INTERNATIONAL STANDARD

ISO 9961

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Draughting media for technical drawings — Natural tracing paper

Supports de traçage pour dessins techniques — Papier calque naturel

Reference number
ISO 9961:1992(E)

Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established 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. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

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

International Standard ISO 9961 was prepared by Technical Committee ISO/TC 10, *Technical drawings, product definition and related documentation*, Sub-Committee SC 9, *Media and equipment for drawing and related documentation*.

Annexes A and B form an integral part of this International Standard.

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Draughting media for technical drawings — Natural tracing paper

1 Scope

This International Standard specifies the minimum requirements for draughting media made from natural tracing paper. It details qualities necessary for draughting and reproduction, and specifies appropriate test methods for the most commonly used grammages within the range 40 g/m^2 to 160 g/m^2, i.e. 62,5 g/m^2, 72,5 g/m^2, 92,5 g/m^2 and 112,5 g/m^2.

2 Normative references

The following standards contain provisions which, through reference in this text, constitute provisions of this International Standard. At the time of publication, the editions indicated were valid. All standards are subject to revision, and parties to agreements based on this International Standard are encouraged to investigate the possibility of applying the most recent editions of the standards indicated below. Members of IEC and ISO maintain registers of currently valid International Standards.

ISO 5-2:1991, *Photography — Density measurements — Part 2: Geometric conditions for transmission density.*

ISO 186:1985, *Paper and board — Sampling to determine average quality.*

ISO 187:1990, *Paper, board and pulps — Standard atmosphere for conditioning and testing and procedure for monitoring the atmosphere and conditioning of samples.*

ISO 216:1975, *Writing paper and certain classes of printed matter — Trimmed sizes — A and B series.*

ISO 217:1974, *Unprocessed writing and printing paper — Method of expression of dimensions and direction of manufacture.*

ISO 536:1976, *Paper and board — Determination of grammage.*

ISO 1974:1990, *Paper — Determination of tearing resistance (Elmendorf method).*

ISO 2469:1977, *Paper, board and pulps — Measurement of diffuse reflectance factor.*

ISO 4046:1978, *Paper, board, pulp and related terms — Vocabulary.*

ISO 5457:1980, *Technical drawings — Sizes and layout of drawing sheets.*

ISO 5627:1984, *Paper and board — Determination of smoothness (Bekk method).*

ISO 5630-1:1991, *Paper and board — Accelerated ageing — Part 1: Dry heat treatment at 105 °C.*

ISO 8791-2:1990, *Paper and board — Determination of roughness/smoothness (air leak methods) — Part 2: Bendtsen method.*

ISO 9175-1:1988, *Tubular tips for hand-held technical pens using India ink on tracing paper — Part 1: Definitions, dimensions, designation and marking.*

ISO 9175-2:1988, *Tubular tips for hand-held technical pens using India ink on tracing paper — Part 2: Performance, test parameters and test conditions.*

ISO 9957-1:—[1], *Fluid draughting media — Part 1: Water-based India ink — Requirements and test conditions.*

IEC 50(845):1987, *International Electrotechnical Vocabulary — Chapter 845: Lighting.*

1) To be published.

3 Definitions

For the purposes of this International Standard, the definitions given in ISO 4046 and the following definition apply.

3.1 natural tracing paper: Drawing paper for use with ink and/or pencil, the translucency of which is achieved by mechanical treatment during the manufacturing process.

4 Requirements

4.1 Appearance and cleanness

The appearance of the paper when viewed using transmitted light shall be uniform throughout. The paper shall be free from dirt spots, wrinkles, pin holes and other defects which may affect its use.

4.2 Grammages

Grammages, determined in accordance with ISO 536, shall be as shown in table 1.

4.3 Transparency

Transparency, determined in accordance with 5.3, shall be as shown in table 1.

4.4 Draughting quality

4.4.1 Draughting quality using tubular technical pens

Draughting quality with India ink is of interest only for smooth papers.

NOTE 1 Depending on the surface characteristics of the tracing paper and the type of eraser, a reduced contrast between the ink line and the natural tracing paper to be tested may occur where lines made using black leads have been removed.

A line of nominal width 0,35 mm, drawn using a tubular technical pen in accordance with ISO 9175-1, and using India ink complying with ISO 9957-1 and recommended by the manufacturer, on natural tracing paper complying with this International Standard, shall have a tolerance of ± 10 % (± 0,04 mm) of its nominal width after the ink has dried (see the table in ISO 9175-2:1988).

