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Non destructive examination of welds - Radiographic examination of welded joints in steel - Acceptance level

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Non destructive examination of welds - Radiographic examination of welded joints in steel - Acceptance level

Contrôle non destructif des assemblages soudés - Contrôle par radiographie des assemblages soudés en acier - Niveaux d'acceptation

Zerstörungsfreie Prüfung von Schweißverbindungen - Durchstrahlungsprüfung von Schweißverbindungen - Zulässigkeitsgrenzen

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EUROPEAN COMMITTEE FOR STANDARDIZATION
COMITÉ EUROPÉEN DE NORMALISATION
EUROPÄISCHES KOMITEE FÜR NORMUNG

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Contents

Foreword

This document (prEN 12517:2004) has been prepared by Technical Committee CEN/TC 121 “Welding”, the secretariat of which is held by DIN.

This document is currently submitted to the CEN Enquiry.

This document will supersede EN 12517:1998

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).

1 Scope

This standard specifies acceptance levels for indications from imperfections in steel butt welds detected by radiographic testing . If agreed, the acceptance levels may be applied to other types of welds or materials.

The acceptance levels may be related to welding standards, application standards, specifications or codes. Such a relationship is shown in EN 12062 for EN ISO 5817.

This standard assumes that the radiographic testing has been carried out in accordance with EN 1435.

When assessing whether a weld meets the requirements specified for a weld quality level, the sizes of imperfections permitted by standards are compared with the dimensions of indications revealed by a radiograph made of the weld.

2 Normative references

The following referenced documents are indispensable for the application of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

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

EN 1435, *Non-destructive examination of welds — Radiographic examination of welded joints.*

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

EN ISO 5817, *Welding — Fusion-welded joints in steel, nickel, titanium and their alloys (beam welding excluded) — Quality levels for imperfections (ISO 5817:2003).*

EN ISO 6520-1, *Welding and allied processes — Classification of geometric imperfections in metallic materials — Part 1: Fusion welding (ISO 6520-1:1998).*

3 Radiographic technique

Depending on the weld quality level, radiographic technique A or B in accordance with EN 1435 is used as shown in table 1.

Table 1 – Radiographic examination

Quality levels in accordance with EN ISO 5817	Examination techniques and classes in accordance with EN 1435	Acceptance levels in accordance with EN 12517
B	B	1
C	B [a]	2
D	A	3
[a] However, the minimum number of exposure for circumferencial weld testing shall correspond to the requirements of class A of EN 1435.		

4 General

Welded joints should be visually tested and evaluated in accordance with EN 970 before radiographic testing.

The acceptance levels in this document are basically valid for evaluation of imperfections which cannot be detected and evaluated by visual testing. Surface imperfections (such as undercut and excessive penetration, surface damage, weld spatter, etc.) which due to object geometry cannot be evaluated, but where the interpreter suspects the EN ISO 5817 quality levels are not fulfilled, shall be subject to more specific testing.

When quantification of undercut and/or excessive penetration by radiographic testing is required, specific procedures using test exposures may be applied in order to established a basis for approximate quantification in accordance with the requirements of EN ISO 5817. This shall be specified.

5 Acceptance levels

The acceptance levels for indications are shown in table 2. The types of imperfections are those listed in EN ISO 5817.

The symbols used in table 2 are the following :

l length of imperfection, in millimeters ;

s nominal butt weld thickness, in millimeters ;

t material thickness, in millimeters ;

L any 100mm testing length, in millimeters ;

L_p length of projected area;

w_p width of the weld;

h width of internal imperfection, the width or height of surface imperfection, in millimeters ;

d diameter of pore ; in millimeters

b width of weld reinforcement, in millimeters.

