

Non-destructive testing of steel forgings

- Part 2: Penetrant testing (BS EN 10228-2:1998)

1 Scope

This part of EN 10228 describes the method and acceptance criteria to be used for the penetrant testing of steel forgings. The method described is used for the detection of surface discontinuities.

2 Normative references

This part of EN 10228 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 part of EN 10228 only when incorporated in by amendment or revision. For undated references the latest edition of the publication referred to applies.

EN 473, Qualification and certification of NDT personnel - General principles.

EN 571, Non-destructive testing -

Penetrant testing - Part 1: General principles for the examination.

prEN 1330, Non-destructive testing -

Terminology - Part 6: Terms used in penetrant systems.

prEN ISO 3452, Non-destructive testing -

Penetrant testing - Part 2: Testing of penetrant materials.

prEN ISO 3452, Non-destructive testing -

Penetrant testing - Part 4: Equipment

3 Definitions

For the purposes of this part of EN 10228 the definitions given in prEN 1330-6 shall apply.

4 Items for agreement

The following aspects concerning penetrant testing shall be agreed between the purchaser and the supplier at the time of enquiry and order:

- a) the manufacturing stage(s) at which penetrant testing is to be performed (see clause 8);
- b) the surface areas to be examined (see clause 9);
- c) whether testing is to be performed with colour contrast or fluorescent penetrants (see 7.1);
- d) the quality class required, or the quality classes and surfaces areas to which they apply (see clause 14);
- e) the applicable recording and acceptance criteria if different from those detailed in Table 1;
- f) whether the test is to be conducted in the presence of the purchaser or his representative;
- g) whether the written procedure must be submitted for approval by the purchaser (see clause 5).

5 Written procedure

5.1 General

Penetrant testing shall be performed in accordance with a written procedure. Where specified in the enquiry or order, the written procedure shall be submitted to the purchaser for approval prior to the examination.

5.2 Form

The written procedure shall be one of the following:

- a) a product specification;
- b) a procedure written specifically for the application;
- c) this part of EN 10228 may be used if it is accompanied by examination details specific to the application.

5.3 Content

The written procedure shall contain the following details as a minimum requirement:

- a) description of the forgings to be examined;
- b) reference documents;
- c) qualification and certification of testing personnel;
- d) stage of manufacture at which the testing is carried out;
- e) surface area(s) specified in terms of the applicable quality classes;
- f) type of penetrant testing products used: penetrant, remover, emulsifier, developer;
- g) surface conditions required;
- h) viewing conditions;
- i) description of pre-testing cleaning and drying, including cleaning materials used and minimum time allowed for drying;
- j) description of penetrant application, including application temperature and penetration time;
- k) description of excess penetrant removal and of drying before developer application;
- l) description of developer application, including development time;
- m) method of marking or recording indications;
- n) acceptance criteria;
- o) whether post-cleaning is required; if so, a description of the process;
- p) examination report.

6 Personnel qualification

Personnel shall be qualified and certificated in accordance with EN 473.

7 Testing system

7.1 Testing products

Penetrant testing products (penetrant, emulsifier, remover and developer) shall conform to EN 571-1.

The combination of penetrant testing products to be used shall meet the following requirements:

- a) they shall conform to EN 571-1;
- b) they shall be compatible with the material to be inspected (see EN 571-1 for guidance);
- c) they shall enable the applicable recording level (see Table 1) to be achieved (see EN 571-1) for the determination of sensitivity levels.

7.2 Equipment

The equipment used shall conform to prEN ISO 3452-4.

NOTE The following equipment may be used:

- a) spray gun or aerosol spray;
- b) immersion tank;
- c) electrostatic spray gun.

7.3 Function test

The sensitivity of the penetrant shall be determined in accordance with prEN ISO 3452-2.

NOTE The temperature of the forging should be checked to ensure that it is within the detection media manufacturer's specified temperature limits.

8 Stage of manufacture

Where practicable, final acceptance testing shall be performed on the forging in its delivery conditions.

(See clause 4.)

9 Surface condition

Surfaces to be tested shall be clean and free from scale, oil, grease, machining marks, paint and any other foreign matter which could adversely affect test sensitivity or the ability to interpret indications.

The surface finish of the surfaces to be examined shall be Ra # 6,3 mm for quality classes 2, 3 and 4 and Ra # 12,5 mm for quality class 1.

10 Coverage

Where practicable, the test shall be performed in such a way that 100 % coverage of the surface to be examined is achieved.