The draughting quality shall be tested as described in 5.4.

NOTE 2 At present it is not possible to determine the draughting quality for pencils.

4.4.2 Redraughting quality using tubular technical pens

Corrections change the surface of tracing paper. The thickness of ink lines in corrected areas is therefore allowed to differ by up to 10 % from line thicknesses in uncorrected areas. Ink lines shall nonetheless fulfil the above requirement for at least the minimum number of corrections given in table 1. The minimum number of corrections given in table 1 applies to erasure by any method recommended by the tracing paper manufacturer or retailer.

The redraughting quality shall be tested as described in 5.4.

4.5 Surface characteristics (smoothness/roughness)

Natural tracing papers are classified as smooth or matt according to their surface characteristics. Tests carried out in accordance with ISO 8791-2 or ISO 5627 shall give the values specified in table 1.

4.6 Tearing resistance

The tearing resistance determined using either the Elmendorf method (see ISO 1974) or the Brecht-Imset method (see annex B) shall comply with the values specified in table 1.

NOTE 3 The Elmendorf and Brecht-Imset methods are alternative methods.

4.7 Resistance to ageing

Natural tracing paper shall have good ageing properties when correctly stored. When aged in accordance with ISO 5630-1, the tearing resistance shall be not less than 70 % of the previous value.

NOTES

4 The transparency loss on ageing may be considered in a future revision of this International Standard.

5 During storage the quality of natural tracing paper may be influenced by temperature and/or humidity. Under normal conditions, natural tracing paper can be expected to remain usable for a minimum of 10 years.

5 Testing

5.1 Sampling

Samples shall be taken in accordance with ISO 186.

5.2 Conditioning and testing of samples

Where appropriate to the test method, samples shall be conditioned and tested in accordance with the

preferred atmosphere given in ISO 187 [(23 ± 1) °C and (50 ± 2) % relative humidity].

5.3 Transparency

5.3.1 General

The transparency of natural tracing paper shall be determined either by a transmission method using a densitometer designed to read ISO diffuse visual transmission density, as defined in ISO 5-2, or by a reflectance method using a reflectometer complying with ISO 2469.

Measurements shall be made with a specified light source to determine the transparency to total light and with a UV filter (Wratten 18A[2] or equivalent) between the test piece or test sample and the photo cell to determine the transparency to UV light.

5.3.2 Transmission method

5.3.2.1 Apparatus

5.3.2.1.1 Densitometer, complying with ISO 5-2 and fitted with a light source complying with standard CIE illuminant D_{65} described in IEC 50(845-03-12) and a UV filter as described in 5.3.1.

5.3.2.2 Procedure

Set up the apparatus in accordance with the manufacturer's instructions. Make two measurements on each test sample and record the results (total light). Place the UV filter between the test sample and the photo cell, make two measurements on each test sample and record the results (UV light).

5.3.2.3 Expression of results

Calculate the mean and standard deviation for total light and for UV light and report the results to two significant figures.

5.3.3 Reflectance method

Carry out the determination in accordance with annex A.

5.4 Draughting quality

5.4.1 Draughting quality using tubular technical pens

5.4.1.1 Apparatus

5.4.1.1.1 Tubular technical pen, complying with ISO 9175-1, with a nominal line width of 0,35 mm. The pen shall be prepared for use in accordance with the manufacturer's recommendations (i.e. for cleaning, kind of draughting fluid complying with ISO 9957-1 to be used, method of filling, etc.).

5.4.1.1.2 Test machine, comprising an electromechanical line-draughting device with adjustable writing angle, writing head and line pitch.[3]

5.4.1.1.3 Microscope with a micrometer scale in the ocular, or a **projector microscope**, with a minimum accuracy of 0,01 mm.

5.4.1.2 Procedure

Testing shall be carried out at a temperature of (23 ± 1) °C and a relative humidity of (50 ± 2) %.

The line-draughting device settings shall be as follows:

— angle of contact: 87°

— writing force on the tips: 0,2 N

— draughting speed: (5 ± 0,3) cm/s

Ensure that the test sample is free from surface contamination.

Draw five lines, at least 150 mm long, on each test sample. Allow the ink to dry for 5 min and examine the lines for continuity. If any line is interrupted, reject the sample. Two further attempts are allowed with samples from the same batch. If all these samples fail, the draughting quality shall be considered unacceptable.

