

Specification and approval of welding procedures for metallic materials

Part 4. Welding procedure tests for the arc welding of aluminium and its alloys

The European Standard EN 288 : Part 4 : 1992 has the status of a
British Standard

Descriptif et qualification d'un mode
opérateur de soudage sur les matériaux
métalliques
Partie 4: Epreuve de qualification d'un mode
opérateur de soudage à l'arc sur aluminium et
ses alliages

Anforderung und Anerkennung von
Schweißverfahren für metallische Werkstoffe
Teil 4: Schweißverfahrensprüfungen für das
Lichtbogenschweißen von Aluminium und
seinen Legierungen

UDC 621.791.75(083.1) : 669.71 : 620.1

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National foreword

This British Standard has been prepared under the direction of the Welding Standards Policy Committee and is the English language version of EN 288, 'Specification and approval of welding procedures for metallic materials — Part 4 : Welding procedure tests for the arc welding of aluminium and its alloys' published by the European Committee for Standardization (CEN). It will supersede BS 4870 : Part 2 : 1982 which will be withdrawn on 31 January 1993.

EN 288 : Part 4 was produced as a result of international discussion in which the UK took an active part.

National appendix NA gives the constitution of the committees responsible for UK participation in the preparation of this standard.

Compliance with a British Standard does not of itself confer immunity from legal obligations.

EUROPEAN STANDARD

EN 288-4 : 1992

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metallic materials —
Part 4: Welding procedure tests for the arc welding of
aluminium and its alloys

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Up-to-date lists and bibliographical references concerning such national standards may be obtained on application to the Central Secretariat or to any CEN member.

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CEN

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Foreword

This European Standard has been prepared by Working Group 1 'Specification and approval of welding procedures for metallic materials' of CEN/TC 121 'Welding'.

For this standard, ISO/TC 44/SC10N177 was considered and used as a basis. However, alterations were necessary due to the consideration of experience and updated knowledge.

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 1993-02, and conflicting national standards shall be withdrawn at the latest by 1993-02.

In accordance with the Common CEN/CENELEC Rules, the following countries are bound to implement this European Standard: Austria, Belgium, Denmark, Finland, France, Germany, Greece, Iceland, Ireland, Italy, Luxembourg, Netherlands, Norway, Portugal, Spain, Sweden, Switzerland and United Kingdom.

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0 Introduction

All new welding procedure approvals are to be in accordance with this standard from the date of this issue.

However, this standard 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 standard.

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

1 Scope

This standard 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.

Tests shall be carried out in accordance with this standard unless more severe tests are specified by the relevant application standard or contract, when they shall be applied.

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

NOTE: 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

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

- | | |
|----------------|--|
| EN 287-2, | Approval testing of welders – Fusion welding – Part 2: Aluminium and aluminium alloys. |
| EN 288-1, | Specification and approval of welding procedures for metallic materials – Part 1: General rules for fusion welding. |
| EN 288-2, | Specification and approval of welding procedures for metallic materials – Part 2: Welding procedure specification for arc welding. |
| EN 26520, | Classification of imperfections in metallic fusion welds, with explanation |
| EN..., | Welded butt joints in metallic materials – Transverse tensile tests (Document CEN/TC 121/N139) ¹⁾ |
| EN..., | Welded butt joints in metallic materials – Bend test (Document CEN/TC 121/N138) ¹⁾ |
| 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 |

¹⁾ Under preparation

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- 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 6947:1990, Welds – Working positions – Definitions of angles of slope and rotation
- ISO/DIS 10042.2, Arc-welded joints in aluminium and its weldable alloys – Acceptance levels in fusion welding.¹⁾

3 Definitions

For the purpose of this standard, the definitions listed in part 1 of this standard apply.

4 Preliminary welding procedure specification (pWPS)

The preliminary welding procedure specification shall be prepared in accordance with part 2 of this standard. 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 of this standard.

The welder who undertakes the welding procedure test satisfactorily in accordance with this standard is approved for the appropriate range of approval given in the relevant part of EN 287.

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.

In figures 1 to 4, "t" is the thickness of the thicker component part.

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.

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

¹⁾ Under preparation.

6.2.3 Branch connection

The test piece shall be in accordance with figure 3. The angle α 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.

Edge preparation and fit-up as detailed
in the preliminary Welding Procedure Specification (pWPS)

$a = 3t$; minimum value 150 mm

$b = 6t$; minimum value 350 mm

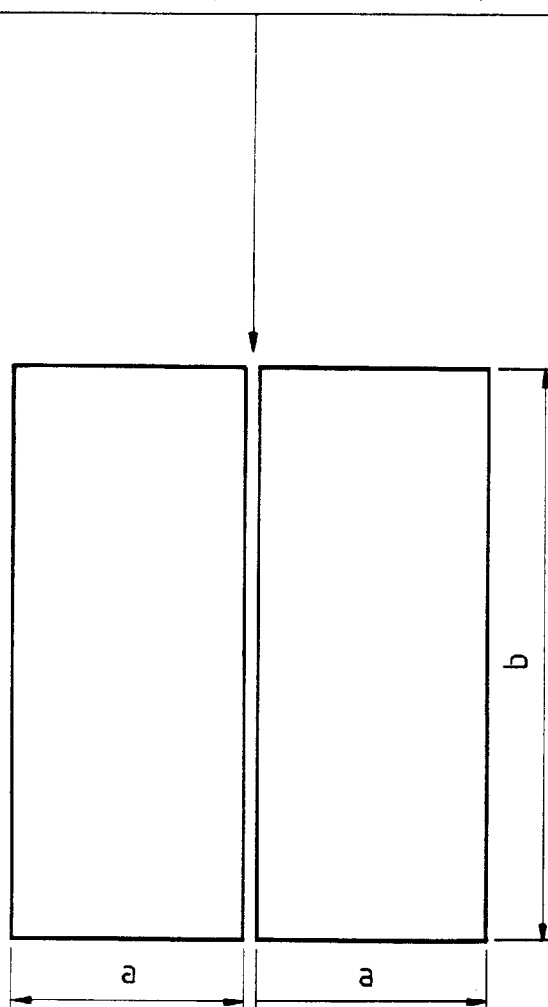
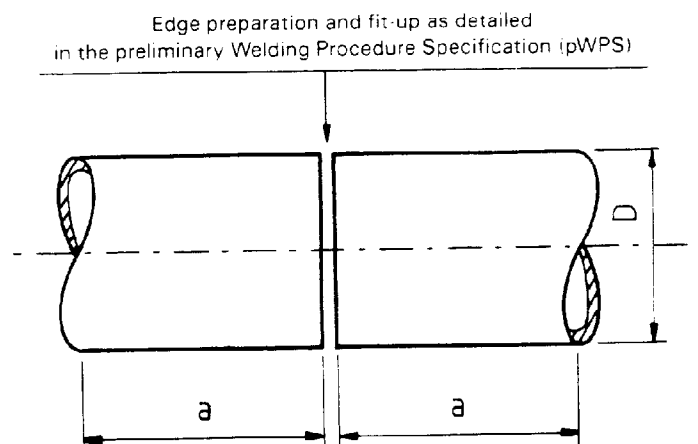