11 Penetrant testing process

The penetrant testing process shall conform to EN 571-1.

12 Viewing

12.1 General

Viewing shall commence immediately the developer is applied and shall continue periodically up to the completion of the development time, when final assessment of indications shall be made.

12.2 Viewing conditions

Viewing conditions shall be as follows:

a) Colour contrast penetrants The surface under examination shall be viewed under white light of at least 500 lx intensity on the surface. Glare and reflections shall be avoided.

NOTE Lower levels of intensity may be agreed between purchaser and supplier.

b) Fluorescent penetrants The surface under examination shall be viewed under UV-A (black light) of at least 10 W/m² intensity on the surface.

The background white light intensity shall not exceed 20 lx.

Prior to the examination at least 5 min shall be allowed for the inspector's eyes to become adapted to the reduced background lighting and the UV-A lamp shall be allowed to warm up for at least 5 min.

13 Classification of indications

The following rules shall apply (see Figure 1).

a) A linear indication shall be considered "isolated"

when it is not aligned with any other linear indication, or when it is aligned with another linear indication, but separated from it by more than five times the length of the longer of the two indications considered.

b) Interacting linear indications are two (or more)

linear indications which are aligned, and shall be considered as one continuous length for the purpose of assessment if their separation is less than, or equal to, five times the length of the longer of the two indications considered. The length of interacting indications is the length measured between the opposite ends of the two outer indications.

c) The cumulative length of linear indications is the sum of the lengths of all linear indications detected in the

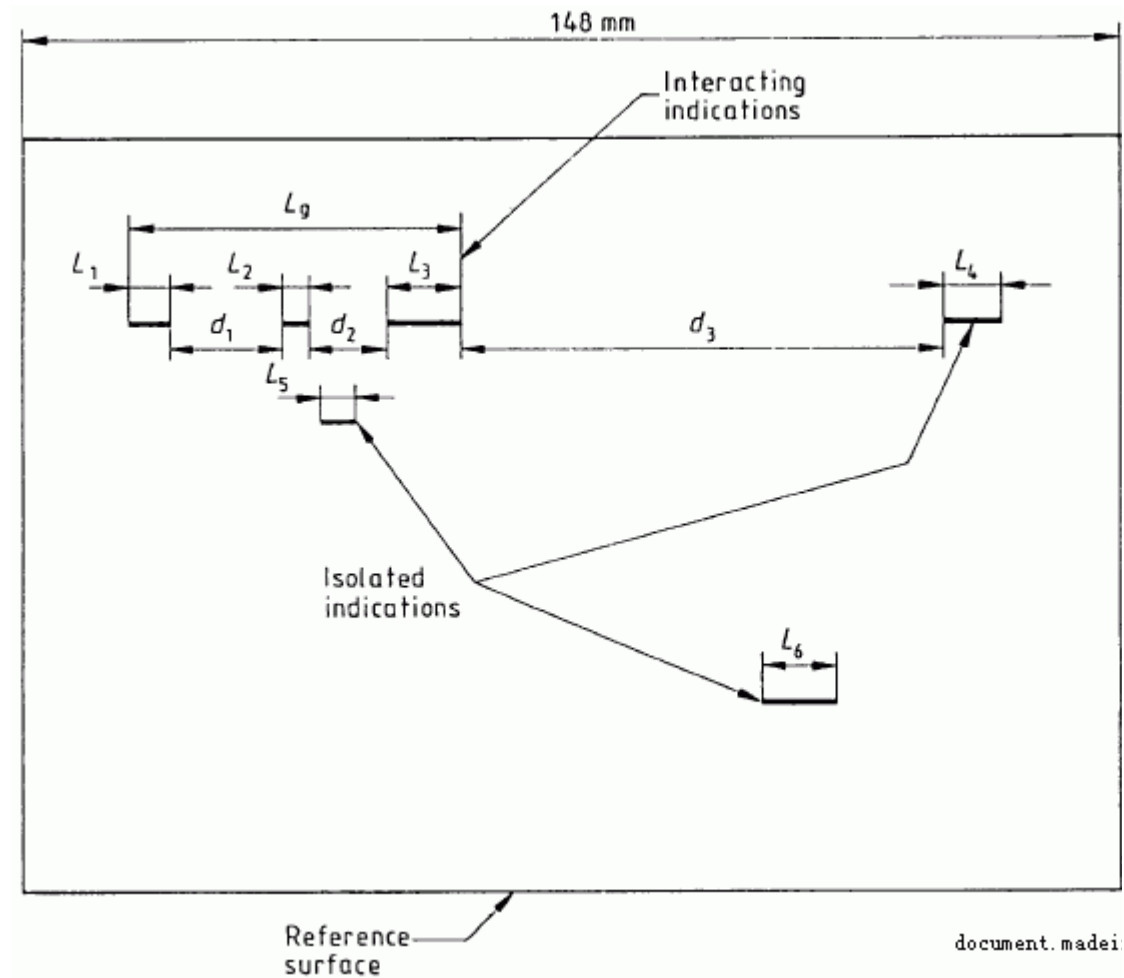
reference surface (i.e. 148 mm 3 105 mm, or = A6 format).