The line width shall be measured in the middle third of each of the five lines. Use preferably a single-barrel measuring microscope with a light source above and × 30 magnification. Measure each line twice in the same spot. Refocus the microscope each time in order to remove inaccuracies due to possible movement in the screw mechanism. Take care when measuring to centre the measuring head over the middle contour of the line edge (see figure 1).

2) Wratten 18A is an example of a suitable product available commercially. This information is given for the convenience of users of this International Standard and does not constitute an endorsement by ISO of this product.

3) Address of the only known present supplier of such a test machine: Rotring-Werke, Kieler Str. 301-303, D-2000 Hamburg 54, Germany.

Report the line width as the average of the 10 measurements, rounded to the nearest 0,01 mm.

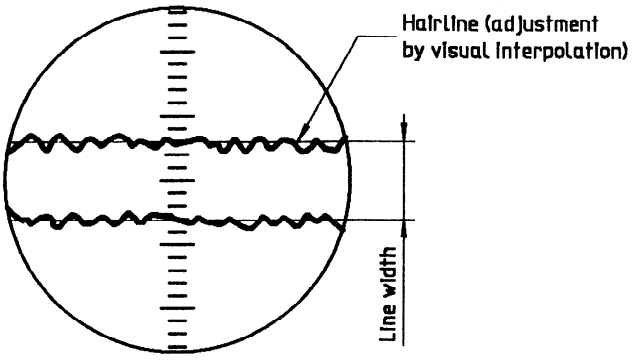

Figure 1

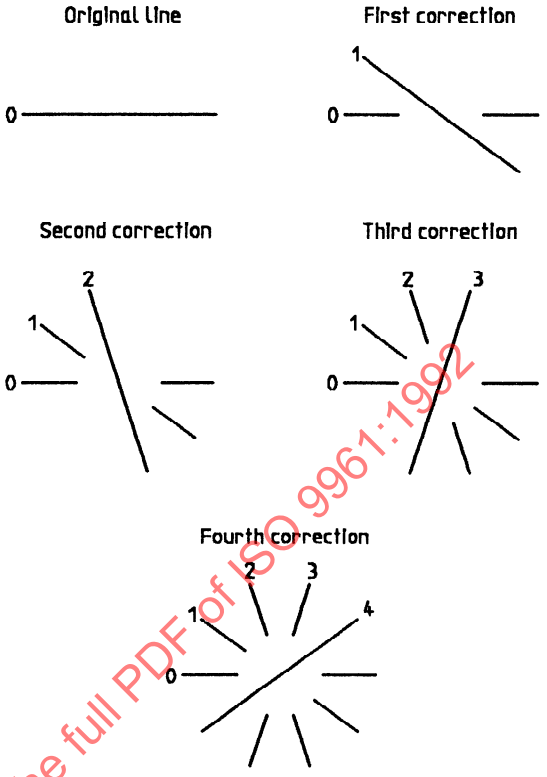

Figure 2

5.4.2 Redraughting quality using tubular technical pens

Draw by hand on the test sample an ink line of minimum length 50 mm using a tubular technical pen of nominal line width 0,35 mm complying with ISO 9175-1. After allowing the ink to dry for at least 5 min, erase a section of approximately 30 mm completely from the centre of the line using any erasure technique recommended by the tracing paper manufacturer or retailer.

The success in drawing over erasures depends partly on suitable after-treatment of the place of erasure. A recommended after-treatment is to rub gently the erased area with a chamois leather or a soft plastic eraser to remove any minute particles of debris that could lead to feathering of the drawn lines constituting the corrections.

Draw lines over the same place according to the pattern of correction given in figure 2.

6 Finished sizes

6.1 Sheet sizes

Sheet sizes shall comply with ISO 216 or ISO 5457.

6.2 Rolls

Tolerances on the width shall be as follows:

a) for widths up to and including 150 mm: ± 1,5 mm

b) for widths greater than 150 mm and up to and including 600 mm: ± 2 mm

c) for widths greater than 600 mm: ± 3 mm

The paper length shall be not less than the specified length.

7 Packing and storage

Sheets and rolls shall be packed so that they are protected against mechanical damage and change in moisture content during transit and storage.

The instructions given by the manufacturer or retailer concerning packing and storage shall be followed.

8 Labelling

Each package shall be labelled by the manufacturer or retailer. The label shall include the following information:

a) "Natural tracing paper complying with ISO 9961";

b) the name of the manufacturer or retailer, and the date or batch number or similar identifying mark (if this information is not available from accompanying documentation);

c) the dimensions;

d) the grammage;

e) the number of sheets and the machine direction (see ISO 217).

