

INTERNATIONAL STANDARD

ISO
4586-2

Fourth edition
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High-pressure decorative laminates — Sheets made from thermosetting resins —

Part 2:

Determination of properties

*Stratifiés décoratifs haute pression — Plaques à base de résines
thermodurcissables —*

Partie 2: Détermination des caractéristiques



Reference number
ISO 4586-2:1997(E)

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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 4586-2 was prepared by Technical Committee ISO/TC 61, *Plastics*, Subcommittee SC 11, *Products*.

This fourth edition cancels and replaces the third edition (ISO 4586-2:1995), in which method 13 (resistance to cracking) has been revised.

ISO 4586 consists of the following parts, under the general title *High-pressure decorative laminates — Sheets made from thermosetting resins*:

- Part 1: *Classification and specifications*
- Part 2: *Determination of properties*

High-pressure decorative laminates — Sheets made from thermosetting resins —

Part 2: Determination of properties

1 Scope

This part of ISO 4586 specifies the methods of test for determination of the properties of high-pressure decorative laminated sheets as defined in clause 3. These methods are primarily intended for testing the sheets specified in ISO 4586-1.

The precision of the test methods specified in clauses 4, 7, 9 and 10 of this part of ISO 4586 is not known because inter-laboratory data are not available. When inter-laboratory data are obtained, precision statements will be added to the test methods at the following revision. As all the other test methods have an end point determination based on subjective judgement, it is not meaningful to make a statement of precision in these cases.

2 Normative references

The following standards contain provisions which, through reference in this text, constitute provisions of this part of ISO 4586. At the time of publication, the editions indicated were valid. All standards are subject to revision, and parties to agreements based on this part of ISO 4586 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 105-A02:1993, *Textiles — Tests for colour fastness — Part A02: Grey scale for assessing change in colour.*

ISO 105-B02:1994, *Textiles — Tests for colour fastness — Part B02: Colour fastness to artificial light: Xenon arc fading lamp test.*

ISO 4211-3:1993, *Furniture — Tests for surface finishes — Part 3: Assessment of resistance to dry heat.*

ISO 4586-1:1995, *High-pressure decorative laminates — Sheets made from thermosetting resins — Part 1: Classification and specifications.*

ISO 6506:1981, *Metallic materials — Hardness test — Brinell test.*

ISO 9352:1995, *Plastics — Determination of resistance to wear by abrasive wheels.*

3 Definition

For the purposes of this part of ISO 4586, the definition of high-pressure decorative laminate(s) contained in subclause 3.1 of ISO 4586-1:1995 applies.

The abbreviation "HPDL" for high-pressure decorative laminate(s) is used in ISO 4586. It should be noted that the abbreviation "HPL" is frequently used instead of "HPDL", and the term "HPL" in the European standard EN 438 is equivalent to "HPDL" in ISO 4586.

4 Thickness

4.1 Principle

The thickness of a sheet is measured using a micrometer or a dial gauge indicator.

4.2 Apparatus

4.2.1 Thickness gauge (ratchet-type micrometer or dial gauge indicator), having two flat parallel measuring surfaces of diameter at least 6 mm and capable of being read to 0,01 mm. When the thickness of a decorative laminated sheet is being measured, the two surfaces shall exert a pressure of 10 kPa to 100 kPa upon each other.

4.3 Test specimen

The specimen shall be the sheet under test, as received.

4.4 Procedure

Check the gauge for accuracy and then determine the thickness of the sheet to the nearest 0,02 mm. It is recommended that the thickness be measured at a minimum of four points and at a distance of at least 20 mm from the edge of the sheet.

4.5 Test report

The test report shall include the following information:

- a reference to this part of ISO 4586;
- the name and type of product;
- all values measured;
- the location of the points at which measurements were made;
- any deviation from the specified test method;
- the date of the test.

5 Appearance

5.1 Surface defects

5.1.1 Principle

Sheets are inspected for surface appearance under standardized conditions of lighting and viewing.

5.1.2 Apparatus

5.1.2.1 Horizontal inspection table, of height approximately 700 mm and large enough to accommodate the largest sheets to be inspected.

5.1.2.2 Overhead white fluorescent lights, of colour temperature approximately 5 000 K and giving an intensity of 800 lx to 1 000 lx over the whole area of the largest sheets to be inspected. A convenient distance of the lights from the inspection table is approximately 1,5 m.

5.1.3 Test specimen

The specimen shall be the sheet under test, as received.

5.1.4 Procedure

Place the sheet, decorative face uppermost, on the inspection table. Wipe it free of any loose contamination, if necessary, with a soft cloth. Inspect it from the distance required by ISO 4586-1 for defects such as smudges, smears, fingerprints, scratches, foreign particles, damage or any other form of blemish evident within the decorative surface.

The inspector shall use normal vision, corrected if necessary. No magnifying glass shall be used in viewing the sheet.

5.1.5 Test report

The test report shall include the following information:

- a reference to this part of ISO 4586;
- the name and type of product;
- the viewing distance and any defects observed;
- any deviation from the specified test method;
- the date of the test.

5.2 Flatness

5.2.1 Apparatus

5.2.1.1 Straightedge, of 1 000 mm length, with optional **dial gauge** (see figure 1).

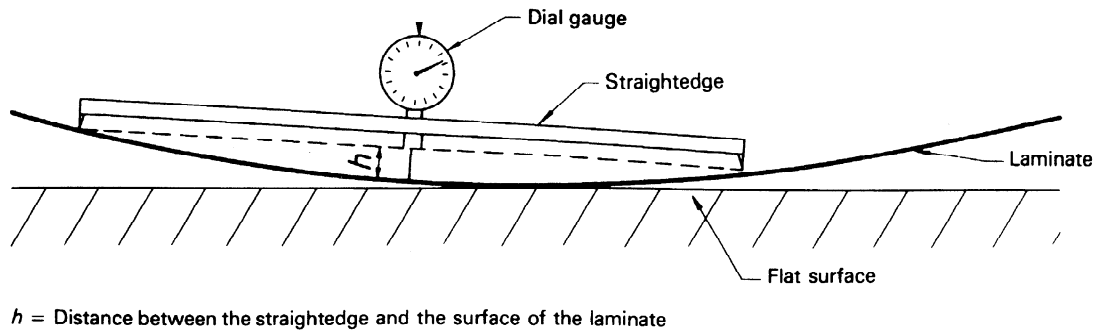


Figure 1 — Example of equipment for measuring flatness (see 5.2.1)

5.2.2 Test specimen

The specimen shall be the sheet under test, as received, stored in the conditions recommended by the manufacturer.

5.2.3 Procedure

Place the sheet under test, concave side up, on a flat surface. Measure the departure between the straightedge and the concave surface of the laminate at the point of maximum curvature.

5.2.4 Test report

The test report shall include the following information:

- a) a reference to this part of ISO 4586;
- b) the name and type of product;
- c) the maximum deviation, in millimetres;
- d) any deviation from the specified test method;
- e) the date of the test.

6 Resistance to surface wear

6.1 Principle

The test measures the ability of the decorative surface of the sheet under test to resist abrasive wear-through to the sub-layer. Abrasion is achieved by rotating a specimen in contact with a pair of loaded cylindrical wheels covered with abrasive paper. The wheels are positioned so that their cylindrical faces are equidistant from the specimen's axis of rotation but not tangential to it. As they are turned by the rotating specimen they abrade an annular track on the specimen's surface. The numbers of revolutions of the specimen required to cause defined degrees of

abrasion are used as measures of resistance to surface wear.

6.2 Materials

6.2.1 Calibration plates of rolled zinc sheet, having a thickness of $0,8 \text{ mm} \pm 0,1 \text{ mm}$ and a Brinell hardness of 48 ± 2 when tested in accordance with ISO 6506, except that the ball diameter shall be 5 mm and the load 360 N.

6.2.2 Abrasive paper strips, of width 12,7 mm and length about 160 mm, having the following composition:

- a) paper of grammage 70 g/m^2 to 100 g/m^2 ;
- b) powdered aluminium oxide having a particle size such that it will pass through a sieve of aperture $100 \mu\text{m}$ and remain on a sieve having an aperture of $63 \mu\text{m}$;
- c) adhesive backing (optional).

6.2.3 Double-sided adhesive tape, required only if the abrasive paper has no adhesive backing.

6.3 Apparatus

6.3.1 Test machine, as specified in ISO 9352.

NOTE 1 A suitable machine is available from Taber Acquisition Corp., Taber Industries, 455 Bryant St, P.O. Box 164, North Tonawanda, NY 14120, USA. (This test machine is an example of a suitable machine available commercially. This information is given for the convenience of users of this part of ISO 4586 and does not constitute an endorsement by ISO of the machine.)

6.3.2 Conditioning chamber, with a standard atmosphere of $23^\circ\text{C} \pm 2^\circ\text{C}$, relative humidity $(50 \pm 5) \%$.

6.4 Test specimens

Each specimen shall be a piece of the sheet under test, shaped to fit the type of clamping device used. It will usually be a disc of diameter about 130 mm, or a square of about 120 mm with its corners rounded to give a diagonal of about 130 mm, and it will usually have a hole of diameter 6 mm in its centre. Three specimens shall be prepared.

6.5 Preparation of specimens and abrasive paper

Clean the surface of the specimens with a non-hazardous organic solvent which is immiscible with water. Precondition the specimens and the abrasive strips for at least 72 h in the conditioning atmosphere (see 6.3.2) before testing.

6.6 Procedure

6.6.1 Preparation of abrasive wheels

Bond a strip of preconditioned abrasive paper (6.2.2) to each of the rubber covered wheels, using either the adhesive backing, if present, or the double-sided adhesive tape (6.2.3), in such a way that the cylindrical surface is completely covered, but without any overlapping of the abrasive paper.

6.6.2 Calibration of abrasive paper

Prepare two abrasive wheels with unused strips of abrasive paper from the batch to be used for testing (see 6.6.1).

Clamp a zinc plate (6.2.1) in the specimen holder, operate the suction device, and abrade the zinc plate for 500 revolutions. Wipe the zinc plate clean and weigh to the nearest 1 mg. Replace the abrasive paper on the wheels with unused strips from the same batch, clamp the same zinc plate in the specimen holder, lower the abrasive wheels and operate the suction device. Abrade the zinc plate for an additional 500 revolutions, then wipe it clean and reweigh it to the nearest 1 mg. Its loss in mass shall be $130 \text{ mg} \pm 20 \text{ mg}$.

Any batch of abrasive paper which causes a loss in mass of the zinc plate outside this permitted range shall not be used for testing.

6.6.3 Abrasion of specimen

Perform the test immediately after removal of the specimen and calibrated abrasive paper from the preconditioning atmosphere.

Prepare sufficient abrasive wheels for the test, using unused abrasive paper. Fit two wheels to the machine and set the revolution counter to zero.

Clamp the specimen in the holder, ensuring that its surface is flat. Lower the abrasive wheels on to the specimen, operate the suction device and allow the specimen to rotate. Examine the specimen for wear after each 25 revolutions and examine the abrasive paper for clogging with abraded particles. Replace the abrasive paper if it becomes clogged, or after 500 revolutions, whichever happens first.

Continue the test in this way until the initial wear point (IP) is reached. Record the number of revolutions and resume the test until the final wear point (FP) is reached. Record the number of revolutions again.

The initial wear point (IP) is the point at which the first clearly recognizable wear-through of the print, pattern, plain colour coating or solid paper appears and the sub-layer becomes exposed in each of four quadrants. The sub-layer for printed patterns is the background on which the pattern is printed; for plain colours it is the first sub-layer of different colour.

The final wear point (FP) occurs in the case of a patterned laminate when about 95 % of the pattern is removed in the abraded area, and in the case of a plain-colour laminate when an underlayer of a different colour is exposed over about 95 % of the abraded area.

6.7 Expression of results

Calculate the wear resistance, expressed as a number of revolutions, for each specimen using the following equation:

$$\text{Wear resistance} = \frac{\text{IP} + \text{FP}}{2}$$

The initial wear point (IP) for the sample under test shall be the average of the IP values obtained on the three specimens.

