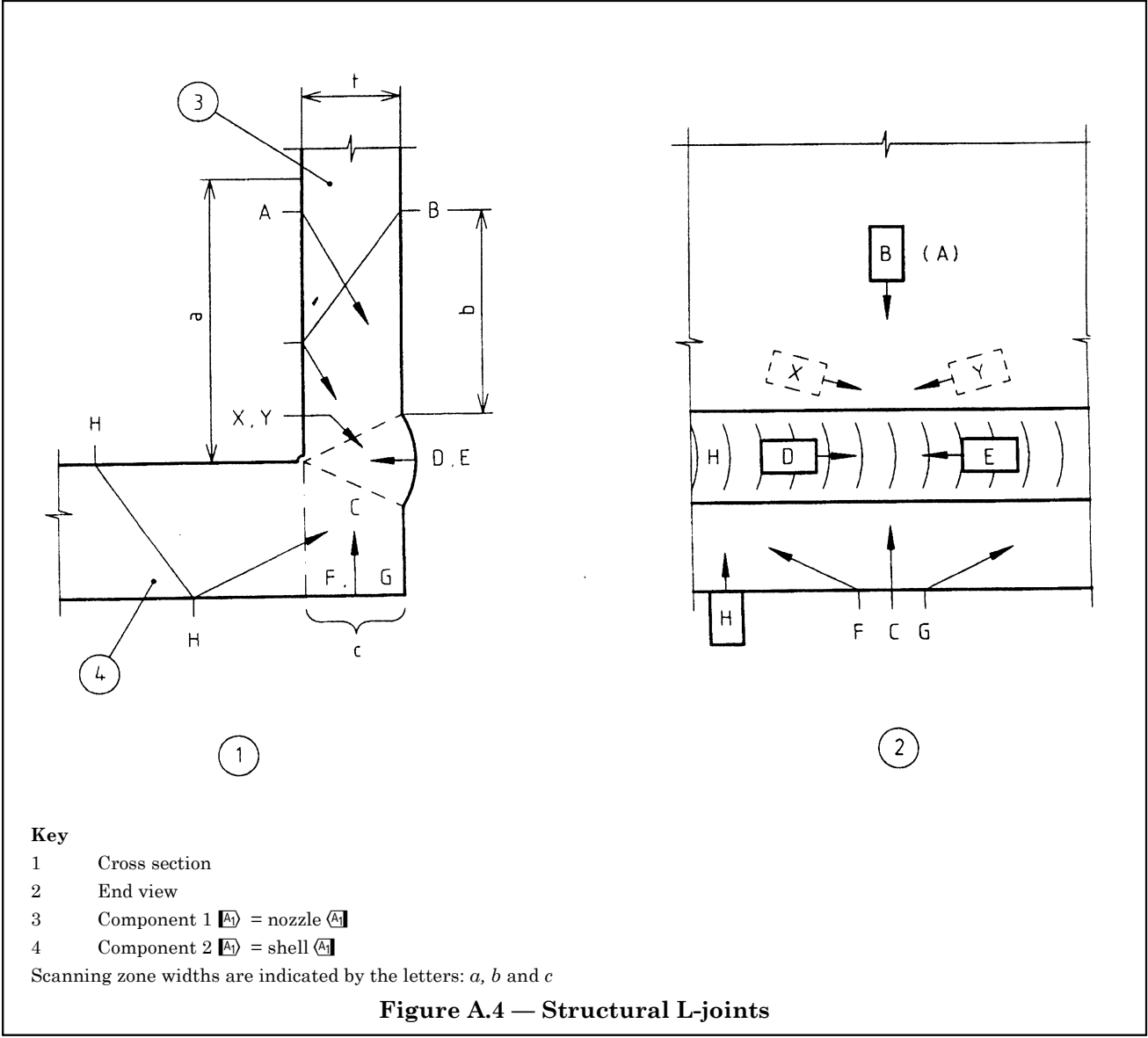


Table A.4 — Structural L-joints

Testing level	Thickness of the parent material mm	Longitudinal indications					Transverse indications				Notes
		Required number of:					Total number of scans	Required number of:			
		probe angles	probe positions	Scanning zone width (SZW)	probe positions	SZW		probe angles	probe positions		
									T-scans		
A	$8 \leq t < 15$	1	A or B or H	1,25p	or C	c	1	—	—	—	1)
	$15 \leq t \leq 40$	1	A or B or H	1,25p	C	c	2	—	—	—	1)
	$8 \leq t < 15$	1	A or B or H	1,25p	or C	c	1	1	(F and G) or (X and Y)	2	2)
B	$15 \leq t < 40$	2	A or B or H	1,25p	C	c	3	2	(F and G) or (X and Y)	4	2)
	$40 \leq t \leq 100$	2	(H or A) and B	0,75p	C	c	5	2	D and E	4	2) 3)
	$8 \leq t < 15$	1	(H or A) and B	1,25p	C	c	3	1	D and E	2	2) 3)
C	$15 \leq t < 40$	2	(H or A) and B	1,25p	C	c	5	1	D and E	2	2) 3)
	$40 \leq t \leq 100$	3	(H or A) and B	0,75p	C	c	7	2	D and E	4	2) 3)
	> 100	3	(H or A) and B	0,5p	C	c	7	2	D and E	4	2) 3)

1) Not applicable.