Figure 1: Test piece for a butt weld in plate

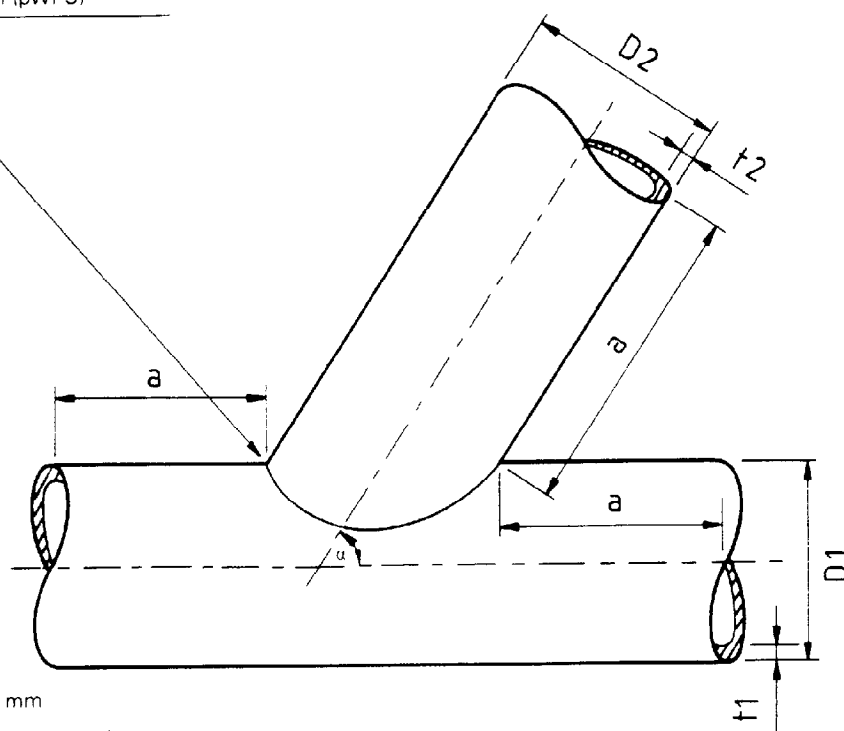


a = minimum value 150 mm

D = outside diameter

Figure 2: Test piece for a butt weld in pipe

Edge preparation and fit-up
as detailed in the preliminary Welding
Procedure Specification (pWPS)



a = minimum value 150 mm

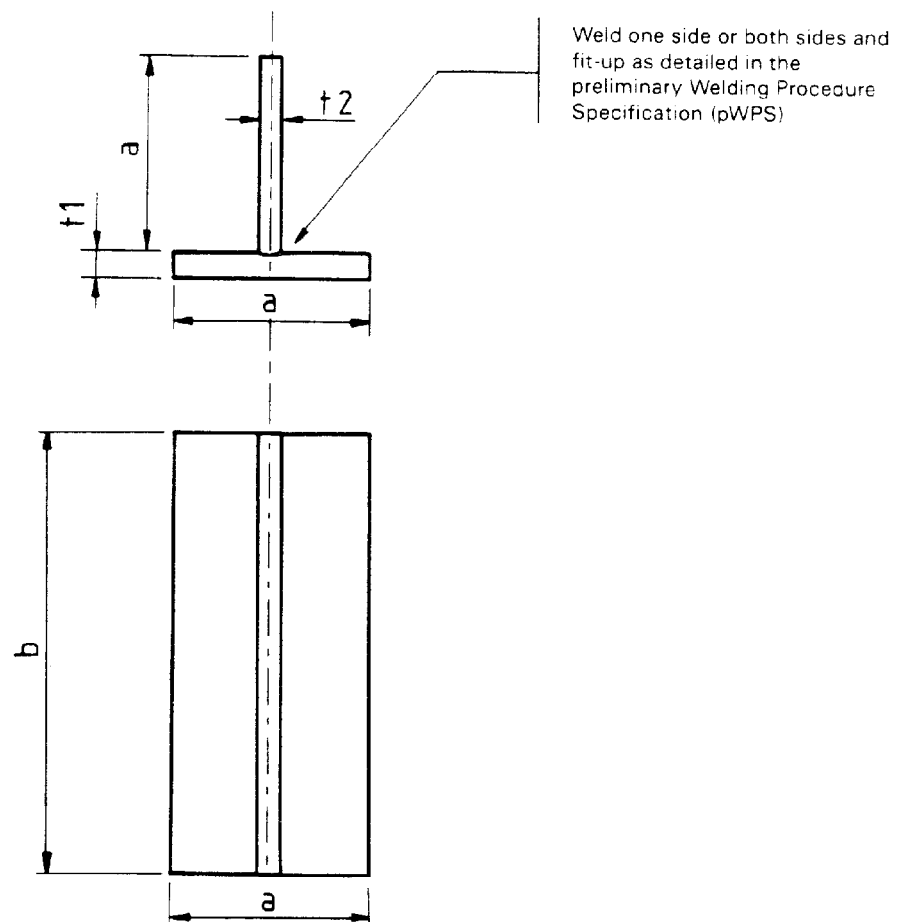
$D1$ = outside diameter of the main pipe