The wear resistance of the sample under test shall be the average of the wear values obtained on the three specimens, rounded to the nearest 50 revolutions.

6.8 Test report

The test report shall include the following information:

- a) a reference to this part of ISO 4586;

- b) the name and type of product;
- c) the initial wear point (IP) for the sample under test, in revolutions;
- d) the wear resistance of the sample under test, in revolutions;
- e) any deviation from the specified procedure;
- f) the date of the test.

7 Resistance to immersion in boiling water

7.1 Principle

The effect of immersion in boiling water for 2 h is determined by the increase in mass and thickness of test specimens and by noting the occurrence of any blistering or delamination.

The test is generally in accordance with ISO 62:1980, *Plastics — Determination of water absorption*, except for a longer period of immersion in the boiling water and the requirement for thickness measurements.

7.2 Apparatus

7.2.1 Balance, accurate to 1 mg.

7.2.2 Oven, capable of being maintained at $50\text{ °C} \pm 2\text{ °C}$.

7.2.3 Vessel, containing boiling distilled water.

7.2.4 Vessel, containing distilled water at $23\text{ °C} \pm 2\text{ °C}$.

7.2.5 Desiccator.

7.2.6 Micrometer thickness gauge, as described in 4.2.

If curvature of the specimen prevents accurate thickness measurement, then a suitable ball-ended micrometer thickness gauge shall be used.

7.2.7 Suitable heating apparatus (for example an electric hotplate).

7.2.8 Specimen holder, to hold specimens vertically during immersion and prevent contact with other specimens or the vessel.

7.3 Test specimens

Three specimens shall be taken from the same sheet. Each specimen shall be $50\text{ mm} \pm 1\text{ mm}$ square, shall have the same thickness as the sheet, and shall be cut in such a way that no appreciable heat is generated and the edges are free from cracks. Cut edges shall be smooth.

7.4 Procedure

Dry the three specimens for $24\text{ h} \pm 1\text{ h}$ in the oven (7.2.2), maintained at $50\text{ °C} \pm 2\text{ °C}$ and allow to cool in the desiccator (7.2.5) to $23\text{ °C} \pm 2\text{ °C}$. Weigh each specimen to the nearest 1 mg (mass m_1).

Measure the thickness of each specimen as specified in clause 4, but at the centres of its four edges (d_1 , d_2 , d_3 , d_4) and with the external edge of the micrometer anvil approximately 5 mm from each edge. Mark the measuring points so that subsequent measurements can be made in the same places.

Place the specimens in the vessel of boiling distilled water (7.2.3). Take care to prevent the specimens from making contact over any substantial area with one another or with the vessel.

After $2\text{ h} \pm 5\text{ min}$, remove the specimens from the boiling water and allow to cool for $15\text{ min} \pm 5\text{ min}$ in the vessel of distilled water maintained at $23\text{ °C} \pm 2\text{ °C}$ (7.2.4). Take them from the water and remove all surface water with a clean dry cloth or with filter paper. Weigh the specimens again to the nearest 1 mg (mass m_2) within 1 min of taking them from the water.

Determine the thickness of each specimen to the nearest 0,01 mm at the same points as before (d_5 , d_6 , d_7 , d_8).

Examine each specimen visually for change in appearance.

7.5 Expression of results

The boiling water absorbed by each specimen is given, as a percentage by mass, by the formula

$$\frac{m_2 - m_1}{m_1} \times 100$$

where

m_1 is the mass of the specimen before immersion;

m_2 is the mass of the specimen after immersion.

The percentage increase in thickness at the measuring points of each specimen is given by the formulae

$$\frac{d_5 - d_1}{d_1} \times 100$$

$$\frac{d_6 - d_2}{d_2} \times 100$$

etc.

where

d_1, d_2, d_3 and d_4 are the thicknesses measured before immersion;

d_5, d_6, d_7 and d_8 are the thicknesses measured after immersion.

The percentage by mass of boiling water absorbed by the sample under test shall be the average of the values obtained on the three specimens.

The percentage increase in thickness of the sample under test shall be the average of the twelve values obtained at the four measuring points on all three specimens.

7.6 Test report

The test report shall include the following information:

- a reference to this part of ISO 4586;
- the name and type of product;
- the average percentage increase in mass of the three specimens;
- the average percentage increase in thickness of the three specimens;
- the effect on the surface of the specimens, expressed in accordance with the following rating scale:

Rating 5: No visible change

Rating 4: Slight change of gloss and/or colour, only visible at certain viewing angles;

Rating 3: Moderate change of gloss and/or colour

Rating 2: Marked change of gloss and/or colour

Rating 1: Blistering and/or delamination

- any deviation from the specified test method;
- the date of the test.

8 Resistance to dry heat

8.1 Principle

A specimen taken from the sheet under test, bonded to wood chipboard to simulate service conditions, is subjected to dry heat by contact with a vessel of defined heat capacity, initially at 180 °C but cooling during the 20 min of contact. Resistance to the test conditions is assessed by visual examination.

The test is intended to determine the suitability of decorative laminated sheets for use in kitchens where contact with moderately hot cooking utensils is to be expected.

8.2 Materials

8.2.1 Glycerol tristearate, or any other material of similar specific heat which will produce the same result. To minimize health and safety risks, metal blocks can be used if it can be shown that similar results will be obtained. The aluminium alloy block specified in ISO 4211-3 has been found to be suitable.

The same glycerol tristearate or other material may normally be used for at least twenty tests, but if it has been heated to a temperature above 200 °C, or in case of dispute, fresh material shall be used.

8.2.2 Fine-faced wood chipboard, 230 mm ± 5 mm square, 18 mm to 20 mm nominal thickness with a tolerance of ± 0,3 mm, density 625 kg/m³ to 700 kg/m³ and moisture content (9 ± 2) %.

8.2.3 Urea-formaldehyde adhesive, containing approximately 15 % filler, or an equivalent adhesive.

8.3 Apparatus

8.3.1 Cast cylindrical aluminium or aluminium alloy vessel, without a lid, the bottom of which has been machined flat. It shall have an external diameter of 100 mm ± 1,5 mm and an overall height of 70 mm ± 1,5 mm. The wall thickness shall be 2,5 mm ± 0,5 mm and the base thickness 2,5^{+0,5}₀ mm.

8.3.2 Heat source, for heating the vessel (8.3.1) uniformly.

8.3.3 Suitable inorganic heat-insulating board, of thickness about 2,5 mm and 150 mm square.

8.3.4 Thermometer, range $-5\text{ }^{\circ}\text{C}$ to $+250\text{ }^{\circ}\text{C}$.

8.3.5 Fixed frame, to hold the specimen flat.

8.3.6 Stirrer.

8.4 Test specimen

The specimen shall be prepared by uniformly bonding a piece of the sheet under test to the wood chipboard (8.2.2), using the specified adhesive (8.2.3). One specimen $230\text{ mm} \pm 5\text{ mm}$ square shall be used. The bonded specimen shall be preconditioned for at least 7 days at $23\text{ }^{\circ}\text{C} \pm 2\text{ }^{\circ}\text{C}$ and $(50 \pm 5)\%$ relative humidity before being used for the test.

For materials of thickness greater than 2 mm, the effect of bonding the specimen is insignificant and the test may be conducted with the specimen resting in close contact with the chipboard. This technique is also acceptable for routine quality control testing of laminates less than 2 mm thick. However, in cases of dispute, laminates less than 2 mm thick shall be bonded to chipboard.

8.5 Procedure

Fill the vessel (8.3.1) with sufficient glycerol tristearate (8.2.1) so that at $180\text{ }^{\circ}\text{C}$ the level is about 15 mm from the top. Fix the thermometer (8.3.4) centrally in the vessel with its bulb about 6 mm from the bottom. Raise the temperature of the glycerol tristearate to approximately $185\text{ }^{\circ}\text{C}$, stirring from time to time. Transfer the vessel to the heat-insulating board (8.3.3) and allow the temperature to fall to $180\text{ }^{\circ}\text{C} \pm 1\text{ }^{\circ}\text{C}$, stirring continuously.

Immediately place the vessel on the surface of the specimen and allow to stand for 20 min without further stirring.

At the end of this period, remove the vessel and allow the specimen to cool for a period of 45 min. Examine the specimen for surface disturbance, for example blistering, crazing, discolouration or loss in gloss visible to the naked eye, corrected if necessary, allowing the light to fall on the specimen at various angles of incidence.

8.6 Test report

The test report shall include the following information:

- a) a reference to this part of ISO 4586;
- b) the name and type of product;

- c) the effect on the surface of the specimen expressed in accordance with the following rating scale:

- Rating 5: No visible change
- Rating 4: Slight change of gloss and/or colour, only visible at certain viewing angles
- Rating 3: Moderate change of gloss and/or colour
- Rating 2: Marked change of gloss and/or colour
- Rating 1: Surface damage and/or blistering

- d) any deviation from the specified test method;
- e) the date of the test.

9 Dimensional stability at elevated temperature

9.1 Principle

The test measures the lateral dimensional changes of specimens from the sheet under test over an extreme range of relative humidities at elevated temperatures.

9.2 Apparatus

9.2.1 Oven, capable of being maintained at $70\text{ }^{\circ}\text{C} \pm 2\text{ }^{\circ}\text{C}$.

9.2.2 Conditioning chamber, with an atmosphere of relative humidity within the range 90 % to 95 % and at a temperature of $40\text{ }^{\circ}\text{C} \pm 2\text{ }^{\circ}\text{C}$.

NOTE 2 This relative humidity occurs at a temperature of $40\text{ }^{\circ}\text{C}$ in equilibrium above a saturated solution of sodium tartrate $[(\text{CHOHCOONa})_2 \cdot 2\text{H}_2\text{O}]$.

9.2.3 Conditioning chamber, with a standard atmosphere of $23\text{ }^{\circ}\text{C} \pm 2\text{ }^{\circ}\text{C}$ and relative humidity $(50 \pm 5)\%$.

9.2.4 Means for measuring lengths of 200 mm to the nearest 0,02 mm.

9.2.5 Desiccator, of suitable size.

9.3 Test specimens

Each specimen shall be 250 mm long, 50 mm wide and of the thickness of the sheet under test. The edges shall be smooth and free from cracks. Measuring marks shall be made on the decorative

face of the specimens approximately 200 mm apart and 25 mm from each end.

Twelve specimens shall be tested, six of them with their major axes parallel to the machine direction of the fibrous sheet material (for example paper) from which the sheet has been made, and six with their major axes at right angles to the machine direction. Three specimens from each direction shall be used for the dry-heat test and three for the high-humidity test.

NOTE 3 If the machine direction is not known, carry out flexural strength tests at various angles. The highest value will usually be given by the specimen cut parallel to the machine direction.

Before making the first measurements, all specimens shall be kept for 4 days in a standard atmosphere of $23\text{ °C} \pm 2\text{ °C}$ and $(50 \pm 5)\%$ relative humidity.

9.4 Procedure

All measurements of length shall be made to the nearest 0,02 mm. Measurements shall be made within 5 min after removal of the specimens from the conditioning atmosphere or the desiccator (9.2.5).

9.4.1 Dry-heat test

Taking three specimens in each direction, measure the distance between the marks on each specimen with the specimens laid flat and then place them in the oven (9.2.1) maintained at $70\text{ °C} \pm 2\text{ °C}$. At the end of 24 h, remove them and allow them to cool to ambient temperature in the desiccator (9.2.5) for 1 h, and then remeasure the distance between the marks.

9.4.2 High-humidity test

Taking the remaining three specimens in each direction, measure the distance between the marks and then place them in the conditioning chamber (9.2.2) at $40\text{ °C} \pm 2\text{ °C}$ and relative humidity within the range 90 % to 95 %. After $96\text{ h} \pm 4\text{ h}$, remove each specimen, wipe it free of surface water with a cloth, and remeasure the distance between the marks.

9.5 Expression of results

For each specimen, calculate the change as a percentage of the initial distance between marks.

Calculate the mean percentage change for each of the four sets of three specimens, to the nearest 0,05 %.