9 Test report

The test report shall include the following information:

a) reference to this International Standard;

b) the date and place of test;

c) the precise identification of the samples;

d) the identification of the test method used to determine the tearing resistance (see 4.6);

e) the results in accordance with the appropriate International Standard;

f) any deviation from the specified procedures.

Table 1 — Physical properties

Grammage[1] g/m²		Roughness[2] ml/min		Smoothness[2] s		Tearing resistance mN				Retention of tearing resistance %		Transparency[3]				Minimum number of corrections
						Elmendorf type		Brecht-Imset type[4]				UV light		Total light		
		Matt	Smooth	Matt	Smooth	MD[5]	CD[5]	MD	CD			Transmission	Reflectance	Transmission	Reflectance	
± 5 %	>	⩽	<	⩾	>	>	>	>	⩾	⩽	⩾	⩽	⩾	
62,5	250	250	20	20	200	250	380	450	70	0,15	66	0,08	73	2
72,5	300	300	18	18	230	290	440	530	70	0,16	64	0,09	72	2
92,5	300	300	18	18	300	380	570	700	70	0,19	60	0,10	70	3
112,5	300	300	18	18	400	480	700	860	70	0,22	56	0,11	68	4

1) The grammages given were selected as the most commonly used in the range 40 g/m² to 160 g/m².

2) Roughness/smoothness — The values specified for the division between matt and smooth finishes have been selected as the most suitable for the purposes of this International Standard. In practice, the differences between matt and smooth finishes are generally greater than indicated in this table. If the surface finish is not indicated, the smoothness and draughting properties shall meet the requirements of this International Standard.

3) UV density and transparency results of natural tracing paper containing optical brighteners may differ substantially from the values given.

4) See annex B.

5) See ISO 4046:

MD: machine direction
CD: cross direction

Annex A
(normative)

Measurement of transparency using the reflectance method

A.1 General

This method is applicable to the measurement of the amount of light that is transmitted through one sheet of paper. If the opacity of the paper is low it is difficult to measure accurately the reflectance factor and therefore measurement of transparency is preferred.

Reflectance factors of the paper are needed for calculating the transparency. The reflectance factor depends on the conditions of measurement and particularly on the spectral and geometric characteristics of the instrument used for its determination. This method shall be read in conjunction with 2469.

A.2 Scope

This annex specifies a method for measuring the transparency of paper by diffuse reflectance.

The use of this method is restricted to white or near-white papers of low opacity. Paper that has been treated with a fluorescent dyestuff or exhibits significant fluorescence may be measured, but agreement between values obtained with different instruments may be unsatisfactory and there may be difficulty in assessing the meaning of the results.

A.3 Definitions

For the purposes of this annex, the following definitions apply.

A.3.1 reflectance: The ratio, expressed as a percentage, of the radiation reflected by a body to that reflected by a perfect reflecting diffuser under the same conditions.

A.3.2 transparency: Measure of the light transmission of paper.

A.4 Sampling

Sampling shall be carried out in accordance with ISO 186.

A.5 Apparatus

A.5.1 Reflectometer, calibrated with the reference instrument described in ISO 2469 and equipped for the measurement of reflectance.

A.5.2 Light source, giving standard illuminant D_{65} [see IEC 50(845)].

A.5.3 Filter(s) or other means of spectrum modification, that in conjunction with the optical characteristics of the basic instrument, gives a spectral response equivalent to the D_{65} illuminant for measurement of transparency by total light and equipped with a filter such as Wratten 18A[2] or equivalent for measurement by UV light in the range 350 nm to 400 nm.

A.5.4 Two working standards, calibrated against ISO reference standards of level 3 supplied by an authorized laboratory for the purpose of reflectance standardization.

Details of the calibration of working standards together with cleaning precautions and use are given in ISO 2469. Calibrate the working standard using ISO reference standards of level 3. In every case, use recently calibrated reference standards intended for the calibration of the instrument for reflectance measurements at suitable intervals to ensure agreement with the reference instrument.

A.5.5 Black cavity, in the form of a hollow cylinder covered on the inside with black velvet and having a reflectance of 0,5 % or less.

The design of the cavity is not critical and any backing giving a measured reflectance of 0,5 % or less may be used. Measurements made using a backing having a reflectance greater than 0,5 % will introduce an error that depends on the translucency and will be greater for paper of high transparency.

