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**Destructive tests on welds in metallic  
materials — Fracture test**

*Essais destructifs des soudures sur matériaux métalliques — Essai de  
texture*



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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 3.

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 International Standard may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights.

International Standard ISO 9017 was prepared by Technical Committee ISO/TC 44, *Welding and allied processes*, Subcommittee SC 5, *Testing and inspection of welds*.

Annex A of this International Standard is for information only.

# Destructive tests on welds in metallic materials — Fracture test

## 1 Scope

This International standard specifies the sizes of test specimen and the procedures for carrying out fracture tests in order to obtain information about types, sizes and distribution of internal imperfections such as porosities, cracks, lack of fusion, lack of penetration and solid inclusions on the fracture surface.

This International Standard applies to metallic materials in all forms of product with joints made by any fusion welding process with a thickness greater or equal to 2 mm.

## 2 Normative references

The following normative documents contain provisions which, through reference in this text, constitute provisions of this International Standard. For dated references, subsequent amendments to, or revisions of, any of these publications do not apply. However, parties to agreements based on this International Standard are encouraged to investigate the possibility of applying the most recent editions of the normative documents indicated below. For undated references, the latest edition of the normative document referred to applies. Members of ISO and IEC maintain registers of currently valid International Standards.

ISO 5817:—<sup>1)</sup>, *Welding — Fusion-welded joints in steel, nickel, titanium and their alloys (beam welding excluded) — Quality levels for imperfections.*

ISO 10042, *Arc-welded joints in aluminium and its weldable alloys — Guidance on quality levels for imperfections.*

EN 970, *Non-destructive examination of fusion welds — Visual examination.*

## 3 Terms and definitions

For the purposes of this International Standard, the following terms and definitions apply.

### 3.1 examination length

$L_f$   
length of the test specimen measured along the weld axis between any side notches

See Figure 6.

### 3.2 total examination length

$\Sigma L_f$   
sum of the lengths of all the test specimens comprising the test piece, measured along the weld axis, of the fracture faces between the side notches of the test specimens

See Figure 6.

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1) To be published. (Revision of ISO 5817:1992)

**3.3  
examination thickness**

$a_f$   
thickness of the fracture area for each test specimen

See Figures 7 and 8.

**3.4  
examination area**

$A_f$   
product of the examination length and the examination thickness for each test specimen

**3.5  
total examination area**

$\Sigma A_f$   
sum of all examination areas

**4 Principle**

Fracture the joint through the weld metal in order to examine the fracture surface. The fracture can be induced by bending or tension, static or dynamic loading. Furthermore, notch dimensions and temperature can be varied to induce the fracture.

Unless otherwise specified, the test shall be carried out at ambient temperature ( $23 \pm 5$ ) °C.

**5 Symbols and abbreviated terms**

The symbols and abbreviated terms to be used for fracture tests are specified in Table 1 and represented in Figures 5 to 8.

Normally, it is sufficient to give the basic denomination, but for special applications, additional denominations about the notching and test method can be requested.

EXAMPLE 1 Test specimen taken from a fillet weld with an examination length of 40 mm and examination thickness of 10 mm.

Without any requirement about notching and test method:

Basic denomination:  $FW/(L_f a_f)$

i.e. for this example:

$FW/(40 \times 10)$

With additional requirement (square face notching and test method):

Comprehensive denomination:  $FW/(L_f a_f)/Fq$

See Figure 8

i.e. for this example:

$FW/(40 \times 10)/Fq$

See Figure 8

EXAMPLE 2 Test specimen taken from a butt weld with an examination length of 40 mm and examination thickness of 10 mm.

Without any requirement about notching and test method:

Basic denomination:  $BW/(L_f a_f)$

i.e. for this example:

$BW/(40 \times 10)$

With additional requirement (round side notching and test method):

Comprehensive denomination:  $BW/(L_f a_f)/Sr$

See Figure 6

i.e. for this example:

