
INTERNATIONAL STANDARD



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Paints and varnishes — Cross-cut test

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FOREWORD

ISO (the International Organization for Standardization) is a worldwide federation of national standards institutes (ISO Member Bodies). The work of developing International Standards is carried out through ISO Technical Committees. Every Member Body interested in a subject for which a Technical Committee has been set up 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.

Draft International Standards adopted by the Technical Committees are circulated to the Member Bodies for approval before their acceptance as International Standards by the ISO Council.

International Standard ISO 2409 was drawn up by Technical Committee ISO/TC 35, *Paints and varnishes*.

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It was approved in August 1971 by the Member Bodies of the following countries :

Austria	Ireland	Romania
Belgium	Israel	South Africa, Rep. of
Canada	Italy	Sweden
Egypt, Arab Rep. of	Netherlands	Switzerland
France	New Zealand	Turkey
Germany	Poland	United Kingdom
India	Portugal	U.S.S.R.

No Member Body expressed disapproval of the document.



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ERRATUM

Page 3

In the table at the bottom of the page, replace the illustrations in the right-hand column by those given in the table below (only the cross-cut areas have been changed in order to correspond more closely to the descriptions given in the middle column).

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TABLE — Classification of test results
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Classification	Description	Appearance of surface of cross-cut area from which flaking has occurred (Example for six parallel cuts)
0	The edges of the cuts are completely smooth; none of the squares of the lattice is detached.	—
1	Detachment of small flakes of the coating at the intersections of the cuts. A cross-cut area not distinctly greater than 5 % is affected.	
2	The coating has flaked along the edges and/or at the intersections of the cuts. A cross-cut area distinctly greater than 5 %, but not distinctly greater than 15 % is affected.	
3	The coating has flaked along the edges of the cuts partly or wholly in large ribbons, and/or it has flaked partly or wholly on different parts of the squares. A cross-cut area distinctly greater than 15 %, but not distinctly greater than 35 % is affected.	
4	The coating has flaked along the edges of the cuts in large ribbons and/or some squares have detached partly or wholly. A cross-cut area distinctly greater than 35 %, but not distinctly greater than 65 % is affected.	
5	Any degree of flaking that cannot even be classified by classification 4.	

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Paints and varnishes — Cross-cut test

0 INTRODUCTION

This International Standard is one of a series dealing with the sampling and testing of paints, varnishes and related products. It should be read in conjunction with ISO/R 1512, *Paints and varnishes — Sampling*, ISO/R 1513, *Paints and varnishes — Examination and preparation of samples for testing*, ISO/R 1514, *Paints and varnishes — Standard panels for testing* and ISO 2808, *Paints and varnishes — Determination of film thickness* (at present at the stage of draft).

This International Standard specifies an empirical test procedure for assessing the performance of a coating of a paint, varnish or related product by measuring a property which depends, among other factors, on the adhesion of the coating to the substrate. However, this procedure must not be regarded as a means of measuring adhesion as such.

The method of test specified requires to be completed for any particular application, by the following supplementary information. This information should be derived from the national standard or other document for the product under test or, where appropriate, should be the subject of agreement between the interested parties :

- 1) material and surface preparation of substrate;
- 2) method of application of test coating to substrate;
- 3) thickness, in micrometres, of the coating, including method of measurement, and whether it is a single coating or a multicoat system;
- 4) duration and conditions of drying of the coated panel (or conditions of stoving and ageing, if applicable);
- 5) the type of cutting tool used and the method of operation (manual or mechanical);
- 6) the number of cuts in one direction of the lattice pattern and the spacing of the cuts therein;
- 7) the performance required of the material in terms of the classification given in section 6.

NOTE — Owing to the fact that the test can be performed under various conditions, the results of several tests are only comparable if all these conditions are the same.

1 SCOPE AND FIELD OF APPLICATION

1.1 This International Standard specifies a procedure for assessing, by means of a simple empirical test, the resistance of a coating of paint, varnish or related product to separation from a substrate when a lattice pattern is cut into the coating, penetrating through it to the substrate.

1.2 When applied to a multicoat system, the procedure also allows assessment of the resistance of the individual layers of the coating to separation from one another.

