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**Specification and approval of welding  
procedures for metallic materials —**

**Part 4:**

Welding procedure tests for the arc welding  
of aluminium and its alloys

ISO 9956-4:1995

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*Descriptif et qualification d'un mode opératoire de soudage pour les  
matériaux métalliques —*

*Partie 4: Épreuve de qualification d'un mode opératoire de soudage à l'arc  
sur l'aluminium et ses alliages*



Reference number  
ISO 9956-4:1995(E)

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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.

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.

International Standard ISO 9956-4 was prepared by Technical Committee ISO/TC 44, *Welding and allied processes*, Subcommittee SC 10, *Unification of requirements in the field of metal welding*.

This part of ISO 9956 is the equivalent of European Standard EN 288-4.

ISO 9956 consists of the following parts, under the general title *Specification and approval of welding procedures for metallic materials*:

- Part 1: *General rules for fusion welding*
- Part 2: *Welding procedure specification for arc welding*
- Part 3: *Welding procedure tests for the arc welding of steels*
- Part 4: *Welding procedure tests for the arc welding of aluminium and its alloys*
- Part 5: *Approval by using approved welding consumables for arc welding*
- Part 6: *Approval related to previous experience*
- Part 7: *Approval by a standard welding procedure for arc welding*
- Part 8: *Approval by a pre-production welding test*
- Part 10: *Welding procedure specification for electron beam welding*
- Part 11: *Welding procedure specification for laser beam welding*
- Part 12: *Welding procedure test for arc welding of cast steels*

Annexes A and B of this part of ISO 9956 are for information only.

## Introduction

This part of ISO 9956 does not invalidate previous welding procedure approvals made to former national standards or specifications providing the intent of the technical requirements is satisfied and the previous procedure approvals are relevant to the application and production work on which they are to be employed.

Also, where additional tests have to be carried out to make the approval technically equivalent, it is only necessary to do the additional tests on a test piece which should be made in accordance with this part of ISO 9956.

Consideration of previous procedure approvals to former national standards or specifications should be agreed between the contracting parties at the time of the enquiry or contract stage.

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# Specification and approval of welding procedures for metallic materials —

## Part 4:

## Welding procedure tests for the arc welding of aluminium and its alloys

### 1 Scope

This part of ISO 9956 specifies how a welding procedure specification is approved by welding procedure tests.

It defines the conditions for the execution of welding procedure approval tests and the limits of validity of an approved welding procedure for all practical welding operations within the range of variables listed in clause 8.

It is intended that tests be carried out in accordance with this part of ISO 9956 unless more severe tests are specified by the relevant application standard or contract.

This part of ISO 9956 applies to the arc welding of wrought aluminium and its weldable alloys according to ISO 2092 and ISO 2107. In this part of ISO 9956 the term aluminium stands for aluminium and its alloys. The principles of this part of ISO 9956 may be applied to other fusion welding processes subject to agreement between the contracting parties.

NOTE 1 Specific service, material or manufacturing conditions may require more comprehensive testing than is specified by this standard in order to gain more information and to avoid repeating the welding procedure test at a later date just to obtain additional test data.

Such tests may include:

— longitudinal weld tensile test;

— weld bend test or special bend test to measure elongation;

— Charpy V-notch impact test;

— 0,2 % proof stress;

— elongation;

— chemical analysis.

Arc welding is covered by the following processes in accordance with ISO 4063:

131 — metal-arc inert gas welding (MIG welding);

141 — tungsten inert gas arc welding (TIG welding);

15 — plasma arc welding;

other fusion welding processes by agreement.

### 2 Normative references

The following standards contain provisions which, through reference in this text, constitute provisions of this part of ISO 9956. At the time of publication, the editions indicated were valid. All standards are subject to revision, and parties to agreements based on this part of ISO 9956 are encouraged to investigate the possibility of applying the most recent editions of the standards indicated below. Members of IEC and ISO maintain registers of currently valid International Standards.