Calculate the cumulative dimensional change for each direction of the sheet. This change is the sum of the average absolute dimensional changes in each of the dry-heat and high-humidity tests if the movements are in opposite directions. If they are in the same direction, the larger of the two average changes shall be taken as the cumulative dimensional change. The absolute figure shall be reported.

EXAMPLE (using specimens in one direction only)

Dry-heat test

Specimen	1	2	3	Mean to nearest 0,05 %
Initial length (mm)	200,90	199,86	200,64	
Final length (mm)	200,12	199,04	199,84	
Change in length (mm)	- 0,78	- 0,82	- 0,80	
Change (%)	- 0,39	- 0,41	- 0,40	- 0,40

High-humidity test

Specimen	4	5	6	Mean
Initial length (mm)	201,40	200,22	199,98	
Final length (mm)	202,00	200,86	200,54	
Change in length (mm)	+ 0,60	+ 0,64	+ 0,56	
Change (%)	+ 0,30	+ 0,32	+ 0,28	+ 0,30

The movements in the two tests are in opposite directions; therefore, the cumulative dimensional change is equal to $(0,3 + 0,4)\% = 0,7\%$.

9.6 Test report

The test report shall include the following information:

- a reference to this part of ISO 4586;
- the name and type of product;
- the cumulative dimensional change for the machine direction;
- the cumulative dimensional change for the cross-machine direction;
- any deviation from the specified test method;
- the date of the test.

10 Dimensional stability at 20 °C

10.1 Principle

The test measures the lateral dimensional changes of specimens from the sheet under test due to changes in humidity at 20 °C.

10.2 Apparatus

10.2.1 Conditioning chambers, maintaining the following three atmospheres:

- 20 °C $\pm$ 2 °C, relative humidity (32 $\pm$ 3) %
- 20 °C $\pm$ 2 °C, relative humidity (90 $\pm$ 3) %
- 23 °C $\pm$ 2 °C, relative humidity (50 $\pm$ 5) %

10.2.2 Means for measuring lengths of 200 mm to the nearest 0,02 mm.

10.3 Test specimens

Four specimens measuring approximately 250 mm $\times$ 50 mm shall be cut from the sheet under test in both the machine and cross-machine directions of the fibrous sheet material (for example paper) from which the sheet was manufactured. If these directions are not known, they may be determined as specified in subclause 9.3. Measuring marks shall be made on the decorative face of the specimens approximately 200 mm apart and 25 mm from each end.

10.4 Procedure

Precondition the specimens for 4 days in a standard atmosphere of 23 °C $\pm$ 2 °C and (50 $\pm$ 5) % relative humidity.

Measure the distance between the marks on all eight specimens to the nearest 0,02 mm with the specimens laid flat.

Keep four specimens, two cut in the lengthwise and two in the crosswise direction, for 7 days at 20 °C $\pm$ 2 °C and (32 $\pm$ 3) % relative humidity.

Keep the remaining four specimens for 7 days at 20 °C $\pm$ 2 °C and (90 $\pm$ 3) % relative humidity.

Remeasure the distance between the marks as before within 5 min after removal from the conditioning atmosphere.

10.5 Expression of results

Calculate the change in measured length of each specimen as a percentage of the initial measured length.

Calculate the mean percentage change in measured length for each of the four pairs of specimens, to the nearest 0,05 %.

Calculate the cumulative dimensional change for each direction of the sheet. This change is the sum of the mean absolute percentage changes in each of the low- and high-humidity tests. The absolute figure shall be reported.

10.6 Test report

The test report shall include the following information:

- a) a reference to this part of ISO 4586;
- b) the name and type of product;
- c) the cumulative dimensional change for the machine direction;
- d) the cumulative dimensional change for the cross-machine direction;
- e) any deviation from the specified procedure;
- f) the date of the test.

11 Resistance to impact by small-diameter ball

11.1 Principle

A specimen from the sheet under test is bonded to wood chipboard to simulate service conditions and its decorative surface is subjected to the impact of a 5 mm steel ball mounted at one end of a spring-loaded bolt. The minimum spring force needed to cause visible damage is used as a measure of resistance to impact.

11.2 Materials

11.2.1 High-quality fine-faced wood chipboard, 18 mm to 20 mm nominal thickness with a tolerance of $\pm$ 0,3 mm, density 625 kg/m³ to 700 kg/m³ and moisture content (9 $\pm$ 2) %.

Where the specimen is bonded to chipboard, the test actually measures the impact resistance of the whole composite material, i.e. laminate, adhesive and

substrate. The correct choice of chipboard quality is therefore very important in achieving good reproducibility with this test. In cases of dispute, the same test shall be carried out on chipboards from three different suppliers.

11.2.2 Urea-formaldehyde adhesive, containing approximately 15 % filler, or an equivalent adhesive.

11.2.3 Solution of dye in alcohol, graphite or talcum, to contrast with the colour of the sheet under test (optional).

11.3 Apparatus

11.3.1 Impact tester (see figure 2), consisting of an impact bolt with a 5 mm steel ball mounted at one end, which is projected once against the surface under test by the release of a compression spring. The spring compression force before release can be adjusted continuously from 0 N to 90 N by means of a force-setting barrel (housing).

The newton metre (N·m) scale also provided on the tester is only to be used for orientation, as the introduction of a non-linear scale involves relatively great inaccuracies.

The compression spring is 100 mm long when released and has a constant of $1\,962\text{ N/m} \pm 50\text{ N/m}$. It is compressed by drawing back the impact bolt and is held in the loaded position by a retainer which engages in the bolt. It is released to deliver the impact blow by a release unit which withdraws the retainer.

11.3.2 Force-producing arrangement (for example a scale-pan and weights), capable of being suspended from the impact bolt to exert a compressive force on the spring.

11.3.3 Support fixture (see figure 3), which clamps to the shaft of the impact tester and provides a convenient mounting of sufficient mass for the tester to be held at right angles to the surface of the specimen and to avoid recoil following the release of the impact bolt.

11.3.4 Steel plate, having dimensions of approximately 300 mm × 300 mm × 50 mm.

11.3.5 Hand lens, with approximately × 6 magnification (optional).

11.4 Test specimens

Specimens shall be prepared by uniformly bonding a piece of the sheet under test to the wood chipboard (11.2.1), using the specified adhesive (11.2.2). About ten specimens, each $230\text{ mm} \pm 5\text{ mm}$ square, shall be prepared. The bonded specimens shall be preconditioned for at least 7 days at $23\text{ °C} \pm 2\text{ °C}$ and $(50 \pm 5)\%$ relative humidity before being used for the test.

11.5 Calibration of the impact tester

Suspend the tester (11.3.1) with the impact bolt pointing upwards so that its longitudinal axis is free to hang vertically under gravity.

Set the force-setting barrel, which serves to vary the impact force, to zero on the scale. Compress the spring by a force F_e (calibration force) using a suitable arrangement (for example weights in a scale-pan) (11.3.2) suspended from the knob used to draw back the impact bolt, ensuring that the bolt is clear of the retainer of the release unit.

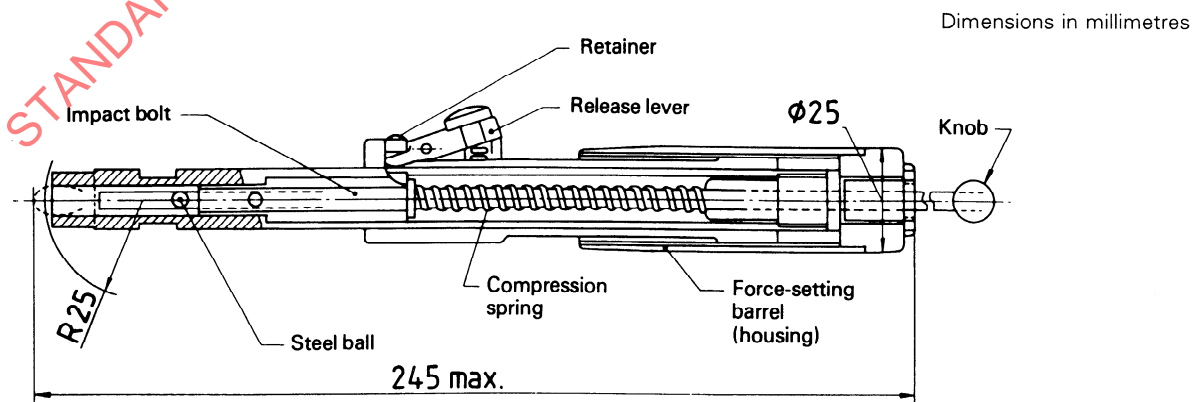


Figure 2 — Impact tester (shown with spring compressed) (see 11.3.1)

Dimensions in millimetres

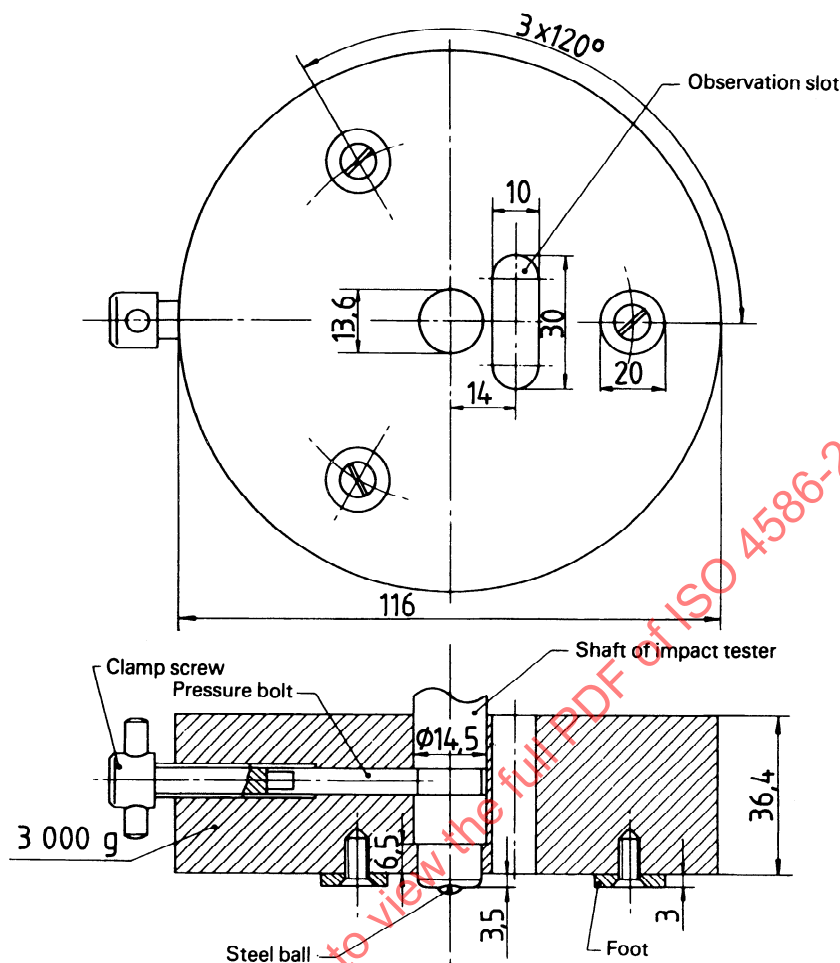


Figure 3 — Support fixture for impact tester (see 11.3.3)

Turn the force-setting barrel until the retainer of the release unit is just in contact with the impact bolt. This position can be determined by increasing or decreasing the compressing force very slightly to observe whether the retainer is just in contact. Record the indicated force F_x on the scale of the instrument corresponding to the calibration force F_e .

Repeat this calibration procedure for various values of F_x in the range required, and draw a graph relating values of the scale reading F_x to values of the calibration force F_e (see figure 4 for an example).

The graph will be an approximately straight line which will not pass through the origin, because a constant but undetermined force is exerted during the calibration procedure by the mass of the impact bolt and any suspension arrangement (for example, a scale-pan). Draw a second line passing through the origin and parallel to the first line. This second line is the calibration graph of the instrument and shall be used to correct every indicated force F_x employed in testing.

Prepare a new calibration graph after every 500 tests.