1.3 The test can be carried out using any of several approved cutting tools. The tool must, however, meet some general requirements (see section 2). The tool may be used manually or mechanically, depending on factors such as the ease of carrying out the test and the reproducibility required.

The choice of the tool, which, among other factors, depends on the type of coating, shall be the subject of agreement between the interested parties.

2 APPARATUS

2.1 Cutting tool

2.1.1 The cutting tool shall be chosen by agreement between the interested parties and shall be such that the essential dimensions are specified by a national or other standard. It is of particular importance to ensure that the cutting portion of the tool has a defined shape and its edges are in good condition.

Suitable tools are the following (see Figure 1) :

- a) single cutting tool with 30° edge, other dimensions as specified;
- b) multiple cutting tool, similar to a), with six cutting edges (1 or 2 mm apart).

Other types of cutting tool, of similar performance, may be used by special agreement.

2.1.2 The tools specified in 2.1.1 are suitable for manual use and although this is the more usual method of use, the tool may be mounted on a mechanical apparatus which provides for a higher degree of uniform cutting. The application of this last procedure shall be subject to agreement between the interested parties.

2.2 Guiding and spacing edges

In order to space the cuts correctly, the use of a suitable series of guiding and spacing edges is preferred and Figure 2 shows a suitable apparatus for use with a single cutting tool.

2.3 Soft brush

3 SAMPLING

A representative sample of the product to be tested (or of each product in the case of a multicoat system) shall be taken as described in ISO/R 1512. The sample shall then be prepared for testing as described in ISO/R 1513.

4 TEST PANELS

4.1 Material and dimensions

The panels shall be of the specified material and where steel, tinplate, aluminium or glass is specified, they shall comply with the requirements of ISO/R 1514.

NOTE – Difficulties may be experienced when carrying out the test on substrates which are relatively soft or anisotropic, for example, wood; particularly in the latter case, multiple cutters are not suitable, since uniform cuts cannot be obtained.

The test panels shall be flat and free from distortion.

The dimensions of the test panels are not critical. They shall allow the test to be carried out at three different positions on the panel, of which the distance from each other and from the nearest edge of the panel shall be not less than 5 mm. Rectangular panels 150 mm X 95 mm have been found convenient. The thickness of the panel shall be greater than 0.25 mm and, additionally, a rigid flat surface shall be provided beneath the panel if there is a risk of deformation of the panel during the test.

4.2 Preparation and coating of panels

The test panels shall be prepared as specified, and where appropriate in accordance with ISO/R 1514, and shall then be coated by the specified method with the product or system under test.

4.3 Thickness of coating

The thickness, in micrometres, of the dry coating shall be determined by the method specified, using one of the procedures described in ISO 2808.

The thickness of the dry coating shall be determined with an accuracy of $\pm 10\%$ or $\pm 5\ \mu\text{m}$, whichever is the smaller of the two values. The measurement shall be made at, or as near as possible to, the positions on the test panel at which the cross-cut test is to be carried out. Three determinations shall be made for each position and each of the results shall be reported.

5 PROCEDURE

5.1 General

5.1.1 Drying the test panels

The coated test panels shall be dried (or stoved and aged) for the specified time and, unless otherwise specified, shall be conditioned at a temperature of $23 \pm 2\ ^\circ\text{C}$ and a relative humidity of $50 \pm 5\%$ for a minimum of 16 h.

5.1.2 Ambient conditions

The test shall be carried out at a temperature of $23 \pm 2\ ^\circ\text{C}$ and a relative humidity of $50 \pm 5\%$, unless otherwise specified.

5.1.3 Number of the cuts

The number of the cuts in each direction of the lattice pattern shall be either 6 or 11, as agreed between the interested parties.

NOTE – The use of 6 cuts has the advantage of faster operation, whereas the use of 11 cuts provides a convenient method of evaluating the degree of flaking of the resulting 100 squares on a percentage basis. The multiple cutting tool (2.1.1b) is not, however, satisfactory for making 11 cuts.

5.1.4 Spacing of the cuts

The spacing of the cuts in each direction shall be equal and, unless otherwise specified, shall be either 1 or 2 mm.

The choice of the spacing is dependent on the properties of the paint film and shall be the subject of agreement between the interested parties.