ISO 2092:1981, *Light metals and their alloys — Code of designation based on chemical symbols.*

ISO 2107:1983, *Aluminium, magnesium and their alloys — Temper designations.*

ISO 2437:1972, *Recommended practice for the X-ray inspection of fusion welded butt joints for aluminium and its alloys and magnesium and its alloys 5 to 50 mm thick.*

ISO 3452:1984, *Non-destructive testing — Penetrant inspection — General principles.*

ISO 4063:1990, *Welding, brazing, soldering and braze welding of metals — Nomenclature of processes and reference numbers for symbolic representation on drawings.*

ISO 4136:—<sup>1)</sup>, *Welding — Welded butt joints in metallic materials — Transverse tensile tests.*

ISO 5173:—<sup>2)</sup>, *Welding — Welded butt joints in metallic materials — Bend tests.*

ISO 6520:1982, *Classification of imperfections in metallic fusion welds, with explanations.*

ISO 6947:1990, *Welds — Working positions — Definitions of angles of slope and rotation.*

ISO 9606-2:1994, *Approval testing of welders — Fusion welding — Part 2: Aluminium and aluminium alloys.*

ISO 9956-1:1995, *Specification and approval of welding procedures for metallic materials — Part 1: General rules for fusion welding.*

ISO 9956-2:1995, *Specification and approval of welding procedures for metallic materials — Part 2: Welding procedure specification for arc welding.*

ISO 10042:1992, *Arc-welded joints in aluminium and its weldable alloys — Guidance on quality levels for imperfections.*

### 3 Definitions

For the purposes of this part of ISO 9956, the definitions given in ISO 9956-1 apply.

1) To be published. (Revision of ISO 4136:1989)

2) To be published. (Revision of ISO 5173:1981)

## 4 Preliminary welding procedure specification (pWPS)

The preliminary welding procedure specification shall be prepared in accordance with ISO 9956-2. It shall specify the range for all the relevant parameters.

## 5 Welding procedure test

The making and testing of test pieces representing the type of welding used in production shall be in accordance with clauses 6 and 7.

The welder who undertakes the welding procedure test satisfactorily in accordance with this part of ISO 9956 is approved for the appropriate range of approval given in the relevant part of ISO 9606.

## 6 Test piece

### 6.1 General

The welded assembly to which the welding procedure will relate in production shall be represented by making a standardized test piece or pieces, as specified in 6.2.

### 6.2 Shape and dimensions of test pieces

The test pieces shall be of a sufficient size to ensure a reasonable heat distribution.

Additional test pieces, or longer test pieces than the minimum size, may be prepared in order to allow for extra and or for re-testing specimens (see 7.5).

If required by the application standard, the direction of working, e.g. extrusion, should be marked on the test piece.

The thickness and/or pipe outside diameter of the test pieces shall be selected in accordance with 8.3.2.1 to 8.3.2.4.

Unless otherwise specified, the shape and minimum dimensions of the test piece shall be as follows.

NOTE 2 In figures 1 to 4,  $t$  is the thickness of the thicker component part.

#### 6.2.1 Butt weld in plate

The test piece shall be in accordance with figure 1. The length of the test piece shall be such as to pro-



vide for the appropriate test specimens as given in table 1.

### 6.2.2 Butt weld in pipe

The test piece shall be in accordance with figure 2. When small pipe diameters are used, several test pieces may be necessary.

NOTE 3 The word "pipe", alone or in combination, is used to mean "pipe", "tube" or "hollow section".

### 6.2.3 Branch connection

The test piece shall be in accordance with figure 3. The angle  $\alpha$  is the minimum to be used in production.

A branch connection is considered as a fully penetrated joint (set-on or set-in or set-through joint).

### 6.2.4 Fillet weld

The test piece shall be in accordance with figure 3 or 4.