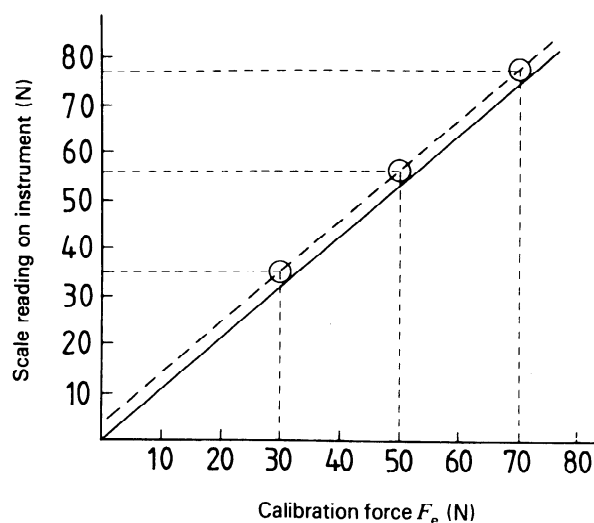


Figure 4 — Example of calibration graph relating actual force to scale value (see 11.5)

11.6 Procedure

The test shall be carried out in the laboratory atmosphere, and in cases of dispute it shall be carried out at 23 °C ± 2 °C.

Place the steel plate (11.3.4) on a convenient rigid horizontal surface and locate the specimen on it with its decorative surface uppermost. Fix the impact tester in its support fixture (11.3.3), load the tester, place the assembly on the specimen and release the impact bolt. Start preliminary tests with a spring force of 10 N and increase by 5 N on each occasion to determine the minimum spring force at which the surface of the specimen shows damage due to impact stress.

Test at least five additional specimens for the final determination of the maximum force at which no damage occurs. For this purpose, start with the spring force determined in the preliminary test and reduce it in suitable stages, for example 1 N, after every five tests.

To make the damage more easily visible, the surface of the specimen may be rubbed after the test with a solution of dye in alcohol or with graphite or talcum (depending on the colour of the decorative surface). A magnifier (11.3.5) with × 6 magnification may also be used.

The distance between points of impact shall be at least 20 mm and between points of impact and the edge of the specimen at least 30 mm.

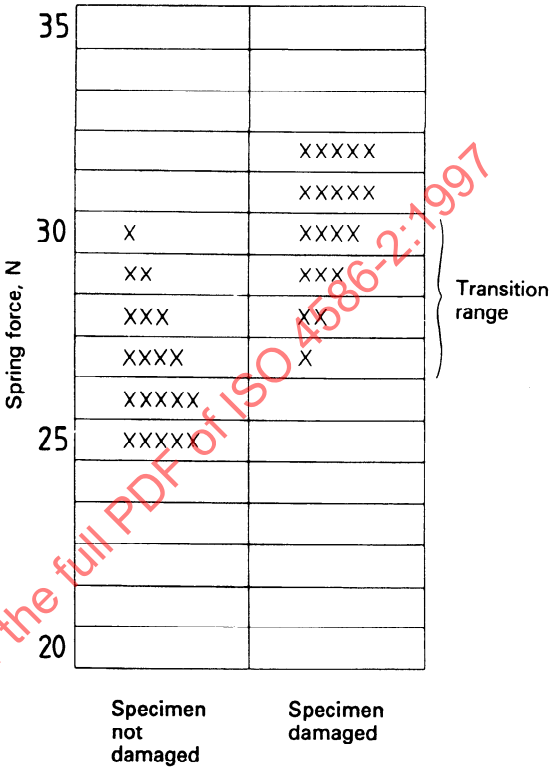
Examine the specimen for damage at the points of impact. For the purpose of this test, damage is defined by the presence of fine hairline cracks (which are frequently concentric), continuous cracks or flaking of the decorative surface. Indentations without cracks do not count as damage.

If the test is only conducted to determine whether the impact strength of a material exceeds a limiting value, the specimen shall sustain no damage after five successive individual impact blows with the prescribed spring force.

11.7 Expression of results

Enter the results of the series of tests on to an evaluation diagram (see figure5 for an example) in which they are subdivided into "Specimen not damaged" and "Specimen damaged", for each value of spring force used. This results in a transition range in which some specimens are damaged and some un-

damaged. The impact strength of the material is the maximum value of the spring force, in newtons, for which no damage occurs in a series of five tests.



NOTE — In the example, the impact strength of the material is 26 N.

Figure 5 — Example of evaluation diagram for assessing the effect of impact blows with an impact tester (see 11.7)

11.8 Test report

The test report shall include the following information:

- a) a reference to this part of ISO 4586;
- b) the name and type of product;
- c) the impact strength, in newtons;
- d) any deviation from the specified procedure;
- e) the date of the test.

12 Resistance to impact by large-diameter ball

12.1 Principle

A specimen from the sheet under test (bonded to wood chipboard if specified) is covered with a sheet of carbon paper and subjected to the impact of a steel ball which is allowed to fall from a known height. Impact resistance is expressed as the maximum drop height which can be achieved without incurring visible surface cracking or producing an imprint greater than a specified maximum diameter.

12.2 Materials

12.2.1 High-quality fine-faced wood chipboard, 18 mm to 20 mm nominal thickness with a tolerance of $\pm 0,3$ mm, density 625 kg/m^3 to 700 kg/m^3 and moisture content $(9 \pm 2) \%$.

Where the specimen is bonded to chipboard, the test actually measures the impact resistance of the whole composite material, i.e. laminate, adhesive and substrate. The correct choice of chipboard quality is therefore very important in achieving good reproducibility with this test. In cases of dispute, the same test shall be carried out on chipboards from three different suppliers.

12.2.2 Urea-formaldehyde adhesive, containing approximately 15 % filler, or an equivalent adhesive.

12.3 Apparatus

12.3.1 Free-fall test apparatus, of the type shown in figure 6, or an equivalent which will produce the same results.

12.3.2 Polished steel ball, of mass $324 \text{ g} \pm 5,0 \text{ g}$ and diameter $42,8 \text{ mm} \pm 0,2 \text{ mm}$, having no damaged or flattened areas on its surface.

12.3.3 Specimen clamping frame, conforming to figure 7.

12.4 Test specimens

Specimens shall be $230 \text{ mm} \pm 5 \text{ mm}$ square. For laminates of thickness less than 2,0 mm, specimens shall be prepared by uniformly bonding a piece of the sheet under test to the wood chipboard (12.2.1) using

the specified adhesive (12.2.2). The bonded specimens shall be pre-conditioned for at least 7 days at $23 \text{ }^\circ\text{C} \pm 2 \text{ }^\circ\text{C}$ and $(50 \pm 5) \%$ relative humidity before being used for the test.

For laminates of thickness $\geq 2,0 \text{ mm}$ and $< 5,0 \text{ mm}$, the effect of bonding the specimen is insignificant and the test may be conducted with the laminate clamped in the frame in contact with the chipboard.

Laminates of thickness $\geq 5,0 \text{ mm}$ shall be tested clamped in the frame without the chipboard support.

12.5 Procedure

The test shall be carried out in the laboratory atmosphere, and in cases of dispute it shall be carried out at $23 \text{ }^\circ\text{C} \pm 2 \text{ }^\circ\text{C}$.

Clamp the specimen in the clamping frame (12.3.3) and place the assembly on the solid base of the free-fall test apparatus (12.3.1). Cover the specimen with a sheet of carbon paper with its coated face in contact with the decorative surface. Adjust the height scale so that its base is touching the face of the specimen.

Position the electromagnet at any arbitrary height (the specification limit for the material under test is a useful starting point).

Place the steel ball (12.3.2) on the energized electromagnet. Operate the release mechanism so that the ball falls on the specimen, catching the ball on the first rebound so that multiple impacts do not occur.

Examine the impact spot. If cracking is evident, or the carbon imprint is greater than the diameter specified in ISO 4586-1, lower the electromagnet and repeat the test. If no cracking is evident and the imprint is smaller than the specified diameter, raise the electromagnet and repeat the test. The distance between points of impact, and between points of impact and the edge of the specimen, shall be at least 50 mm. For referee purposes, only one impact per specimen shall be made, with the point of impact as near as possible to the centre of the specimen.

Repeat the above procedure, as necessary, to determine the impact resistance, which is defined as the maximum height for which no visible surface cracking, or imprint greater than the specified diameter, occurs in five successive strikes.

Dimensions in millimetres

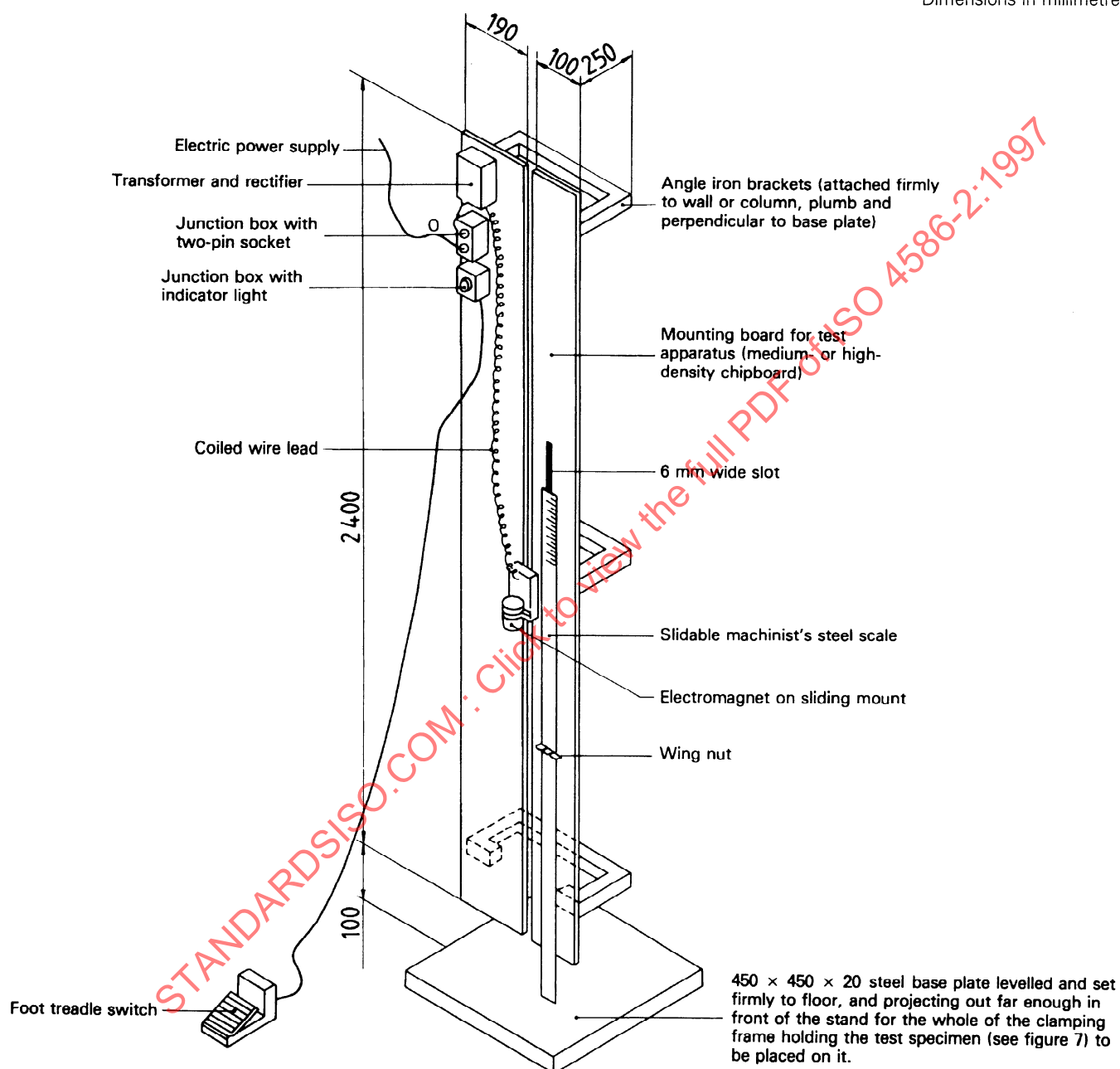


Figure 6 — Resistance to impact by large-diameter ball (see 12.3.1)