$t1$ = wall thickness of the main pipe

$D2$ = outside diameter of the branch pipe

$t2$ = wall thickness of the branch pipe

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



$a = 3t$; minimum value 150 mm

$b = 6t$; minimum value 350 mm

$t1$ and $t2$ = thicknesses of the plates

Figure 4: Test piece for a fillet weld on plate

7 Examination and testing

7.1 Extent of testing

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

Table 1: Examination and testing of the test pieces

Test piece	Type of test	Extent of testing	Note
Butt weld figures 1 and 2	Visual	100 %	—
	Radiographic or ultrasonic	100 %	—
	Dye penetrant test	100 %	5
	Transverse tensile test	2 specimens	—
	Transverse bend test	2 root and 2 face specimens	1
	Macro-examination	1 specimen	—
	Micro-examination	1 specimen	2
Branch connection (3) figure 3	Visual	100 %	—
	Dye penetrant test	100 %	5
	Radiographic or ultrasonic	100 %	4
	Macro-examination	2 specimens	—
	Micro-examination	1 specimen	2
Fillet weld on plate (3) figure 4 Fillet weld on pipe (3) figure 3	Visual	100 %	—
	Dye penetrant test	100 %	5
	Macro-examination	2 specimens	—
	Micro-examination	1 specimen	2
NOTE 1: 2 root and 2 face bend test specimens may be preferably substituted by 4 side bend test specimens for $t \geq 12$ mm.			
NOTE 2: Only for material groups 22 and 23.			
NOTE 3: When the pWPS or WPS has not been approved by other means, additional tests for the mechanical properties of the joint should be considered.			
NOTE 4: For outside diameter ≤ 50 mm no radiographic or ultrasonic test is required.			
NOTE 5: According to ISO 3452.			

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.