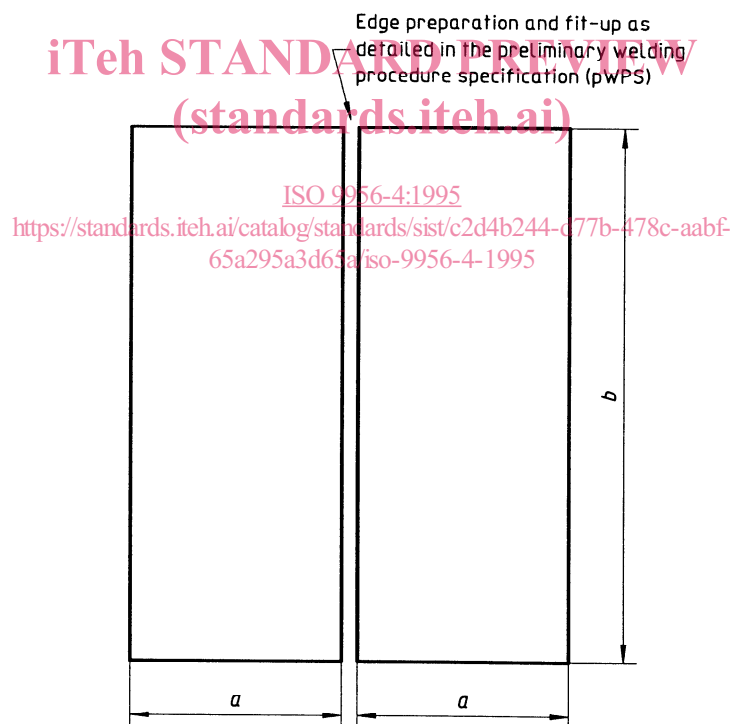
These may also be used with an edge preparation to give partial penetration.

### 6.3 Welding of test pieces

Preparation and welding of test pieces shall be carried out in accordance with the pWPS and under the general conditions of production welding which they shall represent. Welding positions and limitations for the angle of slope and rotation of the test piece shall be in accordance with ISO 6947.

If tack welds are to be fused into the final joint they shall be included in the test piece.

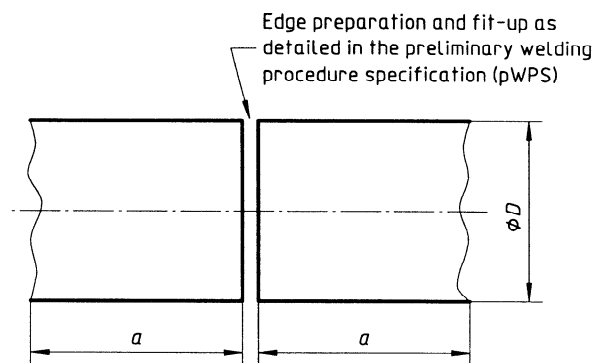
Welding and testing of the test pieces shall be witnessed by an examiner or test body.



$$a = 3t \text{ (150 mm min.)}$$

$$b = 6t \text{ (350 mm min.)}$$

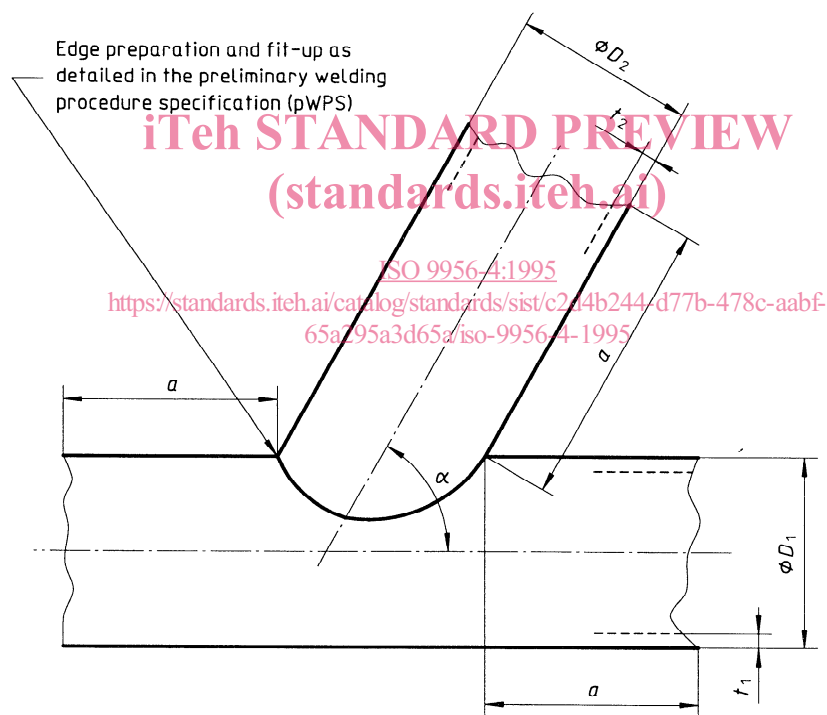
Figure 1 — Test piece for a butt weld in plate