Dimensions in millimetres

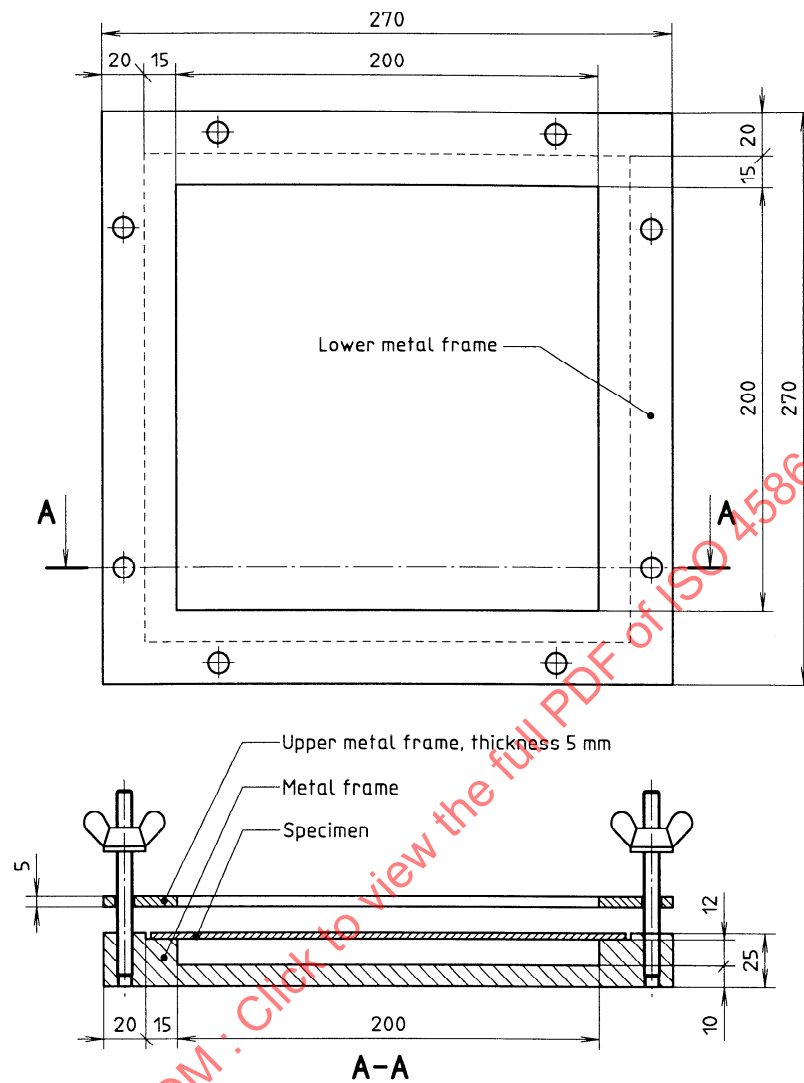


Figure 7 — Clamping frame (see 12.3.3)

12.6 Test report

The test report shall include the following information:

- a reference to this part of ISO 4586;
- the name and type of product;
- the impact resistance, expressed in centimetres;
- the indentation diameter, expressed in millimetres;
- any deviation from the specified test method;
- the date of the test.

13 Resistance to cracking under stress (thin laminates ≤ 2 mm)

13.1 Principle

A specimen, with a drilled hole, taken from the sheet under test is rigidly clamped in a steel fixture. After imposing additional stress by heating at 50 °C for 6 h, the resistance of the specimen to cracking is assessed by visual examination.

13.2 Apparatus

13.2.1 Clamping device, as shown in figure 8 a.

13.2.2 Drilling jig, to facilitate drilling of accurate holes which are free from chipping or cracking. A suitable jig is as shown in figure 8 b.

13.2.3 Conditioning chamber, with a standard atmosphere of $23\text{ }^{\circ}\text{C} \pm 2\text{ }^{\circ}\text{C}$ and relative humidity of $(50 \pm 5)\%$.

13.2.4 Electrically heated oven, provided with air circulation and capable of being maintained at $50\text{ }^{\circ}\text{C} \pm 2\text{ }^{\circ}\text{C}$.

13.2.5 Hand lens, with approximately $\times 6$ magnification.

13.2.6 Lighting, of intensity 800 lx to 1 000 lx.

13.2.7 Drilling machine, operating at less than 400 r/min.

13.2.8 Micrometer thickness gauge, as described in 4.2.1.

13.3 Test specimens

Four specimens shall be prepared, of which three shall be tested and the fourth used as a drill backing piece.

Each specimen shall be $150\text{ mm} \pm 1\text{ mm}$ long, $50\text{ mm} \pm 0,5\text{ mm}$ wide and of the thickness of the sheet under test. The length of the specimen shall correspond to the cross direction of the sheet.

The specimens shall have a $10\text{ mm} \pm 0,5\text{ mm}$ diameter hole drilled in their centres using a drilling jig (13.2.2), the four specimens being clamped together with the decorative surfaces face to face. During the drilling operation, care shall be taken to avoid chipping, cracking or burning around the edge of the holes. The drill shall be sharp, and the speed of the drilling machine shall not exceed 400 r/min. After the drilling has been carried out, the specimen used as a backing piece (i.e. the bottom specimen) shall be discarded.

Any specimen showing cracking, chipping or burning around the edge of the hole shall be discarded, and a replacement prepared. Replacement specimens will also be needed if any specimen movement occurs during the test (see 13.4).

13.4 Procedure

Measure the thickness of the laminate under test in accordance with clause 4.

Pre-condition the specimens for 48 h in a standard atmosphere of $23\text{ }^{\circ}\text{C} \pm 2\text{ }^{\circ}\text{C}$ and $(50 \pm 5)\%$ relative humidity.

Pre-heat the clamping device (13.2.1) in the oven (13.2.4) for 2 h at $50\text{ }^{\circ}\text{C} \pm 2\text{ }^{\circ}\text{C}$.

Take one specimen from the conditioning chamber (13.2.3), place it immediately in the pre-heated clamping device, and tighten the nuts firmly to prevent movement of the specimen. Make reference marks on the surface of the specimen adjacent to each clamping block to confirm absence of movement.

Place the clamping device containing the specimen in the oven at $50\text{ }^{\circ}\text{C} \pm 2\text{ }^{\circ}\text{C}$.

After $6\text{ h} \pm 15\text{ min}$, remove the device from the oven, check the reference marks to ensure that the specimen has not moved, and immediately examine the specimen (while still hot and clamped in the device) with the naked eye and under $\times 6$ magnification for signs of cracking around the hole.

If there is any evidence of movement of the specimen in the clamps during the 6 h test period, discard the specimen without examination and repeat the whole procedure using a new specimen.

Test two further specimens using the same procedure.

13.5 Expression of results

Express the result of the examination in accordance with the following rating scale (see also figure 8 c):

- Rating 5: No evidence of cracking
- Rating 4: Hairline cracks only visible under $\times 6$ magnification
- Rating 3: Cracks visible with normal vision (corrected if necessary) from the edge of the hole, but not extending to either edge of the specimen
- Rating 2: A crack visible with normal vision (corrected if necessary) from the edge of the hole, extending to one edge of the specimen such that the specimen is not broken into two pieces.
- Rating 1: Specimen broken into two pieces

The resistance to cracking under stress is expressed as the arithmetic mean of the three individual ratings rounded to the nearest integer.

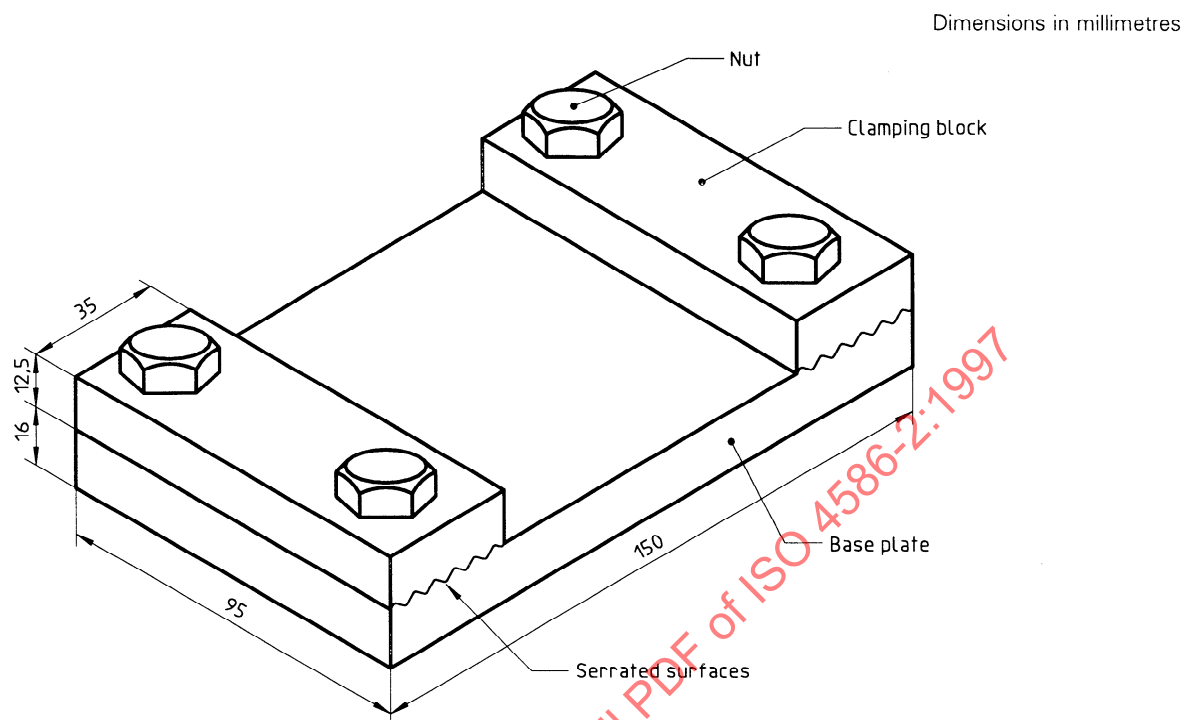


Figure 8 a — Clamping device (mild steel)

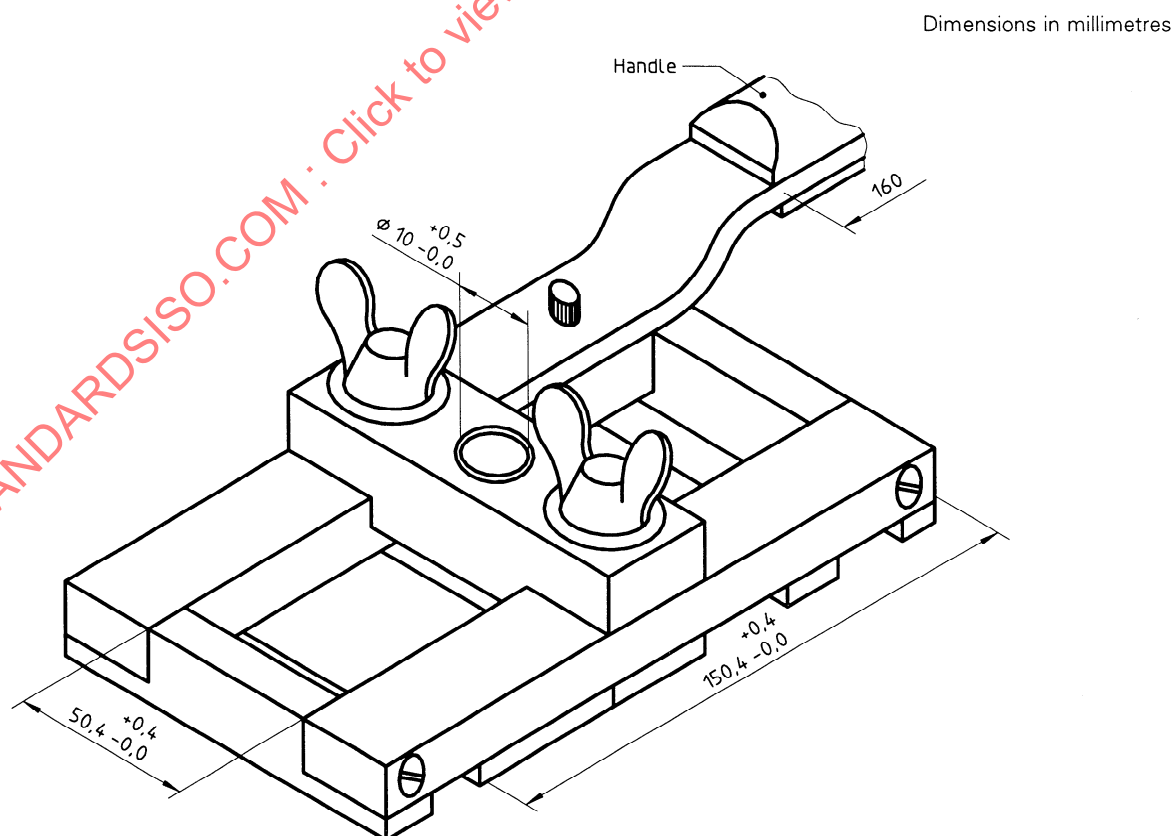


Figure 8 b — Drilling jig (mild steel)