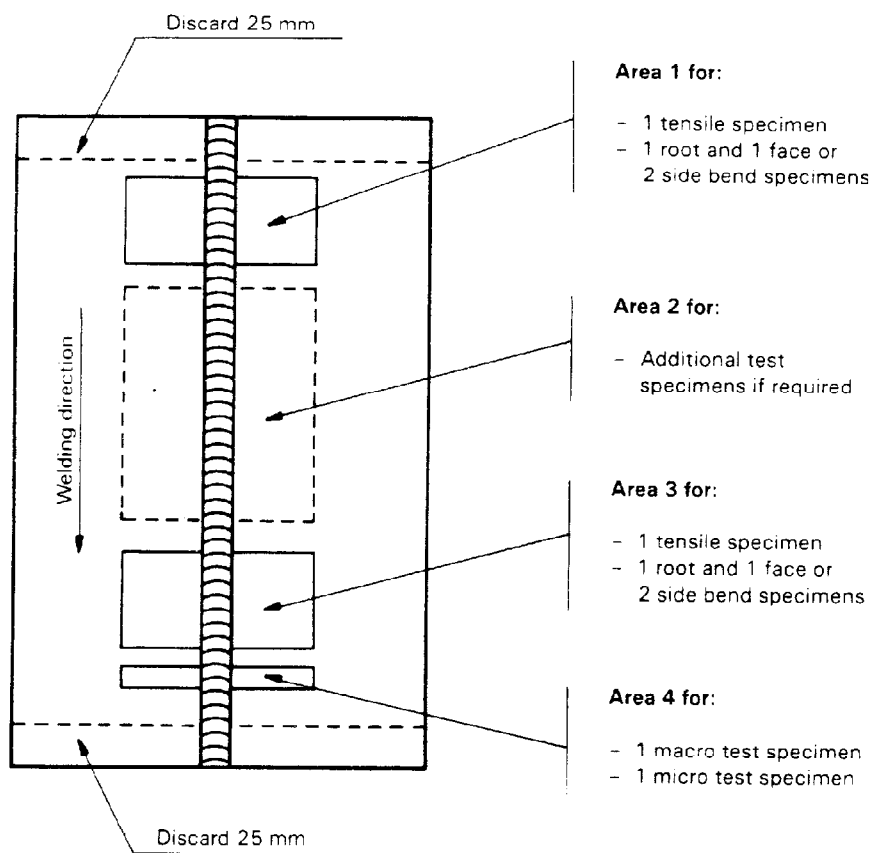


Figure 5: Location of test specimens for a butt weld in plate

Top for fixed pipe

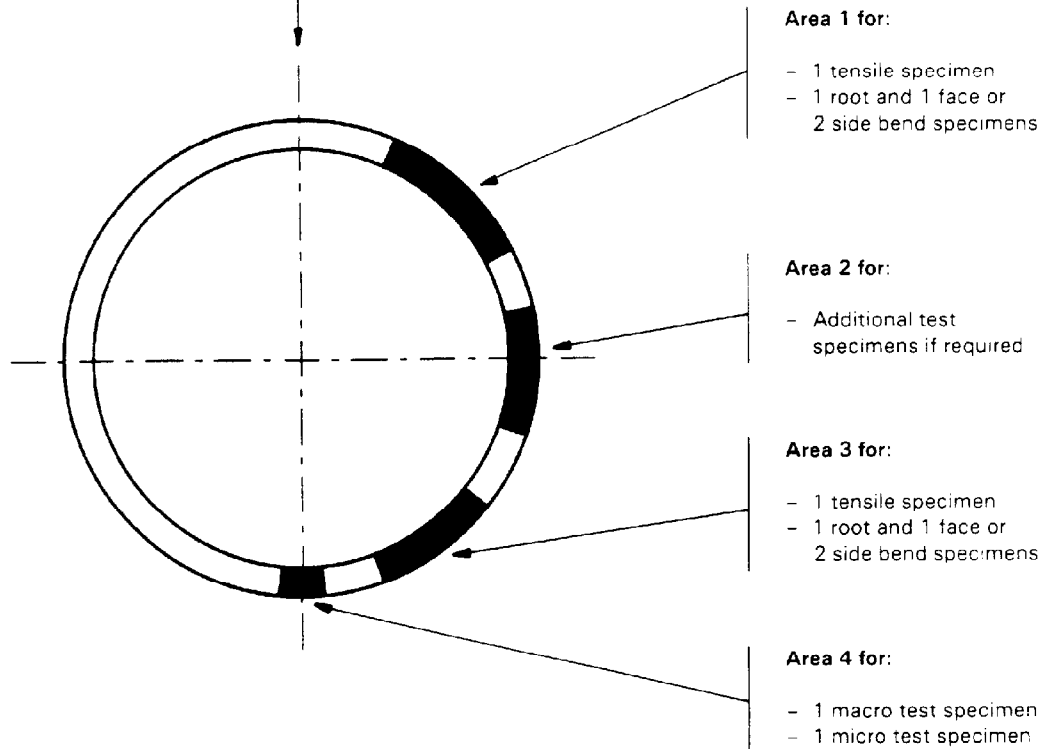


Figure 6: Location of test specimens for a butt weld in pipe

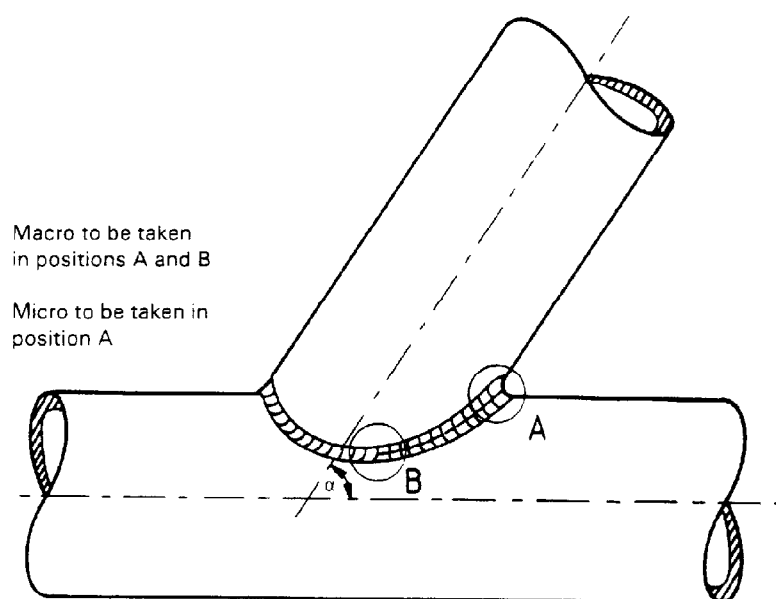


Figure 7: Location of test specimens for a branch connection or a fillet weld on pipe

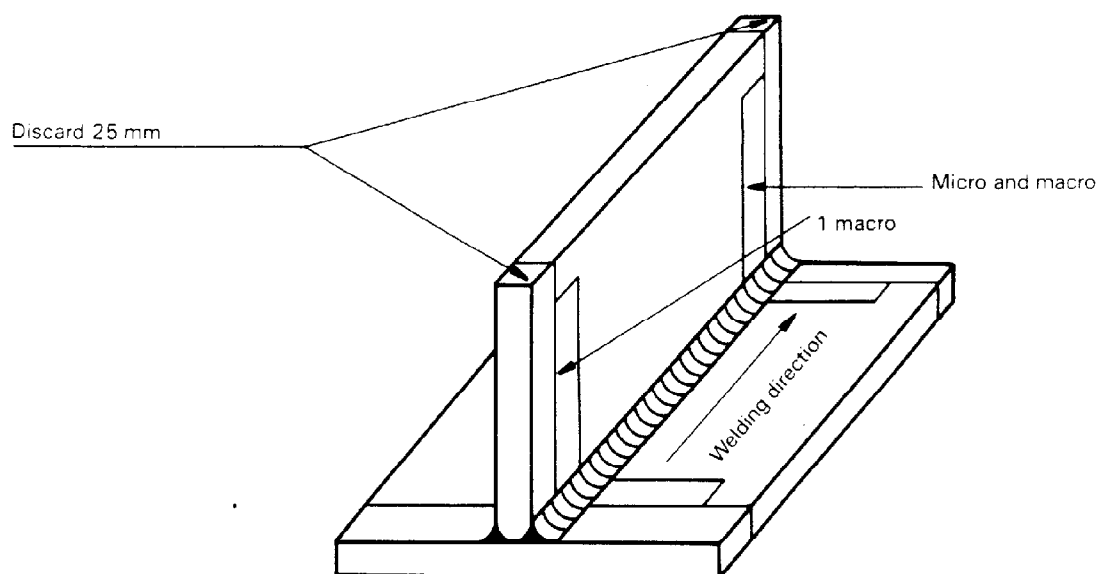


Figure 8: Location of test specimens for a fillet weld on plate

7.3 Non-destructive 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 according to appropriate standards (e.g. ISO 2437).

7.3.2 Acceptance levels

A weld procedure is approved if the imperfections in the test piece are within the specified limits of level B in ISO DIS 10042.2, except for imperfection types as follows: excess weld metal, excessive convexity, excess throat thickness and excessive penetration, for which level C shall apply.

7.4 Destructive tests

7.4.1 Transverse tensile testing

Specimens and testing for transverse tensile testing for butt joints shall be in accordance with EN... (Document CEN/TC 121/N139).

Note: The testing should be carried out to agreed conditions until ISO- or EN standard covering the test is available.

For pipes > 50 mm outside diameter, the weld reinforcement shall be removed on both faces to give the test specimen a thickness equal to the wall thickness of the pipe.

For pipes ≤ 50 mm outside diameter, and when full section small diameter pipes are used, the weld reinforcement may be left undressed on the inside surface of the pipe.

The tensile strength of the test specimen shall normally not be less than the corresponding specified minimum value for the parent metal, in the soft condition for groups 21, 22 a and 22 b, see table 2.