$BW/(40 \times 10)/Sr$

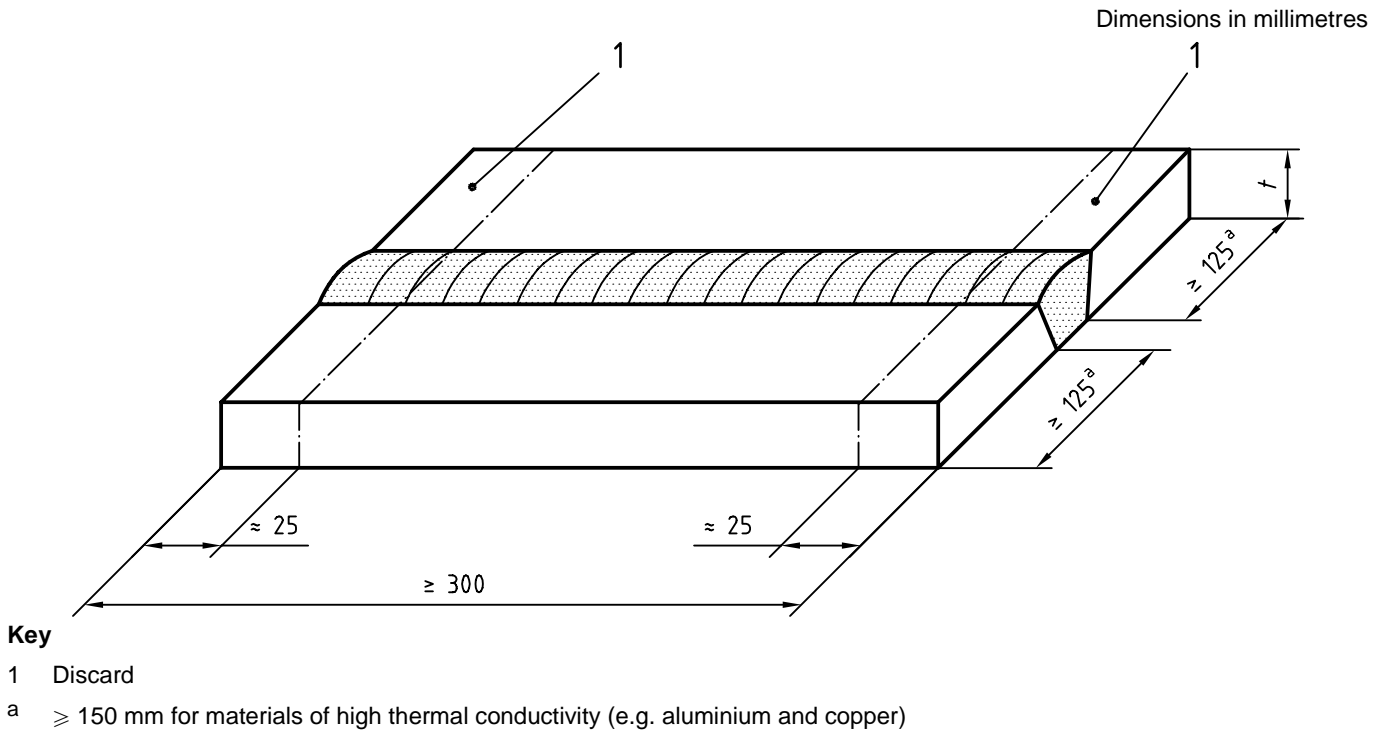
See Figure 6

**Table 1 — Symbols and abbreviated terms**

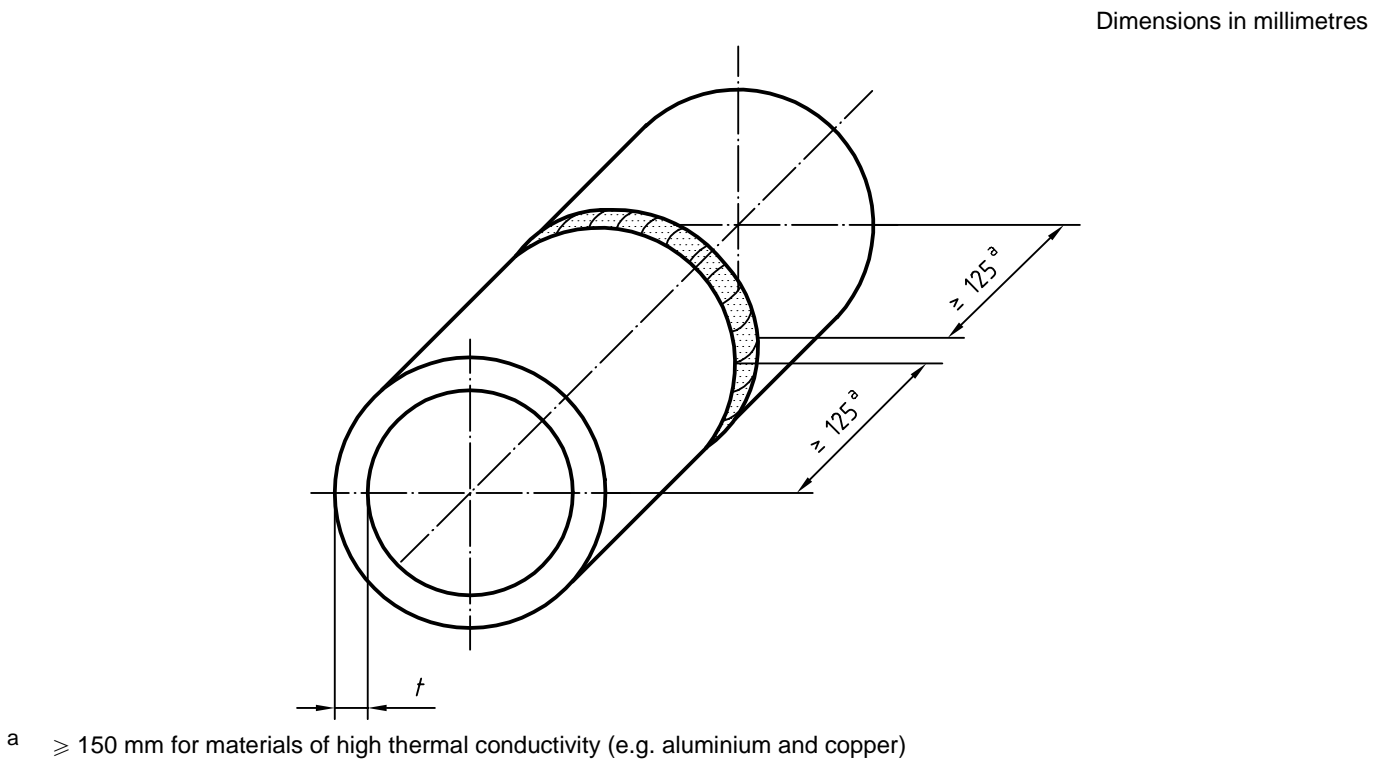
| Denomination   | Symbol or abbreviated term                 | Unit   |
|--|--|--|
| Butt weld<br>Fillet weld   | BW<br>FW                                   | —<br>—   |
| Thickness of test piece<br>Length of test piece<br>Outside diameter of tube  | $t, t_1, t_2$<br>$l_1, l_2$<br>$D$         | mm<br>mm<br>mm                                 |
| Test specimen and test piece<br>examination length<br>examination thickness<br>examination area<br>area of imperfections       | $L_f$<br>$a_f$<br>$A_f$<br>$A_i$           | mm<br>mm<br>mm <sup>2</sup><br>mm <sup>2</sup> |
| Side notch<br>square (q)<br>round (r)<br>sharp (s)   | S<br>Sq<br>Sr<br>Ss                        | —<br>—<br>—<br>—                               |
| Longitudinal notch<br>Face notch<br>square (q)<br>round (r)<br>sharp (s)<br>Root notch<br>square (q)<br>round (r)<br>sharp (s) | F<br>Fq<br>Fr<br>Fs<br>R<br>Rq<br>Rr<br>Rs | —<br>—<br>—<br>—<br>—<br>—<br>—<br>—           |

### 6 Dimensions of test pieces

Unless otherwise specified by the application standard or by agreement between the contracting parties, test piece dimensions shall be in accordance with Figures 1 to 4. The test piece shall provide sufficient test specimens for the required total examination length ( $\Sigma L_f$ ) and area ( $\Sigma A_f$ ).