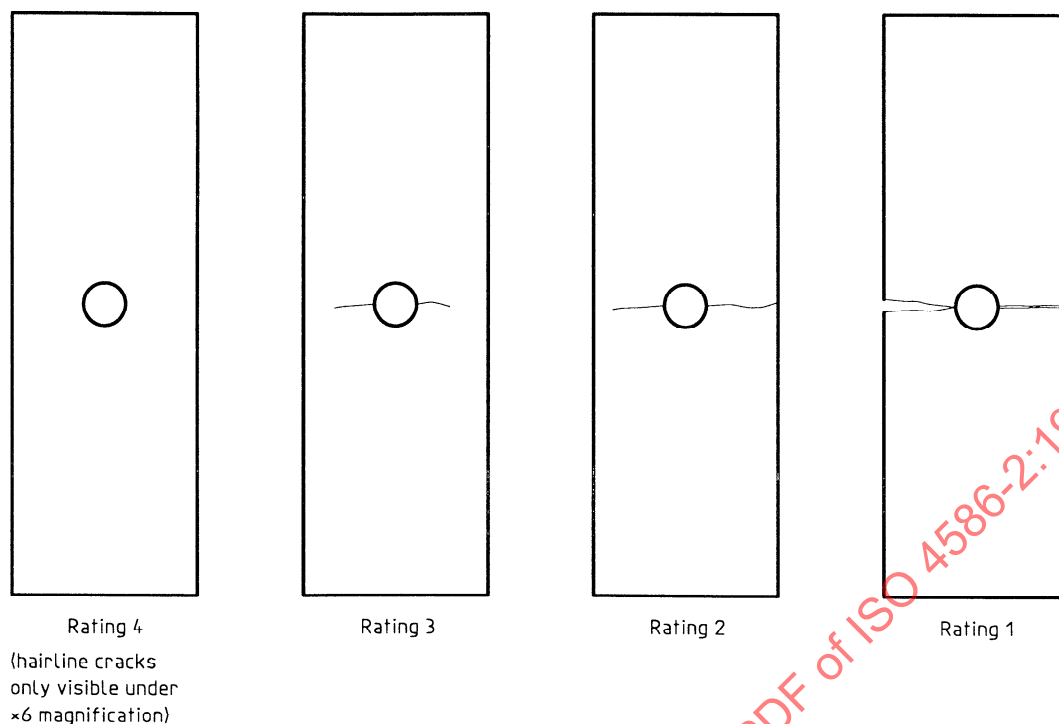


Figure 8c — Classification of types of failure

13.6 Test report

The test report shall include the following information:

- a reference to this part of ISO 4586;
- the name and type of product;
- the thickness of the sheet under test;
- the resistance to cracking under stress;
- any deviation from the specified procedure;
- the date of the test.

14 Resistance to scratching

14.1 Principle

The minimum load applied to a diamond scratching point of defined geometry, which produces a continuous surface mark visible to the naked eye, corrected if necessary, is the resistance to scratching of the decorative laminated sheet under test.

This minimum load is determined by applying successively decreasing loads to the diamond point and examining the marks produced.

14.2 Apparatus

14.2.1 Scratch testing apparatus (see figure 9), consisting of the following parts:

14.2.1.1 Stand, with a **device to indicate the horizontal**, for example a spirit level.

14.2.1.2 Freely rotating supporting turntable (A) for the specimen. This shall rotate about a vertical axis without play and is preferably motor-driven. The rotation frequency shall be $5 \text{ r/min} \pm 1 \text{ r/min}$.

14.2.1.3 Arm (B), carrying the holder for the diamond, mounted on a ball bearing, with a horizontal axis. The height of this axis shall be adjustable so that the arm is exactly horizontal when the scratching point rests on the specimen.

14.2.1.4 Means of applying a known load with an accuracy of $\pm 0,01 \text{ N}$ to the scratching point with weights (C + D).

14.2.1.5 Hemispherical diamond scratching point (E), with a point radius of $0,090 \text{ mm} \pm 0,003 \text{ mm}$ and an included angle of $90^\circ \pm 1^\circ$ (see figure 10). (The diamond shall be mounted in the holder with the flat part on the leading side of the shank facing the

working direction.) Diamonds shall be standardized before use as specified in 14.3.¹⁾

14.2.1.6 Clamping disc (F), to keep the specimen flat.

14.2.2 Viewing enclosure, having a matt black interior and a light source (defined below) located at the top. Its dimensions shall be such that the specimen is located vertically below the light source and at a distance of 600 mm. An aperture in the front shall allow inspection of the specimen at various angles from a distance of $400 \text{ mm} \pm 10 \text{ mm}$. A diagram of a suitable enclosure is shown in figure 11.

The light source consists of a 100 W frosted bulb, mounted in a white reflector having an aperture of approximately 140 mm diameter and producing an illumination of 800 lx to 1 000 lx at the specimen surface.

14.2.3 Conditioning chamber, with a standard atmosphere of $23^\circ\text{C} \pm 2^\circ\text{C}$ and relative humidity $(50 \pm 5) \%$.

14.2.4 Viewing mask (see figure 12), made from thin flat opaque sheet material such as thin metal sheet or plastic card.

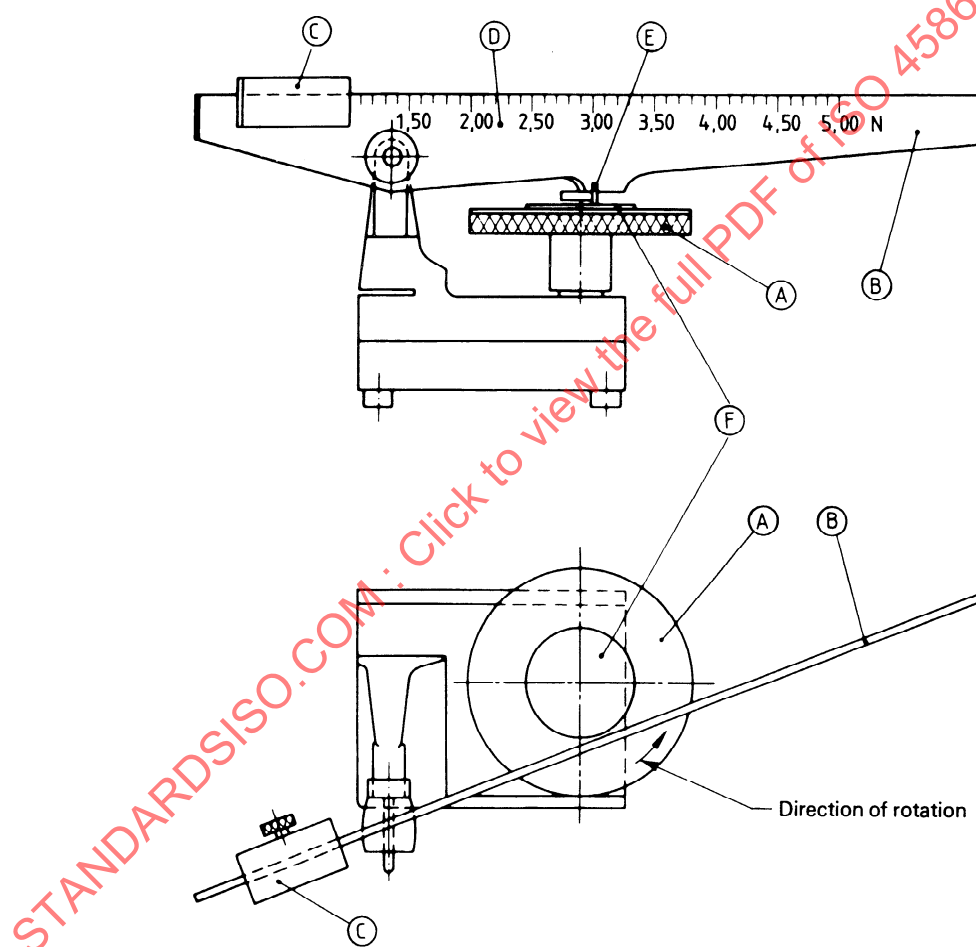
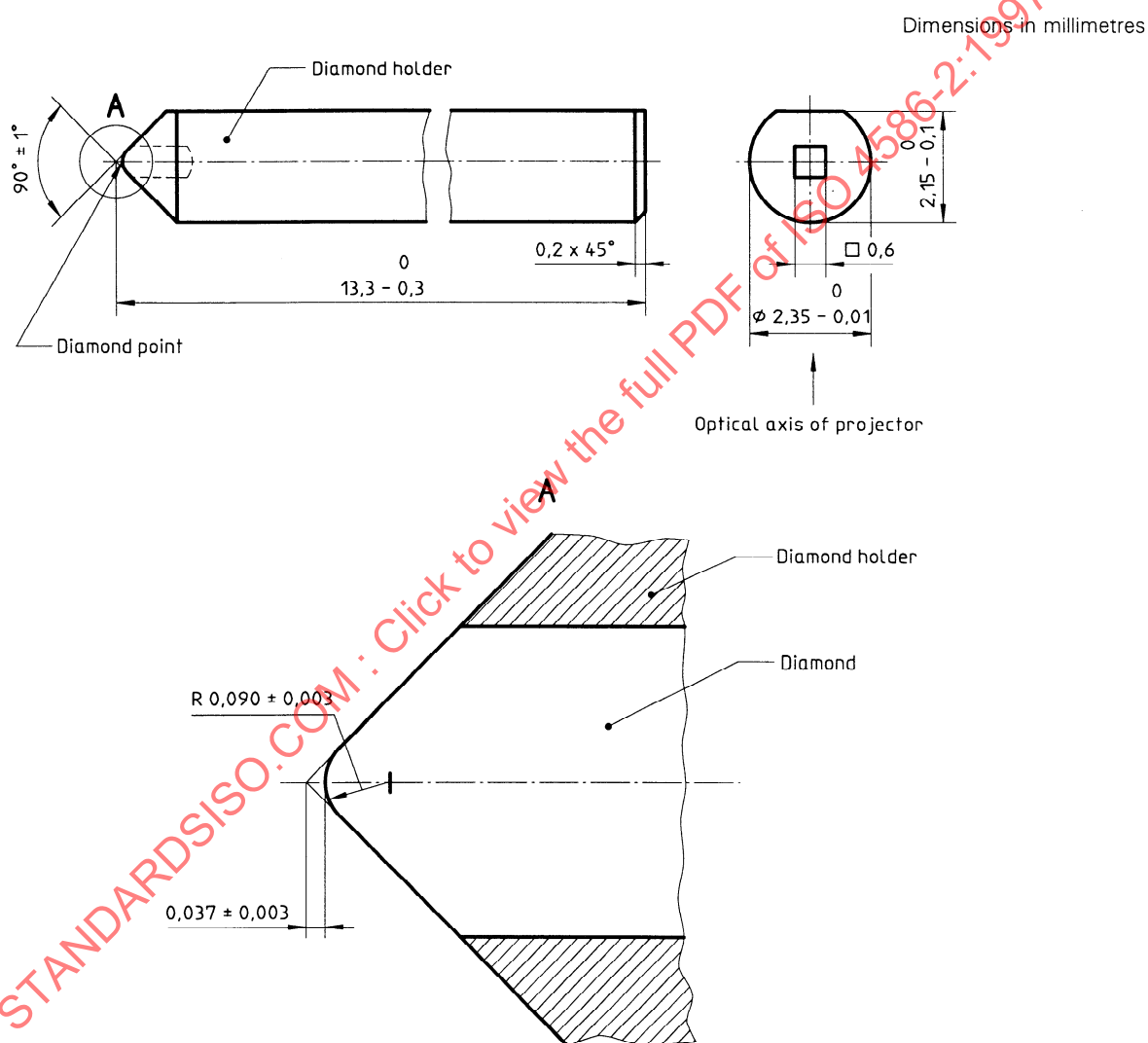