2) Shall be carried out by special agreement only.

3) The surface of the weld cap shall comply with the requirement in Clause 8. This may require dressing of the weld cap.

1) Not applicable.

2) Shall be carried out by special agreement only.

3) The surface of the weld cap shall comply with the requirement in Clause 8. This may require dressing of the weld cap.

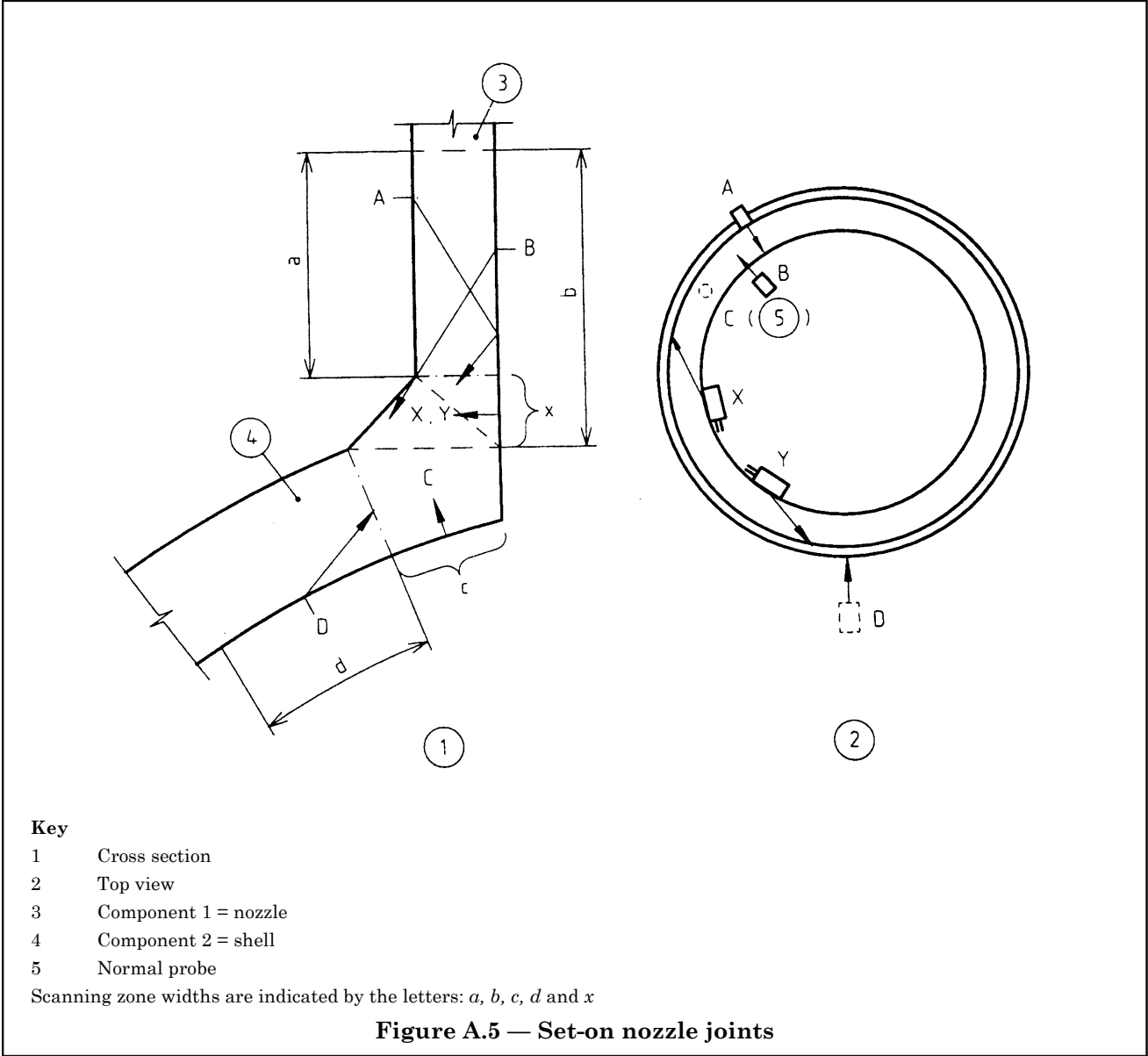


Table A.5 — Set-on nozzle joints

Testing level	Thickness of the parent material	Longitudinal indications						Transverse indications				
		Required number of:						Total number of scans	Required number of:		Total number of scans	Notes
		probe angles	probe positions	Scanning zone width (SZW)	probe positions	SZW	probe angles		probe positions			
										L-scan		
A	8 ≤ t < 15	1	A or B	1,25p 0,50p	—	—	—	1	—	—	—	1)
		1	A or B	1,25p 0,50p	C	c	c	—	—	—	1)	
	8 ≤ t < 15	2	A or B	1,25p 0,50p	—	—	—	2	1	X and Y	2	2) 3)
		2	A or B	1,25p 0,50p	C	c	c	c	3	1	X and Y	2
B	40 ≤ t < 60	2	A and (B or D)	1,25p 0,50p	C	c	c	5	2	X and Y	4	2) 3)
		2	A and (B or D)	1,25p 0,5p	C	c	c	c	5	2	X and Y	4
	8 ≤ t < 15	3	A or B	1,25p 0,5p	C	c	c	4	1	X and Y	2	2) 3)
		3	A or B	1,25p 0,5p	C	c	c	c	4	1	X and Y	2
C	40 ≤ t < 60	3	A and B	1,25p 0,5p	C	c	c	7	2	X and Y	4	2) 3)
		3	A and B	1,25p 0,5p	C	c	c	c	7	2	X and Y	4

¹⁾ Not applicable.

²⁾ Shall be carried out by special agreement only.

³⁾ The surface of the weld cap shall comply with the requirement in Clause 8. This may require dressing of the weld cap.

1) Not applicable.
2) Shall be carried out by special agreement only.