A.6 Preparation of test pieces

Avoid watermarks, dirt and obvious defects in the paper, and cut not less than 10 rectangular pieces of about 75 mm x 150 mm from the samples. Avoid contamination and unnecessary exposure of the test pieces to light and heat.

A.7 Procedure

Set up the instrument for the measurement of the IEC tristimulus value using the relevant filter (A.5.3). On each test piece make two measurements with the white backing and two with the black backing.

Without touching the test area, use the procedure appropriate to the instrument for measuring the reflectances R_w and R_o, where R_w is the reflectance, in per cent, of a sheet of paper backed by a specified white backing (b), and R_o is the reflectance, in per cent, of the same sheet backed by a black backing (light trap).

A.8 Expression of results

Calculate the means of R_w and R_o and use these figures to calculate the transparency, T, using the following equation, taking R_w and R_o as the readings described in A.7 and R_b as the reflectance of the specified white backing (b):

$$T = \sqrt{(R_w - R_o)\left(\frac{10\,000}{R_b} - R_o\right)}$$

A.9 Test report

Report the transparencies for total light and UV light separately.

Annex B
(normative)

Determination of tear growth resistance using the Brecht-Imset method

B.1 General

The tear growth resistance cannot be determined accurately under the conditions specified in this annex; therefore the tear growth work is measured. The tear growth work (product of tear growth resistance and the working travel) is one of the most important strength properties of paper, along with the tensile strength, bursting resistance and folding resistance. It depends to a considerable extent on the mean fibre length of the paper and characterizes the capability of a paper to sustain mechanical stress.

B.2 Definitions

For the purposes of this annex, the following definitions apply.

B.2.1 tear growth resistance: Force which an initially torn test piece offers against tear growth.

NOTE 6 The tear growth resistance can be calculated approximately from the tear growth work assuming a mean tear growth rate derived from the motion of the pendulum. Since the force displacement is twice as large as the tear length, the tear growth resistance using the indicated mean tear growth rate would correspond to half the numerical value of the tear growth work.

B.2.2 tear growth work: Work done to effect tear growth of the test piece under the conditions given in this annex.

B.2.2.1 longitudinal tear growth work: Work done to bring about tear growth of the test piece parallel to the machine direction.

B.2.2.2 transverse tear growth work: Work done to bring about tear growth of the test piece at right angles to the machine direction.

B.3 Sampling

Sampling shall be carried out in accordance with ISO 186.

B.4 Principle

A slide with cutting edges is driven by a pendulum system against a clamped test piece and makes an initial tear approximately 9 mm long in the test piece. Through the kinetic energy imparted by the pendulum, the slide performs a long travel when the tester is empty and a shorter travel when a test piece is in position. The value of this shorter travel depends on the work to be done for increasing the tear.

The work done in bringing about tear growth is expressed in the final position of the pendulum spindle, which is indicated on a dial gauge by a tracer sliding on an eccentric disc.

B.5 Apparatus

B.5.1 Brecht-Imset growth tester (see figure B.1).

B.5.2 Template and knife, or **other means of cutting test pieces** to the required size of 60 mm × 90 mm.

B.6 Preparation of test pieces

The test pieces shall be prepared in the atmospheric conditions used to condition the samples.

Cut at least 20 test pieces, of dimensions 60 mm × 90 mm, so that half of the test pieces have the long edges parallel to the machine direction and half have the long edges parallel to the cross direction. Mark each test piece accordingly.

B.7 Conditioning and testing

Samples shall be conditioned and tests carried out in accordance with the preferred atmosphere of ISO 187.

B.8 Procedure

B.8.1 Set up and check the apparatus according to the instrument manual.

B.8.2 Withdraw the slide to behind the plane of the sample holder and place a test piece in position. Advance the slide as far as the stop to impart the initial tear to the test piece (see figure B.1, views X and Y). Release the stop and allow the pendulum to make a full swing. Record the reading on the indicator scale.

Repeat for all test pieces.

Discard test pieces in which the tear clearly runs at an angle and prepare additional test pieces so that at least 10 valid results are obtained for each direction.

B.9 Calculation and expression of results

Calculate separately the mean and standard deviation of both machine direction and cross direction tests. Express the results in millinewtons to the nearest 10 mN.

B.10 Test report

The test report shall include the following information:

a) all the indications necessary for the complete identification of the sample;

b) the number of replicate tests carried out;

c) the mean and standard deviation of the machine direction and cross direction results;

d) any departures from this test method or any other factor which may have influenced the results.