$a = 150$  mm min.

$D =$  outside diameter

**Figure 2 — Test piece for a butt weld in pipe**



$a = 150$  mm min.

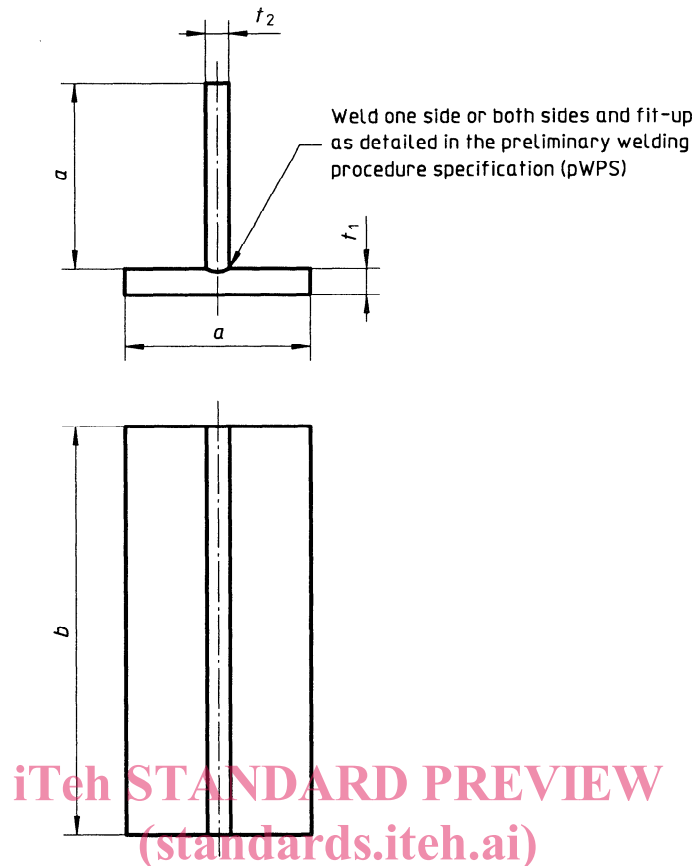
$D_1 =$  outside diameter of the main pipe

$t_1 =$  wall thickness of the main pipe

$D_2 =$  outside diameter of the branch pipe

$t_2 =$  wall thickness of the branch pipe

**Figure 3 — Test piece for a branch connection or a fillet weld on pipe**



$a = 3t$  (150 mm min.)

$b = 6t$  (350 mm min.)

$t_1$  and  $t_2$  = thicknesses of the plates

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**Figure 4 — Test piece for a fillet weld on plate**

## 7 Examination and testing

### 7.1 Extent of testing

The testing includes both nondestructive examination (NDE) and destructive testing which shall be in accordance with the requirements of table 1.

### 7.2 Location and cutting of test specimens

The location of test specimens shall be in accordance with figures 5, 6, 7 and 8.

Test specimens shall be taken after NDE has shown satisfactory results. It is permitted to take the test specimens from locations avoiding areas showing acceptable imperfections.