3) The surface of the weld cap shall comply with the requirement in Clause 8. This may require dressing of the weld cap.



Table A.6 — Cruciform joints

Testing level	Thickness of the parent material mm	Longitudinal indications				Notes	Transverse indications				Notes
		Required number of:			Total number of scans		Required number of:			Total number of scans	
		probe angles	probe positions	Scanning zone width			probe angles	probe positions			
									L-scan		
A	$8 \leq t < 15$	1	(A and C) or (B and D)	1,25p	2	—	—	—	—	1)	
	$15 \leq t < 40$	1	A and B and C and D	0,75p	4	3)	—	—	—	1)	
	$40 \leq t \leq 100$	2	A and B and C and D	0,75p	8	3)	—	—	—	1)	
B	$8 \leq t < 15$	1	A and B and C and D	1,25p	4	—	1	(X1 and Y1 and W1 and Za) and (X2 and Y2 and W2 and Zb)	8	2)	
	$15 \leq t < 40$	2	A and B and C and D	0,75p	8	3)	1	(X1 and Y1 and W1 and Za) and (X2 and Y2 and W2 and Zb)	8	2)	
	$40 \leq t \leq 100$	2	(A and B and C and D) and (E and F and G and H)	0,75p	12	4)	2	(X1 and Y1 and W1 and Za) and (X2 and Y2 and W2 and Zb)	16	2)	
C	$40 \leq t \leq 100$	2	(A and B) and (C and D)	0,75p	14	—	2	(X1 and Y1 and W1 and Za) and (X2 and Y2 and W2 and Zb)	16	2)	
	$40 \leq t \leq 100$	1	(E and F and G and H)	$e - h$	4)	—	—	—	—	—	
	$40 \leq t \leq 100$	2	(A and B) and (C and D) and (E and F) and (G and H)	0,75p	14	—	2	(X1 and Y1 and W1 and Za) and (X2 and Y2 and W2 and Zb)	16	2)	
		1	(E and F) and (G and H)	$e - h$	—	—	—	—	—	—	

1) Not applicable.

2) Shall be carried out by special agreement only.

3) If a more sensitive level is required, a tandem technique shall be applied.