The tensile strength [Rm(w)] of the welded test specimen shall satisfy the following requirement:

$$Rm(w) = Rm(pm) \times T$$

Where Rm(pm) is the specified minimum tensile strength of the parent metal;

T is the joint efficiency factor

Table 2: Efficiency for tensile strength of butt welds

Material group (see table 4)		Temper/Condition of parent metal before welding ^{1) 2)}	Post weld ageing ³⁾	$T = \frac{R_m(w)}{R_m(pm)}$
21		F O H12 H14 H16 H18 H19	–	1,0 ⁴⁾
22a and 22b		H112 H22 H24 H26 H28 H29 H32 H34 H38 H39	–	1,0 ⁴⁾
23	Al-Mg Si alloys	T4	Natural	0,9
		T4	Artificial	0,7 ^{5) 7)}
		T5-T6	Natural	0,6
		T5-T6	Artificial	0,7 ⁷⁾
	Al-Zn Mg alloys	T4	Natural	0,95
		T4	Artificial	0,75 ^{5) 7)}
		T6	Natural	0,75
		T6	Artificial	0,75 ⁷⁾
Other alloys		T4 and T6	– ⁶⁾	– ⁶⁾

NOTE 1: See ISO 2107.

NOTE 2: For parent metal in other tempers not shown in the table, Rm(w) shall be agreed between the contracting parties.

NOTE 3: See 7.3.1.

NOTE 4: Rm(pm) is based on the specified minimum tensile strength of the "O" condition, irrespective of the actual parent metal temper used for the test.

NOTE 5: When the test pieces are artificially aged after welding and prior to testing, the factor T applies to the T6 parent metal condition.

NOTE 6: The post weld ageing conditions and Rm(w) shall be agreed between the contracting parties.

NOTE 7: Higher properties may be achieved if post-weld full heat treatment is applied to group 23 alloys and Rm(w) shall be agreed between the contracting parties.

7.4.2 Bend testing

Specimens and testing for bend testing for butt joints shall be in accordance with EN.... (Document CEN/TC 121/N138).

Note: The testing should be carried out to agreed conditions until ISO- or EN standard covering the test is available.

During testing, the test specimens shall not reveal any one single flaw > 3 mm in any direction. Flaws appearing at the corners of a test specimen during testing shall be ignored in the evaluation.

For alloys of low ductility (group 22b and 23) there are two options:

- The test specimens are annealed before testing and then apply the "O" conditions in table 3 – See 7.4.1.
- The test specimens are not annealed before testing and then apply the conditions in table 3 related to the appropriate temper.

Table 3: Former diameters of bend tests

Group of Materials	Former diameter								
	Temper or condition (See ISO 2107)								
	0	F H 112 H 12 H 22 H 32	H 14 H 24 H 34	H 16 H 26 H 36	H 18 H 28 H 38	H 19 H 29 H 39	T4	T5-T6	T7
21	2t	3t	3t	3t	4t	4t	-	-	-
22a	3t	3t	3t	4t	5t	5t	-	-	-
22b	6t	6t	6t	6t	6t	6t	-	-	-
23	4t	-	-	-	-	-	6t	7t	6t

7.4.3 Macro-examination

The test specimen shall be prepared and etched on one side to clearly reveal the fusion line, the HAZ and the build up of the runs.

The macro-examination shall include unaffected parent metal.

The acceptance levels stated in 7.3.2 shall apply.

7.4.4 Micro-examination

The test specimens shall be prepared and etched on one side to clearly reveal the fusion line, the structure of the weld metal, and of the HAZ.

7.5 Re-testing

If the test piece fails to comply with any of the requirements for visual examination or NDE specified in 7.3.2, one further test piece shall be welded and subjected to the same examination. If this additional test piece does not comply with the relevant requirements, the pWPS shall be regarded as not capable of complying with the requirements of this standard without modification.

If any test specimen fails to comply with the relevant requirements of 7.4 only due to geometric weld imperfections, two further test specimens shall be obtained for each one that failed. These can be taken from the same test piece if there is sufficient material available or from a new test piece, and shall be subjected to the same test.

If either of these additional test specimens does not comply with the relevant requirements, the pWPS shall be regarded as not capable of complying with the requirements of this standard without modification.

8 Range of approval

8.1 General

All the conditions of validity stated below shall be met independently of each other.

Changes outside of the ranges specified shall require a new welding procedure test.

8.2 Related to the manufacturer

An approval of a WPS obtained by a manufacturer is valid for welding in workshops or sites under the same technical and quality control of that manufacturer.

8.3 Related to the material

8.3.1 Parent metal

8.3.1.1 Grouping system

In order to minimize the unnecessary multiplication of welding procedure tests, aluminium shall be grouped as shown in table 4.

The grouping is made in respect of the intentional added elements but not for fortuitous impurities.

A separate welding procedure approval shall be obtained for each material or material combination not covered by the grouping system.

Permanent backing material shall be considered as a parent metal.

Table 4: Grouping system for aluminium and its alloys

Group	Type of aluminium
21	Pure aluminium Pure aluminium $\leq$ 1,5% impurities or alloy content
22a	Non heat treatable alloys Aluminium – magnesium alloys $\leq$ 3,5% Mg
22b	Non heat treatable alloys Aluminium – magnesium alloys with 4% to 5,6% Mg
23	Heat treatable alloys Al-Mg Si alloys and Al-Zn Mg heat treatable alloys which require controlled heat input and heat treatment or ageing after welding
NOTE: The alloy content relates to nominal analysis.	

8.3.1.2 Dissimilar metal joints

For dissimilar metal joints the range of approval is given in table 5.

Any dissimilar metal joint not covered by table 5, shall require a specific test with no range of approval.

Any material within one group gives approval for all other materials or combinations from the same group.

Table 5: Range of approval for dissimilar metal joints

Existing approved welding procedure test for group of aluminium	Range of approval
22b	22a welded to 22a 22a welded to 22b
23	22a welded to 22a ¹⁾ 22a welded to 22b ¹⁾ 22b welded to 22b ¹⁾
¹⁾ Provided that an Al-Mg alloy filler is used.	

8.3.2 Parent metal thickness and pipe diameter

8.3.2.1 General

Nominal thickness t shall have the following meanings:

- a) For a butt joint:
the parent metal thickness, which for joints between dissimilar thicknesses is that of the thinner material.
- b) For a fillet weld:
the parent metal thickness approved for joints between different thicknesses is that of the thicker material. For each thickness range approved as in table 6 there is also an associated range of approved fillet weld throat thicknesses as given in 8.3.2.3.
- c) For a set-on branch connection:
the thickness of the branch pipe.
- d) For a set-in or set-through branch connection:
the thickness of the main pipe.

8.3.2.2 Range of approval for butt welds

The approval of a welding procedure test on thickness t shall include approval for thicknesses in the following ranges given in table 6.