## 7.3 Nondestructive examination

### 7.3.1 Method

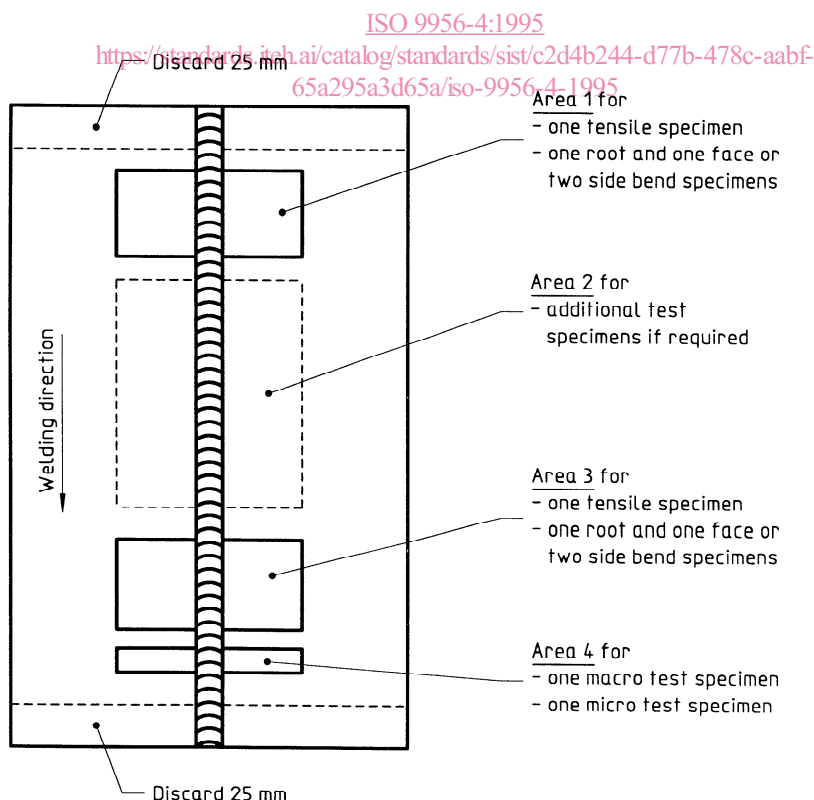
After any required post-weld heat treatment, natural or artificial ageing and prior to the cutting of test specimens, all test pieces shall be examined visually and non-destructively in accordance with 7.1.

Depending upon joint geometry, materials and the requirements for production work, the NDE shall be carried out in accordance with appropriate standards (e.g. ISO 2437).

**Table 1 — Examination and testing of the test pieces**

Test piece	Type of test	Extent of testing
Butt weld (see figures 1 and 2)	Visual Radiographic or ultrasonic Dye penetrant test <sup>1)</sup> Transverse tensile test Transverse bend test <sup>2)</sup> Macro-examination Micro-examination <sup>3)</sup>	100 % 100 % 100 % Two specimens Two root and two face specimens One specimen One specimen
Branch connection <sup>4)</sup> (see figure 3)	Visual Dye penetrant test <sup>1)</sup> Radiographic or ultrasonic <sup>5)</sup> Macro-examination Micro-examination <sup>3)</sup>	100 % 100 % 100 % Two specimens One specimen
Fillet weld on plate <sup>4)</sup> (see figure 4) Fillet weld on pipe <sup>4)</sup> (see figure 3)	Visual Dye penetrant test <sup>1)</sup> Macro-examination Micro-examination <sup>3)</sup>	100 % 100 % Two specimens One specimen

- 1) In accordance with ISO 3452.
- 2) Two root and two face bend test specimens may be substituted by four side bend test specimens for  $t \leq 12$  mm.
- 3) Only for material groups 22 and 23.
- 4) When the pWPS or WPS has not been approved by other means, additional tests for the mechanical properties of the joint should be considered.
- 5) For outside diameter less than or equal to 50 mm, no radiographic or ultrasonic test is required.



**Figure 5 — Location of test specimens for a butt weld in plate**