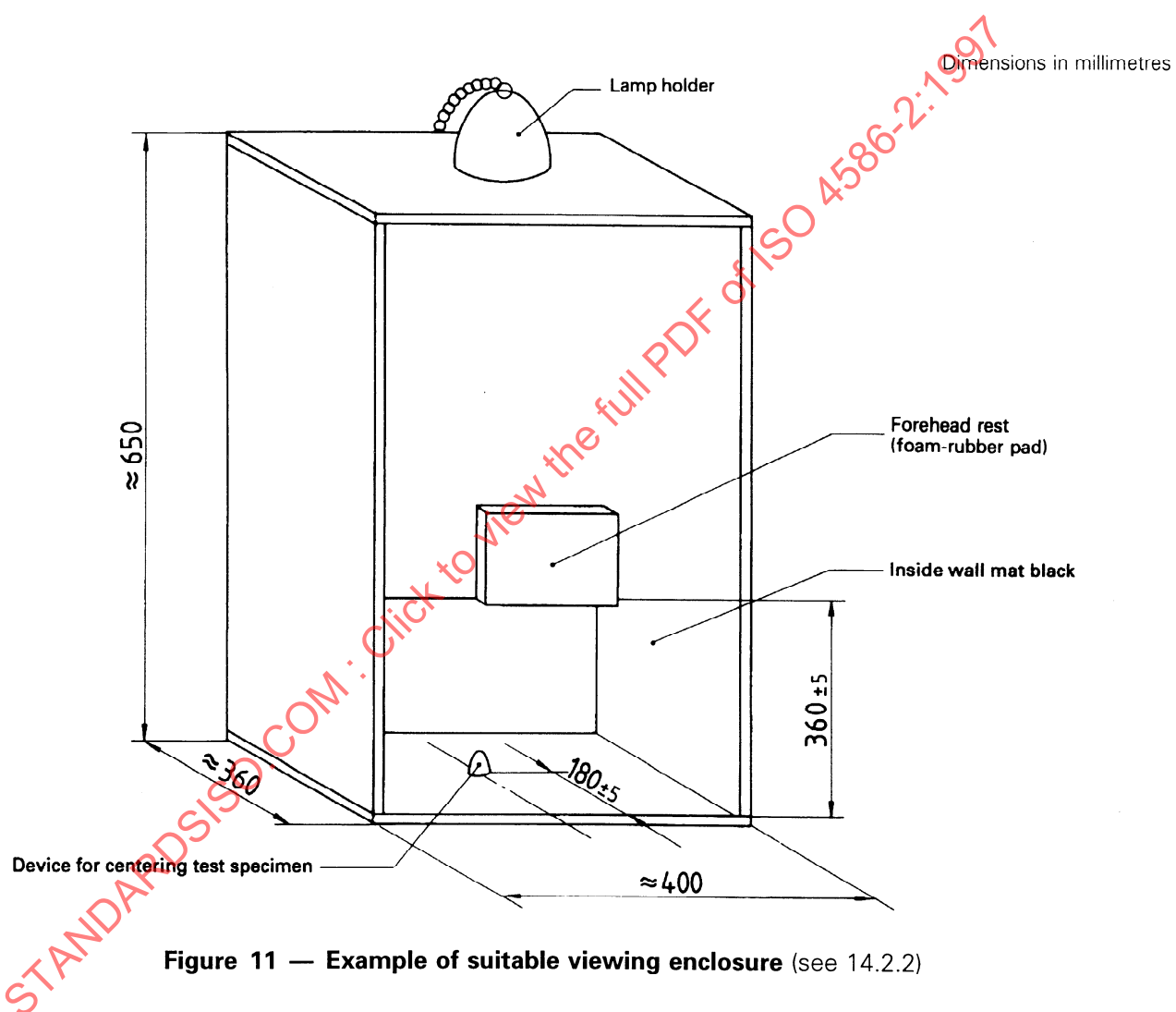
Figure 9 — Type of apparatus for measuring the resistance to scratching (see 14.2.1)

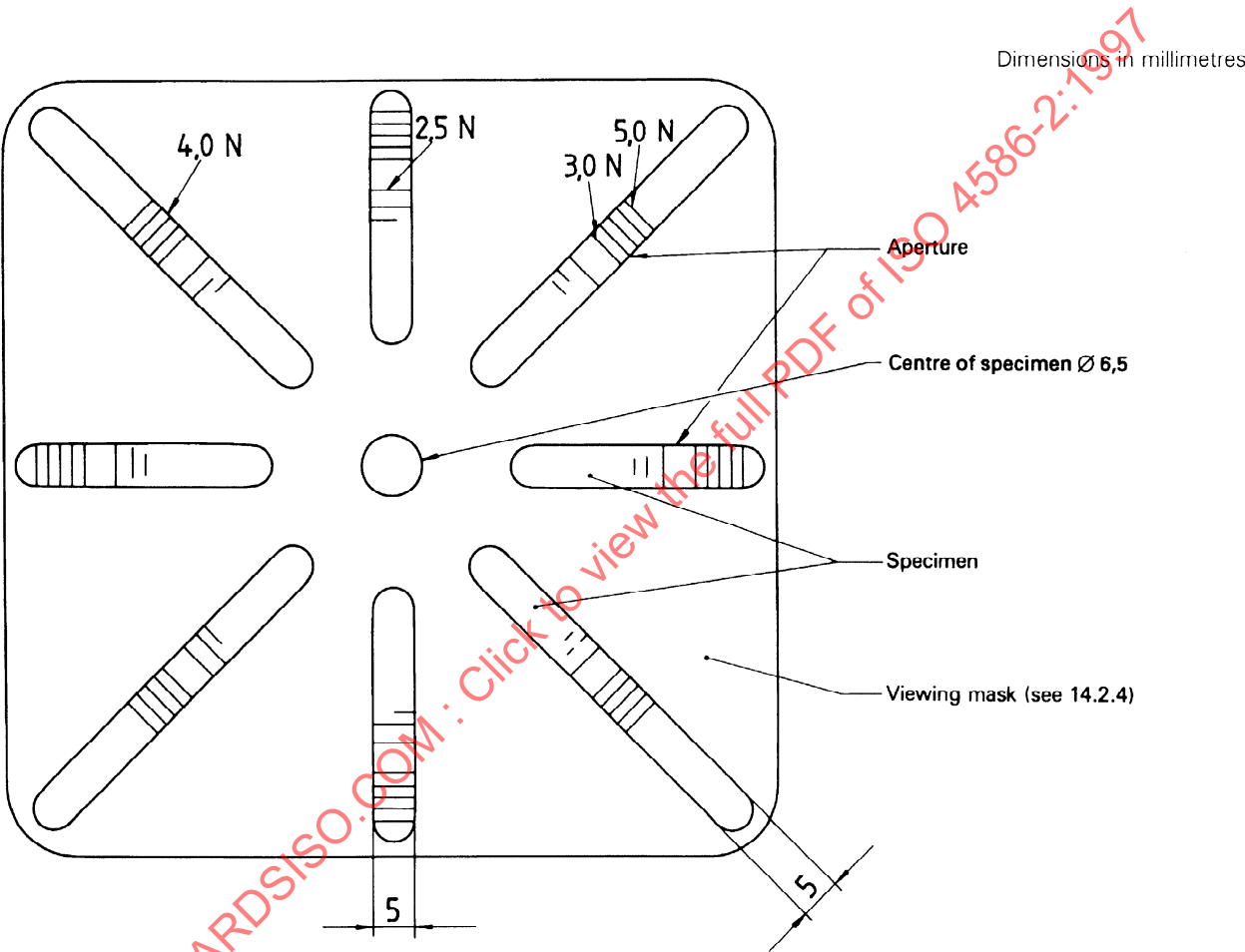
1) Diamond points conforming with these dimensions and profile are available from: Cie Weinz, Industrie Edelstein Fabrik, Postfach 2740, D-55743 Idar-Oberstein, Germany, and through Erichsen GmbH & Co. KG, D-58675 Hemer-Sundwig/Westfalen, Germany. (This is an example of a suitable product available commercially. This information is given for the convenience of users of this part of ISO 4586 and does not constitute an endorsement by ISO of this product.)



NOTE — The crystal axis of the diamond shall be parallel to the longitudinal axis of the diamond holder.

Figure 10 — Scratching point (see 14.2.1.5)





NOTE — The result here is 2,5 N (see 14.6)

Figure 12 — Example of scratching test

14.3 Standardization of the diamond point

14.3.1 With PMMA

Use a disc cut from high-molecular-weight poly(methyl methacrylate) cast sheet of minimum thickness 3 mm (4 mm preferred). The cast poly(methyl methacrylate) shall be vacuum predried for 24 h at 80 °C and shall have a Vicat softening temperature of at least 112 °C.²⁾

Fix the PMMA disc to the supporting turntable, and carry out the procedure described in 14.5. Apply loads of 0,8 N to 1,5 N in 0,1 N steps, making one complete revolution at $5 \text{ r/min} \pm 1 \text{ r/min}$ for each load. The concentric tracks thus produced shall be spaced 2 mm apart.

Inspect the specimen in the viewing enclosure, as described in 14.5.3, to determine the minimum load which produces a continuous mark (L_1).

Continue the calibration with a second PMMA disc, applying loads L_1 , $(L_1 + 0,1) \text{ N}$, $(L_1 + 0,2) \text{ N}$, $(L_1 - 0,1) \text{ N}$ and $(L_1 - 0,2) \text{ N}$, and spacing the tracks 4 mm apart.

Inspect the specimen as before to determine precisely the minimum load which produces a continuous mark (L_2). This is the final PMMA calibration result.

14.3.2 With high-pressure decorative laminates (HPDL)

Use a disc²⁾ cut from white standard HPDL with a satin mat surface, predried for 24 h at 80 °C. Using the procedure described in 14.3.1, apply loads of 4,2 N to 5,6 N in steps of 0,2 N with 2 mm spacing to determine the minimum load which produces a continuous mark (L_3).

Continue the calibration with a second HPDL disc, applying loads L_3 , $(L_3 + 0,2) \text{ N}$, $(L_3 + 0,4) \text{ N}$, $(L_3 - 0,2) \text{ N}$ and $(L_3 - 0,4) \text{ N}$, with 4 mm spacing.

Determine precisely the minimum load which produces a continuous mark (L_4). This is the final HPDL calibration result.

14.3.3 Acceptance values for diamond calibration

The diamond point shall meet the following two requirements:

2) PMMA and HPDL calibration discs may be obtained from Erichsen GmbH & Co. KG, D-58675 Hemer-Sundwig/Westfalen, Germany. (These are examples of suitable products available commercially. This information is given for the convenience of users of this part of ISO 4586 and does not constitute an endorsement by ISO of these products.)

PMMA calibration	$1,1 \text{ N} \pm 0,1 \text{ N}$
HPDL calibration	$5,0 \text{ N} \pm 0,4 \text{ N}$

14.4 Test specimens

Cut two specimens, of the shape and dimensions shown in figure 13, from the sheet under test.

Wipe the surface of each specimen using cotton fabric impregnated with a solvent such as acetone. It is important that, once cleaned, the surface is not touched in the test area.

Before making the scratch test, store the specimens for 4 days in the standard atmosphere specified in 14.2.3.