NOTE A linear indication is an indication the length of which is greater than three times the width.

d) A rounded indication is an indication the length of which is less than or equal to three times the width.

e) False indications due to the geometry of the part (change of section or slot etc.) or surface finish (scar or machining mark etc.) shall not be taken into account.

Figure 1 - Classification of linear indications



Explanations

a) Reference surface = 148 mm 3 105 mm (i.e. A6 format).

b) $d_1 < 5L_1$; $d_2 < 5L_3$; $d_3 > 5L_3$.

c) L_1 , L_2 and L_3 = Individual lengths of interacting indications.

d) Total interacting length $L_g = (L_1 + d_1) + (L_2 + d_2) + L_3$.

e) L_4 , L_5 and L_6 = lengths of isolated indications.

f) $L_g + L_4 + L_5 + L_6$ = cumulative length of linear indications in reference surface.

g) Number of indications in reference surface (as identified by L_g , L_4 , L_5 and L_6), see Table 1: four.

14 Recording and acceptance criteria

Four quality classes shall be applied to a forging or to parts of a forging. Quality class 4 is the most stringent, dictating the smallest recording level and the smallest acceptance standard. For forgings for general application supplied in the as-forged surface condition only, quality classes 1 and 2 are applicable. For closed die forgings, quality class 3 shall be the minimum requirement.

The applicable quality class(es) shall be agreed between the purchaser and the supplier. Table 1 details recording levels and acceptance criteria to be applied for four quality classes.

NOTE Where agreed, recording levels and acceptance criteria different from those detailed in Table 1 may be used.

Parameter	Quality class			
	1	2	3	4 1)
Recording level mm ²)	≥ 7	≥ 3	≥ 3	≥ 1
Maximum allowable length L of isolated linear indications and maximum allowable length Lg of interacting indications mm ²)	2 0	8	4	2
Maximum allowable cumulative length of linear indications in the reference surface mm ²)	7 5	3 6	2 4	5
Maximum allowable size of isolated rounded indications mm ²)	3 0	1 2	8	3
Maximum allowable number of recordable indications on reference surface ³⁾	1 5	1 0	7	5
<p>1) Quality class 4 is not applicable to the examination of areas with machining allowance $\geq 0,5$ mm per face.</p> <p>2) The tabulated values apply to the indication size, not to the surface extent of the flaw.</p> <p>3) Reference surface = 148 mm × 105 mm (i.e. A6 format).</p>				

15 Removal of defects

Indications which do not meet the applicable acceptance criteria shall be considered as defects.

Removal of a defect shall be followed by further penetrant testing, using the same penetrant testing system as the first test. Provided that the forging dimensions remain in tolerance, defects shall be eliminated by grinding or machining. Elimination of a defect by grinding shall be carried out in the direction perpendicular to the defect and in such a manner as to blend the resulting hollow with the rest of the surface.

16 Cleaning

Cleaning shall be carried out after penetrant testing when penetrant testing products could interfere with subsequent processing or service requirements.

17 Reporting

All penetrant tests shall be the subject of a written report which shall include the following information as a minimum requirement:

- a) name of supplier;
- b) order number;
- c) identification of forging(s) under examination;
- d) scope of testing: surface(s) and applicable quality class(es);
- e) stage of manufacture at which penetrant testing was performed;
- f) surface condition;
- g) designation of penetrant system used in accordance with EN 571-1, together with the make and designations of products used;
- h) viewing conditions;
- i) reference to this standard or to the written procedure used (where applicable);
- j) results of inspection:
 - 1) location;
 - 2) classification;
 - 3) orientation and size of all indications exceeding the appropriate recording level;
 - 4) number of recorded indications in reference surface;
 - 5) description of unacceptable indications;
- k) details of any restrictions to the required coverage;
- l) date of examination;
- m) name, qualification and signature of operator.