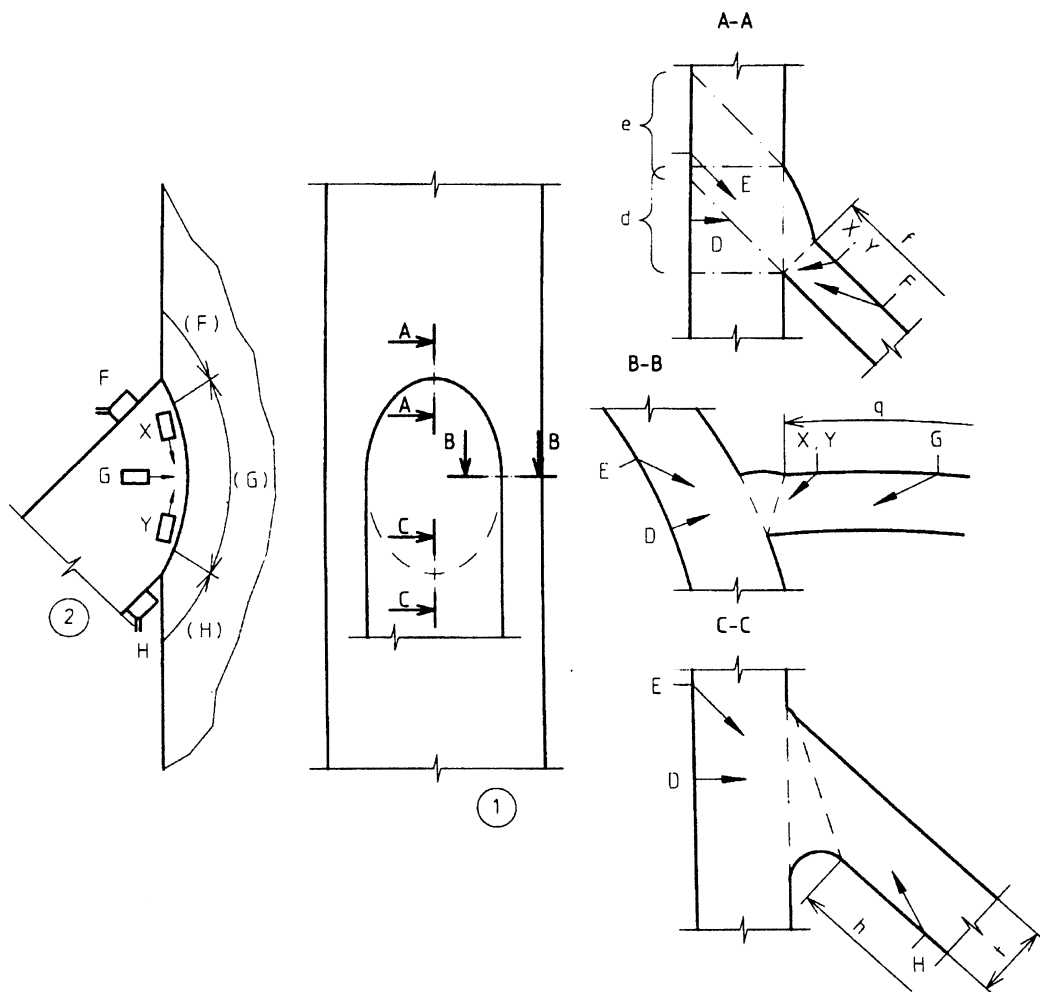
4) If a more sensitive level is required, a tandem technique shall be applied. But E and F and G and H shall be omitted.

1) Not applicable.

2) Shall be carried out by special agreement only.

3) If a more sensitive level is required, a tandem technique shall be applied.

4) If a more sensitive level is required, a tandem technique shall be applied. But E and F and G and H shall be omitted.

**Key**

- 1 Component 1 = main pipe
 2 Component 2 = branch pipe

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

Figure A.7 — Node joints and tubular structures



Table A.7 — Node joints in tubular structures

Testing level	Thickness of the parent material	Longitudinal indications						Transverse indications				Notes	
		Required number of:						Required number of:		Total number of scans			
		probe angles	probe positions	Scanning zone width (SZW)	probe positions	SZW	Total number of scans	probe angles	probe positions				
A	mm	L-scan						N-scan		6	—	—	1) 2)
	$8 \leq t < 15$	2	F and G and H	1,25p	—	—	—	—	—				
	$15 \leq t < 40$	3	F and G and H	1,25p	—	—	—	—	—				
	$40 \leq t \leq 100$	3	F and G and H	1,25p	—	—	—	—	—				
B	$8 \leq t < 15$	2	F and G and H	1,25p	D	d	7	1	X and Y	2	2	1) 3)	
	$15 \leq t < 40$	3	F and G and H	1,25p	D	d	10	2	X and Y	4	4	1) 3)	
	$40 \leq t \leq 100$	3	(F and G and H)	1,25p	D	d	11	2	X and Y	4	4	1) 3)	
		1	and E	e									
C	Not applicable												

1) Node joint testing shall usually be level D, requiring special agreement.

2) Not applicable.

3) If the bore of component 1 is not accessible (probe position D and E) testing level 2 cannot be achieved.

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