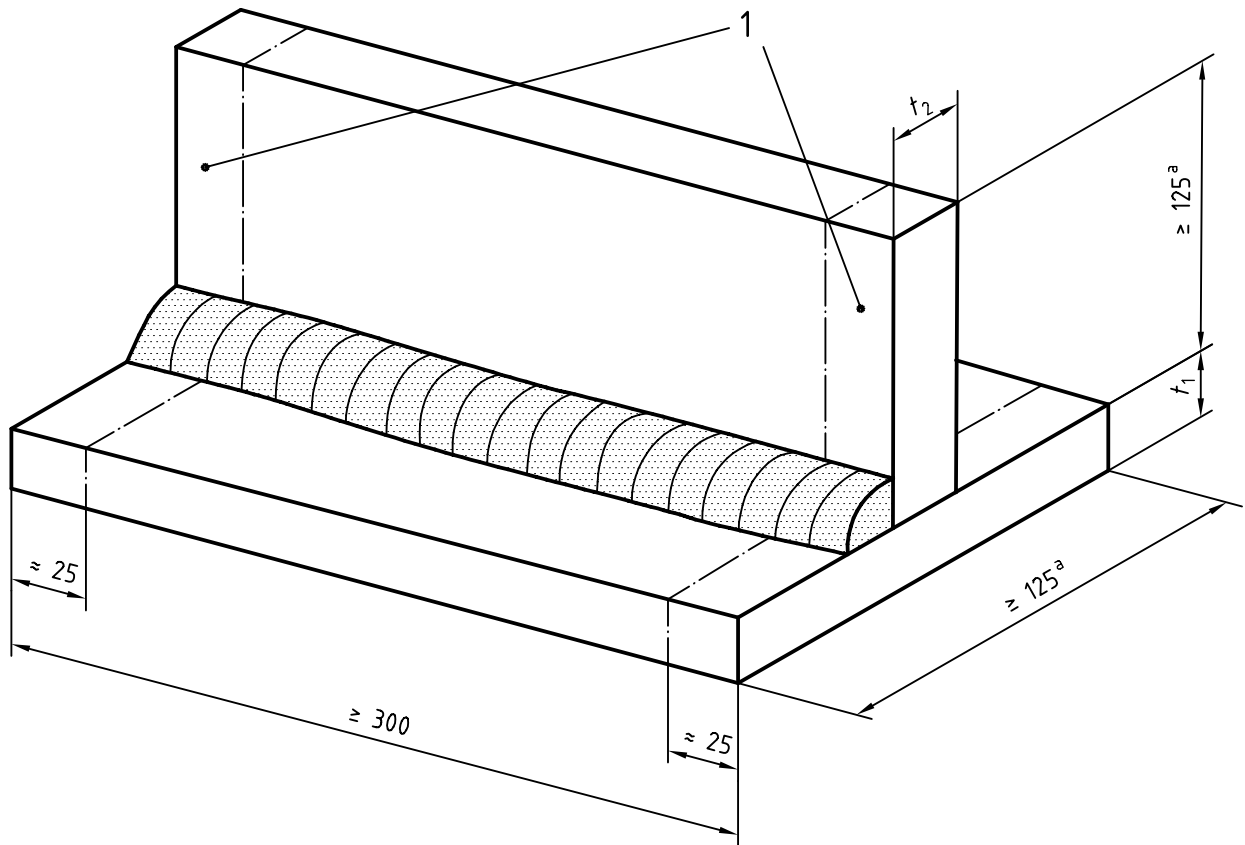
**Figure 1 — Test piece for butt welds in plate**



**Figure 2 — Test piece for butt welds in pipe**



Dimensions in millimetres



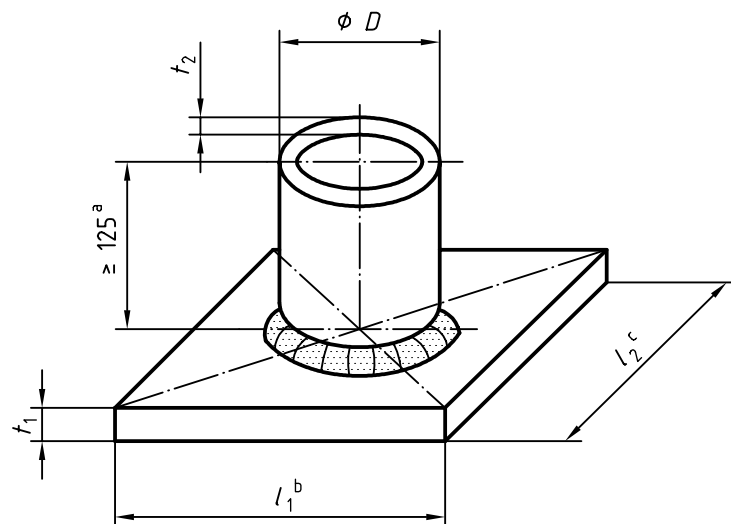
**Key**

1 Discard

a  $\geq 150$  mm for materials of high thermal conductivity (e.g. aluminium and copper)

**Figure 3 — Test piece for fillet welds on plate**

Dimensions in millimetres



a  $\geq 150$  mm for materials of high thermal conductivity (e.g. aluminium and copper)

b  $l_1 \approx l_2$ ;  $l_1 \geq (D + 100)$

c  $l_2 \geq (D + 100)$

**Figure 4 — Test piece for fillet welds on pipe**

## 7 Removal of test specimens

### 7.1 General

The examination length ( $L_f$ ) and area ( $A_f$ ), and the number of test specimens shall be specified by the application standard or by agreement between the contracting parties. Welded joints in plates shall be cut transversely to the welded joint in test specimens of approximately equal weld length. The weld axis shall remain in the middle of the test specimen for butt welds.

For welded joints in pipe, unless otherwise specified in the application standard or by agreement between the contracting parties, the test piece shall provide at least two test specimens.

When carrying out bend tests, equal numbers of specimens shall be tested with the root in tension and the face in tension. If the pipe diameter is too small for removing the required number of test specimens, additional test pieces shall be welded.

### 7.2 Marking

Each test piece shall be marked to identify its exact location in the manufactured product or in the joints from which it has been removed.

When removed from the test piece, each test specimen shall be marked.

