
**Approval testing of welders — Fusion
welding —**

**Part 4:
Nickel and nickel alloys**

*Épreuve de qualification des soudeurs — Soudage par fusion —
Partie 4: Nickel et ses alliages*
(standards.iteh.ai)

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Foreword

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Draft International Standards adopted by the Technical Committees are circulated to member bodies for voting. Publication as an International Standard requires approval by at least 75 % of member bodies casting a vote.

International Standard ISO 9606-4 was prepared by the European Committee for Standardization (CEN) in collaboration with ISO Technical Committee TC 44, *Welding and allied processes*, Subcommittee SC 11, *Approval requirements for welding and allied processes personnel*, in accordance with the Agreement on technical cooperation between ISO and CEN (Vienna Agreement).

Throughout the text of this standard, read "...this European Standard..." to mean "...this International Standard...".

ISO 9606 consists of the following parts, under the general title *Approval testing of welders — Fusion welding*:

- Part 1: Steels
- Part 2: Aluminium and aluminium alloys
- Part 3: Copper and copper alloys
- Part 4: Nickel and nickel alloys
- Part 5: Titanium and titanium alloys
- Part 6: Magnesium and magnesium alloys

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Annexes A and ZA of this part of ISO 9606 are for information only.

For the purposes of this part of ISO 9606, the CEN annex regarding fulfilment of European Council Directives has been removed.

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Introduction

This standard covers the principles to be observed in the approval testing of welder performance for the fusion welding of nickel and nickel alloys.

The term "nickel" stands for nickel and weldable nickel alloys.

The ability of the welder to follow verbal or written instructions and testing of his skill are therefore important factors in ensuring the quality of the welded product.

Testing of skill to this standard depends on welding methods in which uniform rules and test conditions are complied with, and standard test pieces are used.

The test weld can be used to approve a welding procedure and a welder provided that all the relevant requirements, e.g. test piece dimensions, are satisfied (see relevant part of EN 288-2).

1 Scope

This standard specifies essential requirements, ranges of approval, test conditions, acceptance requirements and certification for the approval testing of welder performance for the welding of nickel.

This standard applies to the approval testing of welders for the fusion welding of nickel.

This standard is intended to provide the basis for the mutual recognition by examining bodies for approval relating to welders' competence in the various fields of application. Tests will be carried out in accordance with this standard unless more severe tests are specified by the relevant application standard when these are applied.

During the approval test the welder should be required to show adequate practical experience and job knowledge (test non mandatory) of the welding processes, materials and safety requirements for which he is to be approved; information on these aspects is given in Annex A.

This standard is applicable when the welder's approval testing is required by the purchaser, by inspection authorities or by other organizations.

The welding processes referred to in this standard include those fusion welding processes which are designated as manual or partly mechanized welding. It does not cover fully mechanized and automatic processes (see 5.2).

This standard covers approval testing of welders for work on semi-finished and finished products made from wrought, forged or cast material types listed in 5.4.

The certificate of approval testing is issued under the sole responsibility of the examiner or examining body.

2 Normative references

This European 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 European Standard only when incorporated in it by amendment or revision. For undated references the latest edition of the publication referred to applies.

EN 287-1 : 1992	Approval testing of welders – Fusion welding – Part 1: Steels
EN 288-2 : 1992	Specification and approval of welding procedures for metallic materials – Part 2: Welding procedure specification for arc welding
EN 571-1	Non destructive testing - Penetrant testing – Part 1: General principles
EN 910	Destructive test on welds in metallic materials – Bend tests
EN 970	Non-destructive examination of fusion welds – Visual examination

EN 1289	Non-destructive examination of welds – Penetrant testing of welds – Acceptance levels
EN 1320	Destructive tests on welds in metallic materials – Fracture test
EN 1321	Destructive tests on welds in metallic materials – Macroscopic and microscopic examination of welds
EN 1435	Non-destructive examination of welds – Radiographic examination of welded joints
EN 24063 : 1992	Welding, brazing, soldering and braze welding of metals – Nomenclature of processes and reference numbers for symbolic representation on drawings (ISO 4063 : 1990)
EN 25817 : 1992	Arc-welded joints in steel – Guidance on quality levels for imperfections (ISO 5817 : 1992)
EN 26520 : 1991	Classification of imperfections in metallic fusion welds, with explanations (ISO 6520 : 1982)
EN ISO 6947 : 1997	Welds – Working positions – Definitions of angles of slope and rotation (ISO 6947 : 1993)
CR 12187	Welding – Guidelines for a grouping system of materials for welding purposes
ISO 857 : 1990	Welding, brazing and soldering processes – Vocabulary

3 Definitions

For the purposes of this standard the definitions given in EN 287-1 apply.