Table 6: Range of approval for thickness

Thickness of the test piece t mm	Range of approval	
	for single run or single run from both sides	for multi-run welding
$t \leq 3$	$0,8 t$ to $1,1 t$	t to $2 t$
$3 < t \leq 12$	$0,8 t$ to $1,1 t$	3 to $2 t$
$12 < t \leq 100$	$0,8 t$ to $1,1 t$	$0,5 t$ to $2 t$ (max. 150 mm)
$t > 100$	—	$0,5 t$ to $1,5 t$

8.3.2.3 Range of approval for fillet welds

In addition to the requirements of table 6, the range of approval of the throat thickness ' a ' shall be ' $0,75 a$ ' to ' $1,5 a$ '. However a test with a throat thickness ≥ 10 mm. shall give approval for all throat thicknesses ≥ 10 mm.

8.3.2.4 Range of approval for the diameter of pipes and branch connections

The approval of a welding procedure test on diameter D shall include approval for diameters in the following ranges given in table 7.

Table 7: Range of approval for pipe and branch connection

Diameter of the test piece D ¹⁾ ²⁾ mm	Range of approval
$D \leq 168,3$	0,5 D to 2 D
$D > 168,3$	$\geq 0,5 D$ and plates ³⁾
¹⁾ D is the outside diameter of the pipe or outside diameter of the branch pipe. ²⁾ Approval given for plates also covers pipes when the outside diameter is > 500 mm. ³⁾ See also 8.4.2.	

8.3.3 Angle of branch connection

A procedure test carried out on a branch connection with angle α shall approve all branch angles α_1 in the range of $\alpha \leq \alpha_1 \leq 90^\circ$.

8.4 Common to all welding procedures**8.4.1 Welding process**

The approval is valid only for the welding process used in the welding procedure test. In a multi-process procedure test the approval is only valid for the order used during the approval test.

NOTE: For multi-process procedures each welding process may be approved separately or in combination with other processes. Similarly one or more processes may be deleted from an approved WPS provided the joint thickness is within the approved thickness range of the relevant welding process(es) to be applied.

8.4.2 Welding positions

The range of approval according to the welding position is given in table 8. In this table the range of approval is indicated in the same horizontal line.

Table 8: Range of approval according to welding position

Welding position for the test piece		Range of approval														
		Butt weld in plate					Butt weld in pipe				Fillet weld					
		PA	PC	PE	PF	PG	PA	PC	PF	PG	PA	PB	PD	PF	PG	
Butt weld in plate	PA	★	-	-	-	-	x	-	-	-	x	-	-	-	-	
	PC	x	★	-	x	-	-	-	-	-	x	x	-	x	-	
	PE	x	x	★	x	-	-	-	-	-	x	x	x	x	-	
	PF	x	x	-	★	-	-	-	-	-	x	x	-	x	-	
	PG	-	-	-	-	★	-	-	-	-	-	-	-	-	x	
PA only for rotated pipes	PA	x	-	-	-	-	★	-	-	-	x	-	-	-	-	
Butt weld in pipe	PC	x	x	-	x	-	-	★	-	-	x	x	-	x	-	
	PF	x	x	x	x	-	x	x	★	-	x	x	x	x	-	
	PG	-	-	-	-	x	-	-	-	★	-	-	-	-	x	
Fillet weld on plate and branch connection	PA	-	-	-	-	-	-	-	-	-	★	-	-	-	-	
	PB	-	-	-	-	-	-	-	-	-	x	★	-	x	-	
	PD	-	-	-	-	-	-	-	-	-	x	x	★	x	-	
	PF	-	-	-	-	-	-	-	-	-	x	x	-	★	-	
	PG	-	-	-	-	-	-	-	-	-	-	-	-	-	★	
Key: ★ indicates the welding position for which the WPS is approved in the approval test x indicates those welding positions for which the WPS is also approved - indicates those welding positions for which the WPS is not approved																
NOTE: For symbols of welding positions, see ISO 6947.																

8.4.3 Type of joint

The range of approval for the types of welded joints used in the procedure test is given in table 9. In this table the range of approval is indicated in the same horizontal line.

Table 9: Range of approval for type of joint

Type of joint in approval test piece			Range of approval							
			Butt welds in plate				Fillet weld on plate	Butt welds in pipe		Fillet welds on pipe
			Welded from one side		Welded from both sides			Welded from one side		
			with backing	no backing	with gouging	no gouging		with backing	no backing	
Butt weld in plate	Welded from one side	with backing	★	-	x	x	x	-	-	x
		no backing	x	★	x	x	x	-	-	x
	Welded from both sides	with gouging	-	-	★	x	x	-	-	x
		no gouging	-	-	-	★	x	-	-	x
Butt weld in pipe	Welded from one side	with backing	x	-	x	x	x	★	-	x
		no backing	x	x	x	x	x	x	★	x
Fillet weld	Plate		-	-	-	-	★	-	-	x
	Pipe		-	-	-	-	x	-	-	★

Key:

- ★ indicates the weld for which the WPS is approved in the approval test
- x indicates those welds for which the WPS is also approved
- indicates those welds for which the WPS is not approved

8.4.4 Filler metal, classification

The approval range of filler metals covers other filler metals within the same nominal chemical composition.

8.4.5 Type of current

The approval given is the type of current (AC, DC, pulsed current) and polarity used in the welding procedure test.

8.4.6 Heat Input

The requirements of this clause only apply when the control of heat input is specified.

The upper limit of heat input approved is 15% greater than that used in welding the test piece.

The lower limit of heat input approved is 15% lower than that used in welding the test piece.

8.4.7 Preheat temperature

The lower limit of approval is the nominal preheat temperature applied at the start of the welding procedure test.

8.4.8 Interpass temperature

The upper limit of approval is the nominal interpass temperature reached in the welding procedure test.

8.4.9 Post-weld heat treatment or ageing

Addition or deletion of post-weld heat treatment or ageing is not permitted except that artificial ageing for group 23 gives approval for prolonged natural ageing.

The temperature range and the ageing conditions used for the welding procedure test is the range approved. Where required, heating rates, cooling rates, holding time and ageing time shall be related to the production component.