### 7.3 Extraction

#### 7.3.1 General

The extraction method shall avoid the introduction of detrimental thermal or mechanical effects.

In general a portion 25 mm from both ends of the test welds shall be discarded, unless information about the ends of the welds is required (e.g. start/stop imperfections).

#### 7.3.2 Steels

The test specimens shall be cut by thermal cutting or by mechanical means.

#### 7.3.3 Other metallic materials

Other metallic materials shall only be cut mechanically.

### 7.4 Preparation

Fracture of welds in plates or pipes may be assisted by one or more of the following:

- removing the weld reinforcement;
- notching both edges of the weld (side notching);
- notching into the reinforcement (longitudinal notching).

Depending on the ductility of the weld metal, square, round or sharp notches may be used, (see Figures 5, 6, 7 and 8). For materials of high ductility (e.g. aluminium and copper) sharp notches may be recommended.

The depth of the notches shall be sufficient to induce fracture in the weld.

Unless otherwise specified by the application standard or by agreement between the contracting parties, the notch depth should be such that:

- for the side notch, examination length,  $L_f$ , shall be greater than or equal to 70 % of the original width of the test specimen,  $w$  (see Figure 6), or the total examination length,  $\Sigma L_f$ , shall be greater than or equal to 60 % of the length of the test specimen;
- for the longitudinal notch, examination thickness,  $a_f$ , shall be greater than or equal to 80 % of the original thickness of the test specimen,  $t$  (see Figure 7).

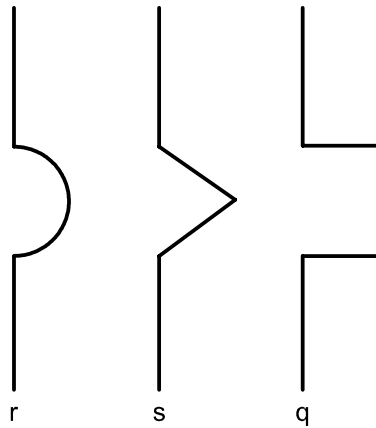
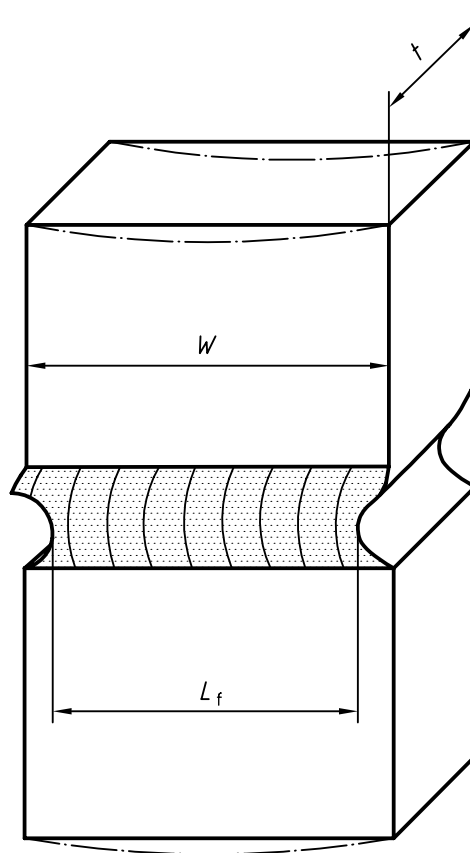