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4 Symbols and abbreviations

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4.1 General

Where the full wording is not used, the following symbols and abbreviations shall be used when completing the test certificate (see Annex B of EN 287-1 : 1992).

4.2 Test piece

a	nominal throat thickness ;
BW	butt weld ;
D	outside diameter of pipe ;
FW	fillet weld ;
P	plate ;
t	plate or pipe wall thickness ;
T	pipe ;
z	leg length of fillet weld.

4.3 Consumables

nm	no filler metal ;
wm	with filler metal.

4.4 Miscellaneous

4.4 Miscellaneous

bs	welding from both sides ;
gg	back gouging or back grinding of welds ;
mb	welding with backing material ;

nb	welding without backing ;
ng	no back gouging or no back grinding ;
ss	single-side welding.

5 Essential variables for approval testing

The criteria specified in this clause shall be examined in order to identify the ability of the welder in these areas. Each criterion is considered to be a significant factor in the approval testing.

The welder's approval test shall be carried out on test pieces and is independent of the type of construction.

5.2 Welding processes

Welding processes are defined in ISO 857 and reference numbers of welding processes for symbolic representation are listed in EN 24063.

This standard covers the following welding processes:

111	metal-arc welding with covered electrode;
131	metal-arc inert gas welding (MIG welding);
135	metal-arc active gas welding (MAG welding);
136	flux-cored wire metal-arc welding with active gas shield;
141	tungsten inert gas arc welding (TIG welding);
15	plasma arc welding;

other fusion welding processes by agreement.

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5.3 Joint types (butt and fillet welds)

Test pieces shall be produced for butt weld (BW) and fillet weld (FW) in plates (P) or pipes¹⁾ (T) for approval tests in accordance with 7.2.

5.4 Material groups

5.4.1 General

In order to minimize unnecessary multiplication of technically identical tests, nickel with similar metallurgical and welding characteristics are grouped for the purpose of a welder's approval (see 5.4.2).

In general, a welder's approval test shall involve depositing weld metal having a chemical composition compatible with any of the nickel in the parent metal group(s).

5.4.2 Nickel groups of parent metal

5.4.2.1 General

Nickel casting alloys are included in the following groups but the filler metal shall be compatible with the filler metal used for the wrought materials in the same group.

Material groups according to CR 12187

5.4.2.2 Group W 41: Pure nickel

5.4.2.3 Group W 42: Nickel-copper alloys Ni ≥ 45 %, Cu > 10 %

¹⁾ The word "pipe", alone or in combination, is used to mean "pipe", "tube" or "hollow section".

- 5.4.2.4 Group W 43: Nickel-chromium alloys (Ni/Fe/Cr/Mo) Ni ≥ 40 %
- 5.4.2.5 Group W 44: Nickel-molybdenum alloys (Ni/Mo) Ni ≥ 45 %, Mo ≤ 30 %
- 5.4.2.6 Group W 45: Nickel-iron-chromium alloys (Ni/Fe/Cr) Ni ≥ 45 %
- 5.4.2.7 Group W 46: Nickel-chromium-cobalt alloys (Ni/Cr/Co) Ni ≥ 45 %, Co ≥ 10 %
- 5.4.2.8 Group W 47: Nickel-iron-chromium-copper alloys (Ni/Fe/Cr/Cu) Ni ≥ 45 %

5.5 Consumables

It is assumed that in most approval tests the filler metal will be similar to the parent metal. When a welder's test according to a relevant pWPS or WPS has been carried out using a filler metal and shielding gas suitable for that material group, this test will confer approval on the welder to use any other similar consumables (filler metal or shielding gas) for the same material group.

5.6 Dimensions

The approval test should be based on the thickness of the material (i.e. plate thickness or wall thickness of pipe) and pipe diameters which the welder will use in production. A test is listed for each of the three ranges of plate thickness and pipe wall thickness or pipe diameter as specified in tables 1 and 2.

It is not intended that thicknesses or diameters should be measured precisely but rather the general philosophy behind the values given in tables 1 and 2 should be applied.