8.5 Specific to processes

8.5.1 Process 131

8.5.1.1 The approval given to the face and/or back shielding gas is restricted to the type of gas (nominal composition) used in the welding procedure test.

8.5.1.2 The approval given is restricted to the wire system used in the welding procedure test (e.g. single-wire or multiple-wire system).

8.5.2 Process 141

The approval given to the face and/or back shielding gas is restricted to the type of gas (nominal composition) used in the welding procedure test.

8.5.3 Process 15

8.5.3.1 The approval given is restricted to the type of plasma gas used in welding procedure test.

8.5.3.2 The approval given to the face and/or back shielding gas is restricted to the type of gas (nominal composition) used in the welding procedure test.

9 Welding procedure approval record (WPAR)

The welding procedure approval record (WPAR) is a statement of the results of assessing each test piece including re-tests. The relevant items listed for the WPS in part 2 of this standard shall be included, together with details of any features that would be rejectable by the requirements of clause 7. If no rejectable features or unacceptable test results are found, a WPAR detailing the welding procedure test piece results is approved and shall be signed and dated by the examiner or test body.

A WPAR format shall be used to record details for the welding procedure and the test results, in order to facilitate uniform presentation and assessment of the data.

An example of the WPAR-format is shown in annex A.

Annex A
(informative)**Welding Procedure Approval Record form (WPAR)****Welding procedure approval - Test certificate**Manufacturer's Welding Procedure
Reference No.:Examiner or test body
Reference No.:

Manufacturer:

Address:

Code/Testing Standard:

Date of Welding:

Extent of Approval

Welding Process:

Joint Type:

Parent metal (s)

Conditions of temper:

Metal Thickness (mm):

Outside Diameter (mm):

Filler Metal Type:

Shielding Gas/Flux:

Type of Welding Current:

Welding Positions:

Preheat:

Post-Weld Heat Treatment and/or ageing:

Other Information:

Certified that test welds prepared, welded and tested satisfactorily in accordance with the requirements of the code/testing standard indicated above.

Location

Date of issue

Examiner or test body

Name, date and signature

continued

Annex A (continued)

Details of weld test

Location:
Manufacturer's Welding Procedure
Reference No.:
WPAR No.:

Examiner or test body:

Method of Preparation and Cleaning:
Parent Material Specification:

Manufacturer:
Welder's Name:
Welding Process:
Joint Type:
Weld Preparation Details (Sketch)*:

Material Thickness (mm):
Outside Diameter (mm):
Welding Position:

Joint Design	Welding Sequences

Welding Details

Run	Process	Size of Filler Metal	Current A	Voltage V	Type of current/ Polarity	Wire Feed Speed	Travel Speed*	Heat input*

Filler Metal Classification and trade name:

Any Special Baking or Drying:

Gas Flux: shielding:
backing:

Gas Flow Rate – Shielding:
Backing:

Tungsten Electrode Type/Size:

Details of Back Gouging/Backing:

Preheat Temperature:

Interpass Temperature:

Other information*:

e.g. weaving (maximum width of run):

Oscillation: amplitude, frequency, dwell time

Pulse welding details:

Stand off distance:

Plasma welding details:

Torch angle:

Post-Weld Heat Treatment and/or Ageing:

Time, Temperature, Method:

Heating and Cooling Rates*:

Manufacturer

Name, date and signature

Examiner or test body

Name, date and signature

* If required

continued

Annex A (continued)

Test results

Manufacturer's Welding Procedure
Reference No.:Examiner or test body
Reference No.:Visual Examination:
Penetrant/Magnetic Particle Test *Radiography*:
Ultrasonic Examination*:

Tensile Tests

Temperature:

Type/No.	Re N/mm ²	Rm N/mm ²	A % on	Z %	Fracture Location	Remarks
Requirement						

Bend Tests

Former Diameter:

Type/No.	Bend Angle	Elongation*	Result

Macro-examination:
Micro-examination*:

Impact Test *

Type:

Size:

Requirement:

Notch Location/Direction	Temp.°C.	Values			Average	Remarks
		1	2	3		

Hardness Tests*

Type/load

Location of Measurements (Sketch*)

Parent Metal:

H.A.Z.:

Weld Metal:

Other Tests:

Remarks:

Tests carried out in accordance with the requirements of:

Examiner or test body

Laboratory Report Reference No.:

Test results were acceptable/not acceptable (Delete as appropriate)

Test carried out in the presence of:

Name date and signature

* If required

concluded

Annex B

(informative)

Types of aluminium and its alloys according to the grouping system of table 4**Table B1: French grouping system according to AFNOR NF 50-451**

Group	Parent materials
21	1050 A : 99.5 1080 A : Al 99.8 A 1100 : Al 99.0 Cu 3003 : Al-Mn1Cu
22a	3004 : Al-Mn1Mg1 3005 : Al-Mn1Mg0.5 5005 : Al-Mg1 5049 : Al-Mg2Mn 5050 : Al-Mg1.5 5052 : Al-Mg2.5 5454 : Al-Mg3Mn 5754 : Al-Mg3
22b	5083 : Al-Mg4.5Mn0.7 5086 : Al-Mg4
23	6061 : Al-Mg1SiCu 6081 : Al-Si1Mg 6082 : Al-Si1MgMn 7020 : Al-Zn4.5Mg1 7075 : Al-Zn5.5MgCu

Table B2: United Kingdom Grouping System according to BS 1470, BS 1474, BS 4300, BS 2898

Group	Parent materials
21	1050 A : Al 99.5 1080 A : Al 99.8 1200 : Al 99.0 1350 : E-Al 99.5 3103 : Al Mn 1
22a	3105 : Al Mn0.5Mg0.5 5005 : Al Mg1 5154 A : Al Mg 3.5 5251 : Al Mg 2 5454 : Al Mg 3 Mn
22b	5083 : Al Mg 4.5 Mn
23	6060 : Al Mg Si 6061 : Al Mg1SiCu 6063 : Al Mg0.7Si 6063 A : Al Mg0.7Si (A) 6082 : Al Si Mg Mn 6101 A : E-Al Mg Si (A) 6463 : Al Mg Si 7020 : Al Zn 4.5 Mg 1