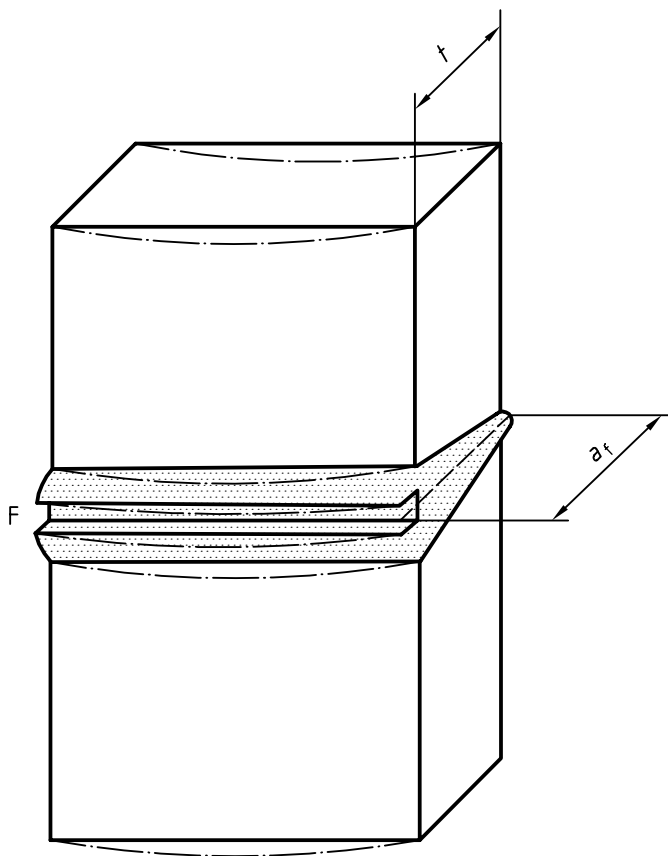
Figure 5 — Notch profiles



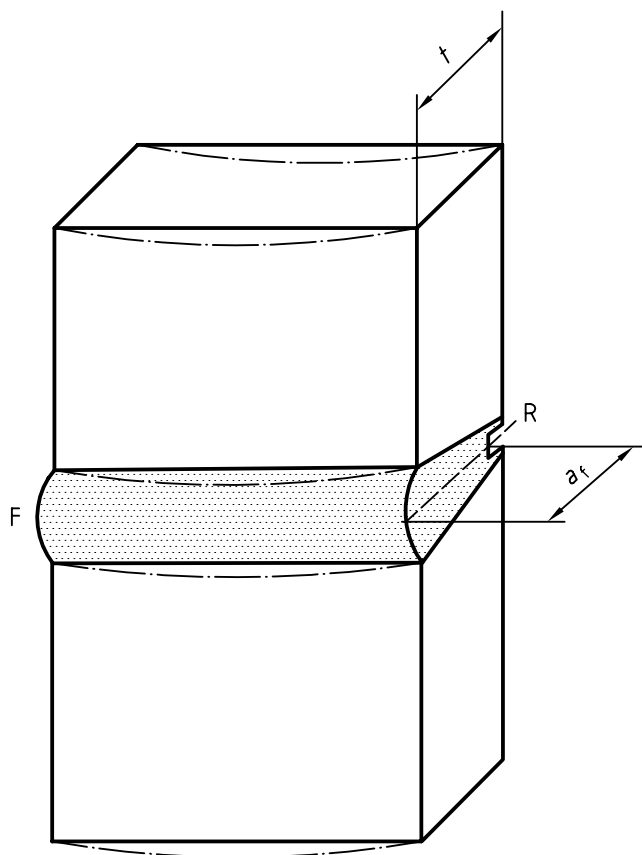
NOTE Full line for plates; chain dotted line for pipes.