5.1.5 Repetition of test

The test shall be made in at least three different places on the panel. If the test results at these three places do not agree, in terms of the classification in section 6, the test shall be repeated at three more places and all the results recorded.

5.2 Cutting the coating using manual procedure

5.2.1 Hold the cutting tool face in a plane normal to the test panel surface.

5.2.2 With uniform pressure on the cutting tool and using the appropriate spacing, make the agreed number of cuts in the coating in an even, non-jerky manner and at a cutting rate of 20 to 50 mm/s. All the cuts shall penetrate through to the surface of the substrate but shall not cut too deeply into the latter. If it is not possible because of the hardness or excessive thickness of the coating to penetrate through to the substrate, the test is invalid and this shall be stated in the test report.

5.2.3 Repeat this operation, making further parallel cuts of equal number, overlapping the original cuts and at 90° to them so that a lattice pattern is formed.

5.2.4 Brush the panel lightly with the soft brush five times backwards and five times forwards along both diagonals of the lattice pattern.

NOTE – In general, the test can be performed by using only the brush for removal of flaked portions of paint film. Special circumstances and requirements may, however, make the use of an adhesive tape for this purpose advisable. In this case, the pertinent details shall be the subject of agreement between the interested parties and/or be specified by additional prescriptions. These specifications shall refer to :

- 1) the adhesive properties of the tape;
- 2) the mode of the application, as well as the removal, of the adhesive tape;
- 3) the system of assessment by comparison of samples tested with and without the use of the adhesive tape.

5.3 Cutting the coating using a mechanically operated tool

If the cutting tool is used with a mechanical apparatus, care shall be taken that the points described in the manual procedure are observed particularly with respect to number and spacing of cuts, cutting rate, and test repetition.

6 EVALUATION

6.1 General remark

A six-step classification is given in the following Table. The first three steps will normally suffice for general purposes and shall be used where a "go/no go" assessment is required. Special circumstances may arise for which the complete six-step classification is necessary.

6.2 Examination

Examine the cut surface of the test coating, using normal vision, corrected if necessary, and classify it according to the Table by comparison with the descriptions, using the illustrations as a guide.

If special circumstances should require the use of a magnifying lens, that use and particularly the value of the magnification shall be the subject of agreement between the interested parties.

TABLE – Classification of test results

Classification	Description	Appearance of surface of cross-cut area from which flaking has occurred (Example for six parallel cuts)
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5	Any degree of flaking that cannot even be classified by classification 4.	

7 TEST REPORT

The test report shall include the following particulars :

- a) a reference to this International Standard or to a corresponding national standard;
- b) type and identification of the coating under test;
- c) the items of supplementary information referred to in the introduction to this International Standard, particularly the tool used and the spacing of the cuts;
- d) the national standard or other document supplying the supplementary information referred to in c) above;

e) any deviation, by agreement or otherwise, from the test procedure described;

f) result of the test, in terms of the stated requirements (see section 6), or classification of the tested area of the coated panel. If the test results differ, each result shall be given (see 5.1.5). In the case of a multilayer system, it must be mentioned whether the flaking has occurred between the layers or from the substrate;

g) thickness of coating, in micrometres, at each of the test positions;