A sum of projected areas of indications

Table 2 – Acceptance levels for indications in butt welds

No.	Type of internal imperfections in accordance with EN ISO 6520-1	Acceptance level 3 [a]	Acceptance level 2 [a]	Acceptance level 1
1	Cracks (100)	Not permitted	Not permitted	Not permitted
2a	Porosity and gas pores (2012, 2011) Single layer	A ≤ 2,5% d ≤ 0,4s, max 5 mm L=100mm	A ≤ 1,5% d ≤ 0,3s, max 4 mm L=100mm	A ≤ 1% d ≤ 0,2s, max 3 mm L=100mm
2b	Porosity and gas pores (2012, 2011) Multilayer	A ≤ 5% d ≤ 0,4s, max 5 mm L=100mm	A ≤ 3% d ≤ 0,3s, max 4 mm L=100mm	A ≤ 2% d ≤ 0,2s, max 3 mm L=100mm
3[b]	Clustered (localized) porosity (2013)	A ≤ 16% d ≤ 0,4s, max 4 mm L=100mm	A ≤ 8% d ≤ 0,3s, max 3 mm L=100mm	A ≤ 4% d ≤ 0,2s, max 2 mm L=100mm
4a[c]	Linear porosity (2014) Single layer	A ≤ 8% d ≤ 0,4s, max 4 mm L=100mm	A ≤ 4% d ≤ 0,3s, max 3 mm L=100mm	A ≤ 2% d ≤ 0,2s, max 2 mm L=100mm
4b[c]	Linear porosity (2014) Multilayer	A ≤ 16% d ≤ 0,4s, max 4 mm L=100mm	A ≤ 8% d ≤ 0,3s, max 3 mm L=100mm	A ≤ 4% d ≤ 0,2s, max 2 mm L=100mm
5[d]	Elongated cavities (2015) and wormholes (2016)	h < 0,4s, max 4 mm l ≤ s, max 75 mm	h < 0,3s, max 3 mm l ≤ s, max 50 mm	h < 0,2s, max 2 mm l ≤ s, max 25 mm
6	Shrinkage cavity (202)	h < 0,4s, max 4 mm l ≤ 25 mm	Not permitted	Not permitted
7	Crater pipe (2024)	l ≤ 0,2t ≤ 2 mm	Not permitted	Not permitted
8	Slag inclusions (301), flux inclusions (302) and oxide inclusions (303)	h < 0,4s, max 4 mm l ≤ s, max 75 mm	h < 0,3s, max 3 mm l ≤ s , max 50 mm	h < 0,2s, max 2 mm l ≤ s, max 25 mm
9	Metallic inclusions (304) (other than copper)	l ≤ 0,4s, max 4 mm	l ≤ 0,3s, max 3 mm	l ≤ 0,2s, max 2 mm

(to be continued)

Table 2 *(concluded)*

No.	Type of imperfections in accordance with EN ISO 6520-1	Acceptance level 3 a)	Acceptance level 2 a)	Acceptance level 1
10	Copper inclusions (3042)	Not permitted	Not permitted	Not permitted
11	Lack of fusion (401)	Permitted, but only intermittently and not breaking the surface $l \leq 25$ mm	Not permitted	Not permitted
12	Lack of penetration (402)	$l \leq 25$ mm	Not permitted	Not permitted
Surface imperfections: The acceptance levels are those defined for visual testing. These defects are normally accepted or rejected by visual testing.				
13	Crater cracks (104)	Not permitted	Not permitted	Not permitted
14 e)	Undercut (501)	Smooth transition is required $h \leq 0,2t \leq 1$mm	Smooth transition is required $h \leq 0,1t \leq 0,5$ mm	Smooth transition is required $h \leq 0,05t \leq 0,5$ mm
15a e)	Excessive penetration (504), 0,5 mm $\leq t \leq$ 3 mm	$h \leq 1$mm + 0,6 b	$h \leq 1$mm + 0,3 b	$h \leq 1$mm + 0,1 b
15b e)	Excessive penetration (504), t > 3mm	$h \leq 1$mm + 1,0 b ≤ 5 mm	$h \leq 1$mm + 0,6 b ≤ 4 mm	$h \leq 1$mm + 0,2 b ≤ 3 mm
16	Stray arc (601)	Permitted, if the properties of the parent metal are not affected	Not permitted	Not permitted
17 e)	Spatter (602)	Acceptance depends on application, e.g. material, corrosion protection		

a) Acceptance levels 3 and 2 may be specified with prefix X which denoted that all indications over 25 mm are unacceptable.
b) see Annex C, Fig. C.1 (normative)
c) see Annex C, Fig. C.2 (normative)
d) see Annex C, Fig. C.3 (normative)
e) Surface imperfections: The acceptance levels are those defined for visual testing.
These defects are normally accepted or rejected by visual testing.

Annex A
(informative)

Guide to the limitations of radiographic testing

NOTE : The numbers between brackets conform to those used in EN ISO 6520-1.

A.1 Volumetric imperfections in butt welds

Porosities and gas pores (2011, 2013, 2015 and 2017)

Wormholes and elongated cavities (2016 and 2015)

Solid inclusions (300)

Copper inclusions (3042)

The above imperfections listed in table 2 will be readily detected using radiographic technique A or B of EN 1435 as shown in table 1 of this standard.

A.2 Cracks in butt welds

Crater cracks (104)

Cracks (100)

The detectability of cracks by radiographic testing depends on the crack height, the ramification (presence of branching parts), opening width, orientation of the X-ray beam and radiographic technique parameters.

Reliable detection of all cracks is therefore limited. The use of radiographic technique B or better, as specified in EN 1435, will provide better crack detectability than radiographic technique A.

A.3 Planar imperfections in butt welds

Lack of fusion (401)

Lack of penetration (402)

The detection of lack of fusion and lack of penetration depends on characteristics of imperfections and radiographic technique parameters.

Lack of side wall fusion will probably not be detected (unless it is associated with another flaw such as slag) unless it is favourably oriented to the X-ray beam.