Figure 6 — Side notches

a) Face notch



b) Root notch



NOTE Full line for plates; chain dotted line for pipes

Figure 7 — Longitudinal notches in butt welds

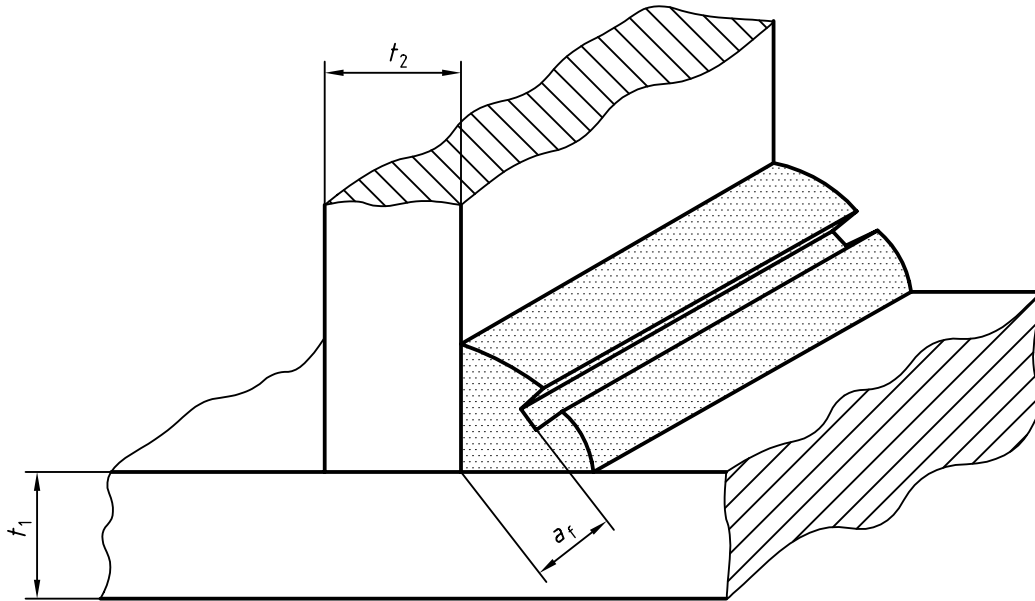


Figure 8 — Longitudinal notch in fillet welds

## 8 Test procedure

### 8.1 Butt welds

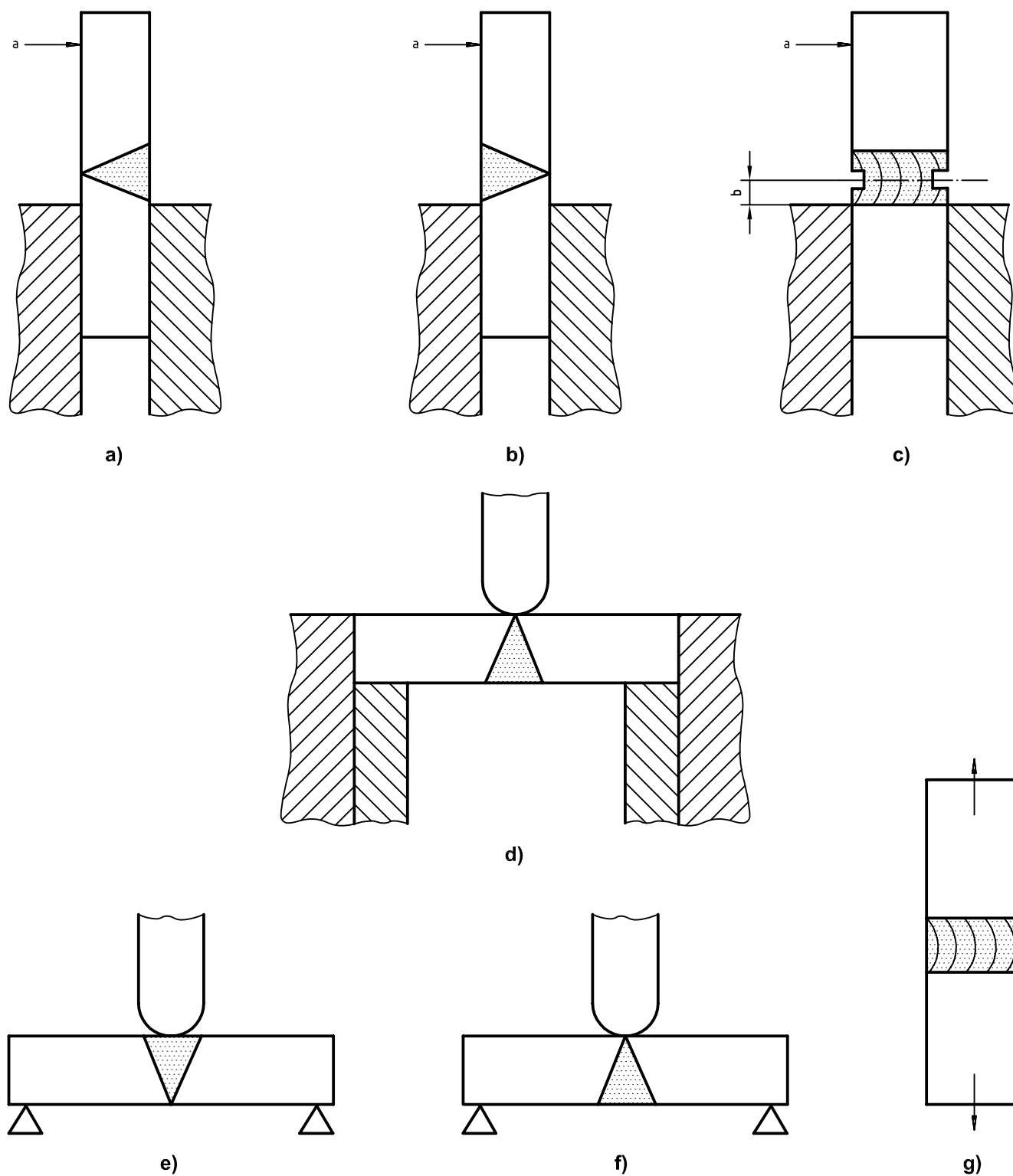
#### 8.1.1 General

Fracture tests may be carried out by:

- dynamic strokes e.g. with a hammer, [see Figures 9 a) ,b) ,c)];
- applying a load by pressing in a vice, bending machine or workshop press [see Figures 9 d), e), f)];
- applying a load by tension [see Figure 9 g)].

For ductile materials, it may be useful to have a minimum distance between the notch and the jaws of the clamping device [see Figure 9 c)].

For some materials, it may be useful to test at a low temperature in order to initiate fracture.