Table B3: Norwegian Grouping System according to NS 17.001

Group	Parent materials
21	1050 A : Al 99,5 1070 A : Al 99,7 1100 : Al 99,0 Cu 3003 : Al-Mn 1 Cu
22a	3004 : Al-Mn 1 Mg 1 3005 : Al-Mn 1 Mg 0,5 5005 : Al-Mg 1 5049 : Al-Mg 2 Mn 5052 : Al-Mg 2,5 5454 : Al-Mg 3 Mn 5754 : Al-Mg 3
22b	5083 : Al-Mg 4,5 Mn 0,7 5086 : Al-Mg 4
23	6061 : Al-Mg 1 Si Cu 6082 : Al-Si 1 Mg Mn 7020 : Al-Zn 4,5 Mg 1 7075 : Al-Zn 5,5 Mg Cu

Table B4: Finnish Grouping System according to SFS

Group	Parent materials
21	SFS 2580 : Al 99,8 SFS 2581 : Al 99,7 SFS 2582 : Al 99,5 SFS 2583 : E-Al 99,5 SFS 2584 : Al 99,0 SFS 2585 : AlMn 1
22a	SFS 2586 : AlMg 1 SFS 2587 : AlMg 2,5 SFS 2588 : AlMg 3
22b	SFS 2589 : AlMg 5
23	SFS 2590 : AlSi 5 SFS 2591 : AlMgSi SFS 2592 : E-AlMgSi SFS 2593 : AlSi1Mg SFS 2596 : AlZn5Mg1

Table B5: Switzerland Grouping System according to SN 210 900

Group	AA	SN	ISO ¹⁾
21	1080 A 1050 A 1200 3103	Al 99.8 Al 99.5 Al 99.0 Al Mn	Al 99.8 (A) Al 99.5 Al 99.0 Al Mn 1
22a	all 3 xxx alloys 5005 5052 5754 5454	AlCu AlMg 1 AlMg 2.5 AlMg 3 AlMg 2.7 Mn	AlCu AlMg 1 (B) AlMg 2.5 AlMg 3 AlMg 3 Mn
22b	5086 5083	AlMg4Mn AlMg 4.5Mn	AlMg4 AlMg 4.5 Mn 0.7
23	6060 6061 6005 A 6082 7020 7075 7022	AlMgSi 0.5 AlMg 1 SiCu AlMgSi 0.7 AlMgSi 1 Mn AlZn 4.5 Mg 1 AlZn6 MgCu 1.5 AlZnMgCu 0.5	AlMgSi AlMg1SiCu AlSiMg (A) AlSi1MgMn AlZn 4.5 Mg1 AlZn 5.5 MgCu -
¹⁾ Note: ISO/DIS 209-1.			

Table B6: Italian Grouping System according to UNI

Group	Parent metal	UNI
21	1200 : Al 99.0 1050 A: Al 99.5 1070 A: Al 99.7 1080 A: Al 99.8 3003 : Al Mn 1,2 Cu	UNI 9001-1 UNI 9001-2 UNI 9001-3 UNI 9001-4 UNI 9003-1
22a	3004 : Al Mn 1,2 Mg 3005 : Al Mn 1,2 Mg 0,4 5005 : Al Mg 0.8 5050 : Al Mg 1,5 5052 : Al Mg 2,5 5151 : Al Mg 2,7 Mn 5154 B: Al Mg 3,5	UNI 9003-2 UNI 9003-4 UNI 9005-1 UNI 9005-7 UNI 9005-2 UNI 9005-3 UNI 9005-8
22b	5083 : Al Mg 4,5 5086 : Al Mg 4,4	UNI 9005-5 UNI 9005-1
23	6061 : Al Mg 1 Si Cu 6082 : Al Mg Si 1 Mn 7020 : Al Zn 1,5 Mg 7075 : Al Zn 5,8 Mg Cu	UNI 9006-2 UNI 9006-4 UNI 9007-1 UNI 9007-2

Table B7: German Grouping System according to DIN 1745

Group	Parent materials
21	Al 99,98 R Al 99,5 Al 99,7 Al 99,8 Al Mn Cu Al Mn
22a	Al Mn 1 Mg 1 Al Mn 1 Mg 0,5 Al Mg 1 Al Mg 1,5 Al Mg 2,5 Al Mg 2 Mn 0,8 Al Mg 3 Al Mg 2,7 Mn
22b	Al Mg 4 Mn Al Mg 4,5 Mn
23	Al Mg Si 1 Mn Al Mg Si Cu Al Mg Si 0,7 Al Zn 4,5 Mg 1

Table B8: Austrian Grouping System

Group	Parent materials
21	Al 99,0 Al 99,5 Al 99,7 Al 99,8 Al 99,98 Al Mn Cu Al Mn
22a	Al Mn 1 Mg 1 Al Mn 1 Mg 0,5 Al Mg 1 Al Mg 1,5 Al Mg 2,5 Al Mg 3 Al Mg 2 Mn 0,5 Al Mg 2 Mn 0,8 Al Mg 2,7 Mn
22b	Al Mg 4 Mn Al Mg 4,5 Mn
23	Al Mg Si 1 Mn Al Mg Si 0,5 Al Mg Si 0,7 Al Mg Si 0,9 Al Zn 4,5 Mg 1

National appendix NA (informative)

The United Kingdom participation in the preparation of this European Standard was entrusted by the Welding Standards Policy Committee (WEE/-) to Technical Committee WEE/36 upon which the following bodies were represented:

Aluminium Federation
Associated Offices Technical Committee
Association of Consulting Scientists
British Constructional Steelwork Association Ltd.
British Gas plc
British Nuclear Fuels plc
British Railways Board
British Steel Industry
Electricity Industry in United Kingdom
Engineering Equipment and Materials Users' Association
General, Municipal, Boilermakers' and Allied Trades Union
Health and Safety Executive
Lloyd's Register of Shipping
Ministry of Defence
Power Generation Contractors' Association (BEAMA Ltd.)
Process Plant Association
Railway Industry Association of Great Britain
Stainless Steel Fabricators' Association of Great Britain
United Kingdom Atomic Energy Authority
Welding Institute
Welding Manufacturers' Association (BEAMA Ltd.)

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