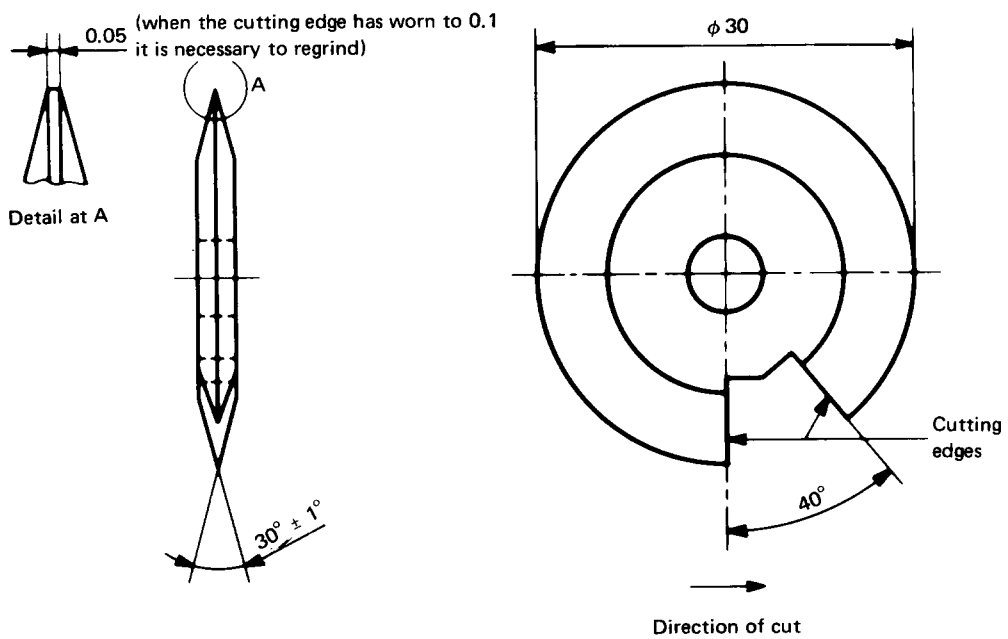
h) date of test.

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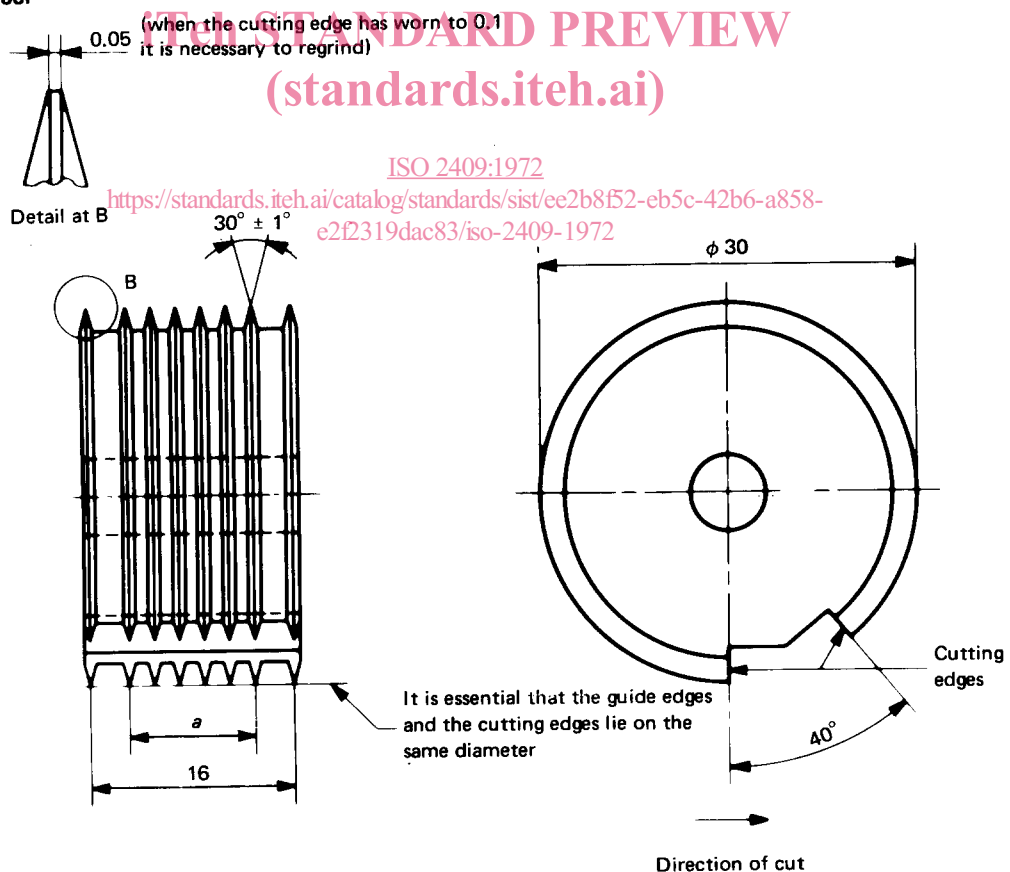
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a) Single cutting tool



b) Multiple cutting tool



Spacing of cutting edges	a
1	5
2	10

FIGURE 1 – Cutting tools