- a Impact.
- b See 8.1.1

**Figure 9 — Examples of test methods for butt welds (BW)**  
 (Notches according to Figures 5 to 7)

### 8.1.2 Thin material

For fracturing thin welded joints alternate bending may be necessary. The limit depends on the ductility of the material. It shall be carried out by pressing the test specimen, close to the notch, in the jaws. If no fracture occurs, straightening and repeated bending shall follow.

Tension testing [see Figure 9 g)] may be also used instead of bending. Striking with a hammer is not recommended for fracture tests on thin materials.

### 8.1.3 Thick material

Thicker materials may be fractured by hammer strokes.

When a bending machine is used, the diameter of the former shall be chosen in such a way that the fracture occurs without the need for alternate bending.

Bending may be carried out either with the weld perpendicular or transverse to the direction of the applied force according to Figures 9 c), d), e), f). The lowest limit for the test for aluminium is approximately 8 mm thickness.

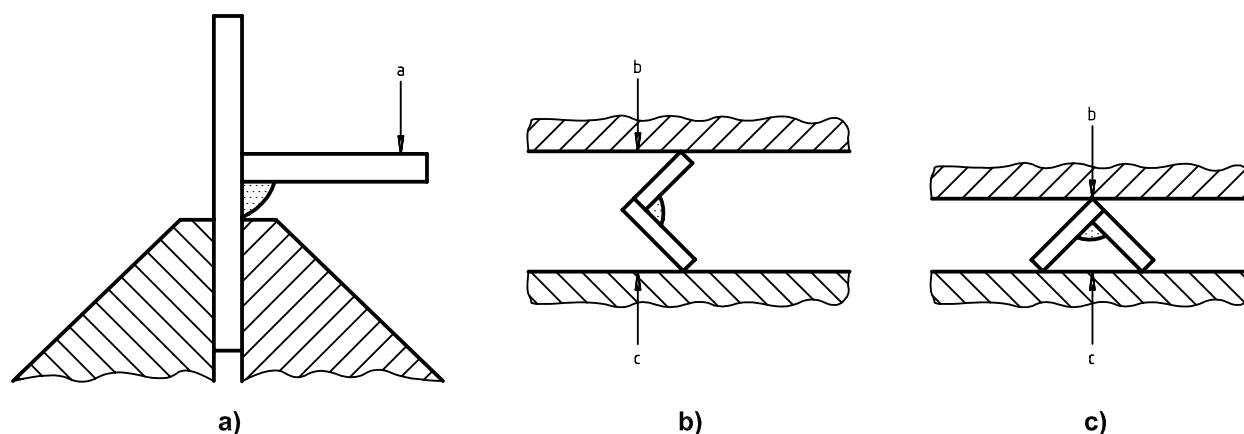
## 8.2 Fillet welds

Test methods are similar to those for butt welds (see 8.1) except that tension testing is not possible. Examples are given in Figure 10.

### 8.3 Special recommendations for ductile weld metals

For ductile weld metals such as austenitic steels, aluminium, copper, nickel and their alloys, it may be necessary to restrict the thickness of the test specimen and the throat thickness, increase the width of the notch, decrease the radius of the notch and increase the severity (stroke loading, hammer loading) of the test, if fracture is required in the weld metal.

For ductile weld metals such as ferritic steel, it may be necessary to cool the test specimen.



- a Stroke
- b Direction of movement
- c Movement, if applicable

**Figure 10 — Examples of test methods for fillet welds (FW)**  
(Notches according to Figures 5 and 8)

## **9 Test result**

The fracture surface shall be examined visually in accordance with EN 970. For clear detection and identification of imperfections a low magnifying glass (up to five times) may be used.

A full description of the appearance of the fracture surface and the type and location of any imperfection present shall be reported. It shall be stated that the quality has been evaluated in accordance with ISO 5817 or ISO 10042. The quality level is specified by the application standard or by agreement between the contracting parties.

## **10 Test report**

The test report shall contain the following information:

- a) reference to this International Standard, i.e. ISO 9017;
- b) identification of the test specimen;
- c) specimen denomination in accordance with Table 1;
- d) records of types, locations and sizes of all unacceptable imperfections in accordance with the relevant quality level.

An example of a typical test report is given in annex A.



**Annex A**  
(informative)

**Example of a test report**

No. ....

According to pWPS .....

According to test result "fracture test"  
test result "....."

Manufacturer: .....

Purpose of the examination: .....

Form of product: .....

Parent metal: .....

Consumable: .....

Denomination of test piece: .....

**Table A.1 — Fracture test in accordance with ISO 9017**

| Test specimen | Denomination | Results                        |               |
|---------------|--------------|--------------------------------|---------------|
|               |              | Type and size of imperfections | Quality level |
|               |              |                                |               |

Examiner or examining body:  
.....  
(name, date and signature)

Certified by:  
.....  
(name, date and signature)