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Table 1: Test piece (plate or pipe) and range of approval

Test piece thickness <i>t</i> mm	Range of approval
$t \leq 3$	t to $2t$
$3 < t \leq 12$	3 mm to $2t$
$t > 12$	≥ 5 mm

Table 2: Test piece diameter and range of approval

Test piece diameter <i>D</i> mm	Range approval
$D \leq 25$	D to $2D$
$D > 25$	$\geq 0,5 D$ (25 mm min.)

5.7 Number of test pieces

Plate: One test piece per position.
 Pipe: A minimum weld length of 150 mm is required, but not more than three test pieces.

5.8 Welding positions

The welding positions shall be taken from EN ISO 6947.
 The test pieces shall be welded in accordance with the nominal angles of the positions according to EN ISO 6947.

6 Range of approval for the welder

6.1 General

As a general rule, the test piece approves the welder not only for the conditions used in the test, but also for all joints which are considered easier to weld. The range of approval for each type of test is given in the relevant sub-clauses and tables. In these tables the range of approval is indicated in the same horizontal line.

6.2 Welding process

Each test normally approves one process. A change of process requires a new approval test. However, it is possible for a welder to be approved for more than one welding process by a single test or by two separate approval tests to be used to cover a multi-process joint. For example in a case where approval is required for a single-side butt joint with the root to be welded by TIG (141) without backing and to be filled by metal-arc welding with covered electrode (111), the welder may be approved by either of the following routes:

- a) a successful completion of an approval test simulating the multi-process joint, i. e. the root run welded by TIG (141) without backing, subsequent runs or layers welded by metal-arc welding with covered electrode (111) within the limits of the range of approval for each welding process;
- b) successful completion of separate relevant approval tests (within the limits of each range of approval) one for TIG (141) without backing for the root run and a separate test for the fill by metal-arc welding with covered electrode (111) with backing or welded from both sides with or without back gouging or grinding.

6.3 Joint types

Depending on the test piece, the range of welds for which the welder is approved is shown in table 3; the following criteria are applicable:

- a) approval for butt welds in pipes, diameter > 25 mm, includes butt welds in plates;
- b) approval for butt welds in plates in all relevant positions covers butt welds on pipes having an outside diameter \geq 500 mm, except when item c) also applies;
- c) approval on test butt joints in plates welded in the flat (PA) or horizontal (PC) position shall include approval for butt joints in pipes of outside diameter \geq 150 mm welded in similar positions according to table 4;
- d) butt welds approve fillet welds. In cases where the majority of production work is fillet welding, the welder shall be approved also by an appropriate fillet welding test;
- e) approval for butt welds in pipes without backing includes approval for branch connections within the same range of approval as in tables 3 and 4. For a branch weld the range of approval is based on the diameter of the branch;
- f) in cases where the majority of production work is predominantly branch welding or involves a complex branch connection, the welder should receive special training. In some cases a welder approval test on a branch connection can be necessary.

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Table 3: Range of approval for tests on butt joints (Detail of weld type)

Details of weld type				Range of approval					
				Butt welds in plate				Butt welds in pipe	
				welded from one side ss		welded from both sides bs		welded from one side ss	
				with backing mb	no backing nb	with gouging gg	no gouging ng	with backing mb	no backing nb
Butt weld in plate	welded from one side ss	with backing	mb	*	-	x	-	¹⁾	-
		no backing	nb	x	*	x	x	¹⁾	¹⁾
	welded from both sides bs	with gouging	gg	x	-	*	-	¹⁾	-
		no gouging	ng	x	-	x	*	¹⁾	-
Butt weld in pipe	welded from one side ss	with backing	mb	x	-	x	-	*	-
		no backing	nb	x	x	x	x	x	*

1) See 6.3 b) and 6.3 c)

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

6.4 Material groups

A test carried out in group W 41 covers all other groups, but not vice versa. A test carried out in any of the groups W 42 to W 47 covers all groups of W 42 to W 47.

Groups W 41 to W 47 also cover the group W 11 according to EN 287-1, but not vice versa.

Approval of dissimilar metal joints: When using filler metal from groups W 41 to W 47, all combinations of steel/steel and steel/nickel alloy are covered.

6.5 Consumables

A change in the type of electrode may require a change in the welder's technique, therefore a new test may be necessary.

A change of shielding gas is permitted (see 5.5). However, a change from active to inert shielding gas or from inert to active shielding gas requires a new approval test for the welder.

6.6 Dimensions

The range of approval according to plate thickness or wall thickness of pipe and/or pipe diameter is shown in tables 1 and 2.

6.7 Welding positions

The range of approval for each welding position is given in table 4. The welding positions and codes refer to EN ISO 6947.

Table 4: Range of approval according to welding position

Welding position of approval test piece		Range of approval																					
		Plates								Pipes													
		Butt welds				Fillet welds				Butt welds				Fillet welds									
		Pipe-axis and -angle				Pipe-axis and -angle				Pipe-axis and -angle				Pipe-axis and -angle									
		rotating		fixed		rotating 1)		fixed		rotating		fixed		rotating 1)		fixed							
		0°	90°	45°	90°	45°	0°	45°	90°	45°	0°	90°	45°	90°	0°	90°							
Plates	Butt welds	PA	PC	PG	PF	PE	PA	PC	PG	PF	PE	PA	PC	PG	PF	PE	PA	PC	PG	PF	PE		
		PA	PC	PG	PF	PE	PA	PC	PG	PF	PE	PA	PC	PG	PF	PE	PA	PC	PG	PF	PE		
Pipes	Butt welds	PA	PC	PG	PF	PE	PA	PC	PG	PF	PE	PA	PC	PG	PF	PE	PA	PC	PG	PF	PE		
		PA	PC	PG	PF	PE	PA	PC	PG	PF	PE	PA	PC	PG	PF	PE	PA	PC	PG	PF	PE		
Pipes	Fillet welds	PA	PC	PG	PF	PE	PA	PC	PG	PF	PE	PA	PC	PG	PF	PE	PA	PC	PG	PF	PE		
		PA	PC	PG	PF	PE	PA	PC	PG	PF	PE	PA	PC	PG	PF	PE	PA	PC	PG	PF	PE		
Plates	Butt welds	PA	*	-	-	-	X	X	-	-	-	X	X	-	-	-	X	X	-	-	-	-	
		PC	X	*	-	-	-	X	X	-	-	-	X	X	-	-	-	X	X	-	-	-	-
		PG	-	-	*	-	-	-	-	X	-	-	-	-	X	-	-	-	-	-	-	-	-
		PF	X	-	-	*	-	X	X	-	-	-	X	X	-	-	-	X	X	-	-	-	-
		PE	X	X	-	X	*	X	X	-	-	-	X	X	-	-	-	X	X	-	-	-	-
		PA	-	-	-	-	-	*	-	-	-	-	-	-	-	-	-	X	X	-	-	-	-
	Fillet welds	PB	-	-	-	-	-	X	X	-	-	-	-	-	-	-	-	X	X	-	-	-	-
		PG	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
		PF	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	*	-	-	-	-	-
		PD	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	X	X	-	-	-	-
		PA	X	-	-	-	-	X	X	-	-	-	*	-	-	-	-	X	X	-	-	-	-
		PG	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Pipes	Butt welds	rotating 0°	PA	X	-	-	-	-	-	-	-	X	X	-	-	-	X	X	-	-	-	-	
		fixed 90°	PG	-	-	-	-	-	-	-	-	-	-	-	-	-	-	X	X	-	-	-	-
			PF	X	-	-	X	X	-	-	-	-	-	*	-	-	-	X	X	-	-	-	-
		fixed 45°	PC	X	X	-	-	-	X	X	-	-	-	-	*	-	-	X	X	-	-	-	-
			H	X	X	-	X	X	-	-	-	-	-	X	X	-	-	X	X	-	-	-	-
		rotating 45°	J	-	-	-	-	-	-	-	-	-	-	-	-	-	-	X	X	-	-	-	-
	PA		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	*	-	-	-	-	
	fixed 0°	PB	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	X	X	-	-	-	-
		PG	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
	fixed 0°	PF	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	X	X	-	-	-	-
		PF	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	X	X	-	-	-	-

1) PB for pipes can be welded in two versions
 (1) pipe: rotating; axis: horizontal; weld: horizontal vertical
 (2) pipe: fixed; axis: vertical; weld: horizontal vertical

2) This is an approved position and is covered by the other related tests.

* indicates the welding position for which the welder is approved in the approval test
 x indicates those welding positions for which the welder is also approved
 - indicates those welding positions for which the welder is not approved