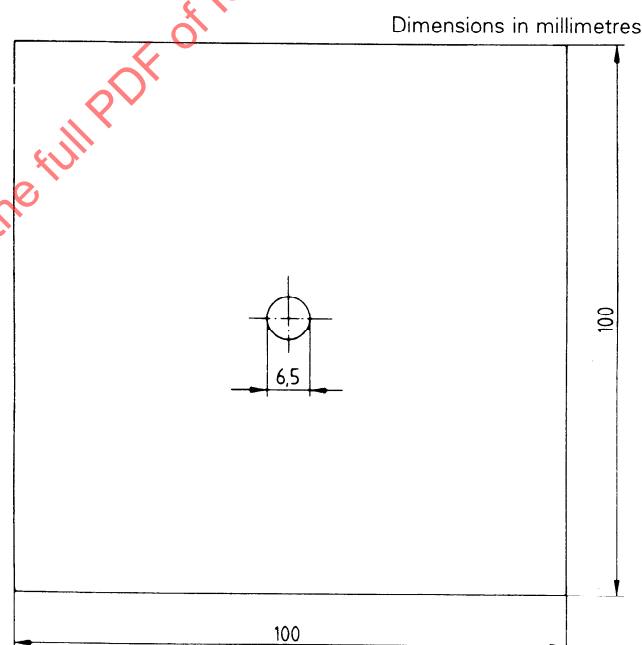


Figure 13 — Test specimen (see 14.4)

14.5 Procedure

Make sure that the stand of the test apparatus is standing horizontally.

Adjust the height of the arm (B) so that it is horizontal when the diamond point rests on the specimen.

14.5.1 Determination of approximate value

Start the test with a preliminary load of 5,0 N. Place the arm (B) in a vertical position. Fix the first specimen with the locking disc (F) and secure it correctly to avoid any slipping.

Lower the arm (B) and place the diamond point in contact with the specimen, taking care to avoid any impact.

Start rotating the turntable counterclockwise for one complete revolution at a uniform rotational frequency of $5 \text{ r/min} \pm 1 \text{ r/min}$.

Stop the turntable and inspect the specimen.

If a continuous mark is visible at a load of 5,0 N, continue the test using other tracks on the specimen concentric with the first and spaced at least 2 mm apart, decreasing the load in steps of 0,5 N down to a load of 2,0 N.

If a continuous mark is visible at a load of 2,0 N, continue testing by reducing the load in 0,25 N steps. For loads below 1,0 N, continue testing by reducing the load in 0,1 N steps.

If no continuous mark is visible at a load of 5,0 N, slide the moveable load (C) back to zero, add a fixed load of 5,0 N to the arm (B) and continue testing by adjusting the moveable load to increase the total load in increments of 0,5 N.

14.5.2 Determination of precise value

After determining the approximate scratch resistance of the material, test the second specimen, starting at this approximate value and then applying the next two higher loads and the next two lower loads at the appropriate steps. The concentric tracks shall be spaced 4 mm apart.

EXAMPLE

- 1 Approximate value determined: 3,5 N.
- 2 Tracks on the second test specimen spaced 4 mm apart: 2,5 N/3,0 N/3,5 N/4,0 N and 4,5 N.

14.5.3 Final inspection

Place the scratched samples in a standard atmosphere as specified in 14.2.3 for 24 h before final inspection.

Clean the surface of the specimen. With the mask in place on the surface of the specimen, place specimen and mask on the viewing point in the viewing enclo-

sure with one aperture of the mask in the 12 o'clock position. Tilt at any angle, without rotating the specimen or mask, and observe each aperture in turn with the naked eye, corrected if necessary.

In judging the lowest load producing a continuous mark, care shall be taken to ensure that the mark selected as the end point is truly continuous in all eight apertures in the viewing mask. The operator shall guard against mentally bridging gaps in the marks.

14.6 Expression of results

Record the minimum load giving a continuous mark visible after 24 h in the standard atmosphere. An example of a test result of 2,5 N is shown in figure 12.

In cases of dispute, three observers shall view the specimen and report their results independently. The final result shall be the average of the three reported values.

14.7 Test report

The test report shall include the following information:

- a) a reference to this part of ISO 4586;
- b) the name and type of product;
- c) the test results (see 14.6);
- d) any deviation from the specified procedure;
- e) the date of the test.

15 Resistance to staining

15.1 Principle

Test specimens are left in contact with a series of staining agents which are likely to be encountered in everyday use. The time and conditions of contact are specified for each staining agent. At the end of the specified contact period, the specimens are washed and examined for residual surface marks.

If the product under test meets specification requirements when tested with each of the six staining agents marked with an asterisk, then it is deemed to comply with the specification for stain resistance. The other staining agents are included for information only. In the case of a specific complaint, the staining agent in question (selected from group 1, 2 or 3) shall be used to verify the quality of the laminate.

15.2 Staining agents

Staining agent	Test conditions	Contact time
Group 1 * Acetone Trichloroethane Other organic solvents Toothpaste Hand cream Urine Alcoholic beverages Natural fruit and vegetable juices Lemonade and fruit drinks Meats and sausages Animal and vegetable fats and oils Water Yeast suspension in water Salt (NaCl) solutions Mustard Lyes, soap solutions Cleaning solution 23 % dodecylbenzene sulfonate 10 % alkyl aryl polyglycol ether 67 % water Phenol and chloramine T disinfectants Stain or paint remover based on organic solvents Citric acid (10 % solution)	15.5 Procedure A Apply staining agent at ambient temperature	16 h to 24 h
Group 2 * Coffee (120 g of coffee per litre of water) Black tea (9 g of tea per litre of water) Milk (all types) Cola beverages Wine vinegar Alkaline-based cleaning agents diluted to 10 % concentration with water Hydrogen peroxide (3 % solution) Ammonia (10 % solution of commercial concentrate) Nail varnish Nail varnish remover Lipstick Water colours Laundry marking inks Ball point inks	15.5 Procedure A } Apply staining agent at approximately 80 °C 15.5 Procedure A } Apply staining agent at ambient temperature	16 h
Group 3 ¹⁾ * Sodium hydroxide (25 % solution) * Hydrogen peroxide (30 % solution) Concentrated vinegar (30 % acetic acid) Bleaching agents and sanitary cleaners containing them Hydrochloric acid based cleaning agents (≤ 3 % HCl) Acid-based metal cleaners Mercurochrome (2,7-dibromo-4-hydroxymercurifluorescein, disodium salt) * Shoe polish Hair colouring and bleaching agents Iodine Boric acid Lacquers and adhesives (except fast-curing materials) Amidosulfonic acid descaling agents (< 10 % solution)	15.5 Procedure A Apply staining agent at ambient temperature	10 min

Staining agent	Test conditions	Contact time
Group 4 * Citric acid (10 % solution) Acetic acid (5 % solution)	15.5 Procedure B	20 min
1) Acids and alkalis, in concentrations stronger than those shown in group 3, which can be contained in commercial cleaning agents, can cause surface damage or marking, even with very short contact time. Any spillage of such materials shall be washed off immediately.		

15.3 Apparatus and materials

15.3.1 Glass covers (for example watch glasses), to restrict evaporation.

15.3.2 Thermometer, range 0 °C to 100 °C.

15.3.3 Flat-bottomed aluminium vessel, in accordance with 8.3.1.

15.3.4 Hotplate, or other suitable heat source.

15.3.5 Horizontal inspection surface, illuminated by overhead and low-angle daylight or white fluorescent light of intensity 800 lx to 1 000 lx.

15.3.6 Wetting agent, for example domestic detergent.

15.3.7 Solvents, such as ethanol, acetone, methyl ethyl ketone, etc. (see 15.5).

15.3.8 Soft clean cloth.

15.3.9 Hard nylon bristle brush (for example a nail brush).

15.4 Test specimens

Individual specimens of any suitable size shall be used, cut from the sheet under test. Alternatively, a single piece of laminate, large enough to allow the staining agents to be applied side by side, can be used. Keep the specimen flat during the test.

In cases of dispute, specimens shall be bonded to chipboard (see 8.4), particularly for procedure B.

15.5 Procedures

15.5.1 Procedure A

The specimens shall be initially at ambient temperature.

Apply a small quantity (for example 2 or 3 drops) of staining agent to two specimens. The staining agent shall be at the temperature specified in 15.2. Cover the staining agent on one of the two specimens with a glass cover (15.3.1).

After the specified contact time has elapsed, if necessary remove the staining agent with a suitable solvent (for example butyl acetate to remove nail varnish), then wash with water containing a suitable wetting agent (15.3.6), and finally with ethanol (15.3.7) or other solvents as required to clean the surface. A suitable brush (15.3.9) may be used to remove staining agent from textured surfaces.

One hour after washing, place the specimen on the inspection surface (15.3.5) and view it from various angles at a distance of 400 mm.

15.5.2 Procedure B

The specimen shall be prepared in accordance with 8.4.

Apply a small quantity (for example 2 or 3 drops) of the staining agent to the specimen. The staining agent shall be at ambient temperature.

Fill the vessel (15.3.3) with water (to within 15 mm of the top) and heat it until the water boils vigorously. Discontinue heating and immediately place the vessel containing the boiling water on the surface of the specimen directly over the pool of staining agent.

After the specified contact time, remove the vessel and wash the specimen with water containing a suitable wetting agent (15.3.6) and then with ethanol (15.3.7) or other solvents as required to clean the surface. A suitable brush (15.3.9) may be used to remove staining agent from textured surfaces.

One hour after washing, place the specimen on the inspection surface (15.3.5) and view it from various angles at a distance of 400 mm.

15.6 Expression of results

The effect on the surface of the specimen shall be expressed in accordance with the following rating scale for each of the six mandatory staining agents.

- Rating 5: No visible change
- Rating 4: Slight change of gloss and/or colour, only visible at certain viewing angles
- Rating 3: Moderate change of gloss and/or colour
- Rating 2: Marked change of gloss and/or colour
- Rating 1: Surface distortion and/or blistering

15.7 Test report

The test report shall include the following information:

- a) a reference to this part of ISO 4586;
- b) the name and type of product;
- c) an assessment of stain resistance for each staining agent applied, expressed in accordance with the rating scale given in 15.6;
- d) any deviation from the specified procedure;
- e) the date of the test.

16 Resistance to colour change in xenon arc light

16.1 Principle

Part of a test specimen taken from the sheet under test is exposed, together with blue wool reference specimens, to the light of a xenon arc lamp. The light dosage is determined by the effect on the wool reference specimens, and the effect on the test specimen is assessed at a specified light dosage by the contrast between the exposed and unexposed portions of the test specimen.

16.2 Apparatus

The apparatus shall be as specified in ISO 105-B02. It shall be operated at a black-panel temperature of $63\text{ }^{\circ}\text{C} \pm 3\text{ }^{\circ}\text{C}$ with a relative humidity of $(50 \pm 5)\%$. The irradiance at the specimen surface shall be $1\,000\text{ W/m}^2 \pm 200\text{ W/m}^2$, unless otherwise agreed.

16.3 Test specimen

The test specimen shall be prepared in accordance with ISO 105-B02 and shall be of sufficient size to be representative of the finished sheet.

16.4 Procedure

Carry out the test using method 3 of ISO 105-B02:1994. Discontinue the exposure when Blue Wool Reference 6 shows grey scale contrast 4, as defined in ISO 105-A02, between the exposed and unexposed portions.

16.5 Evaluation and expression of results

Examine the contrast between the exposed and unexposed portions of the test specimen and record it in terms of a grade on the grey scale.

Express the result in relation to the resistance to colour change of Blue Wool Reference 6 as one of the following:

Test specimen contrast (Grey scale grade No.)	Resistance to colour change (Blue Wool Reference No.)
> 4	< 6
4	6
< 4	> 6

16.6 Test report

The test report shall include the following information:

- a) a reference to this part of ISO 4586;
- b) the name and type of product;
- c) the type of xenon arc lamp apparatus used and the irradiance at the surface of the specimen;
- d) the resistance of the specimen to colour change, expressed as greater than, equal to or less than that of Blue Wool Reference 6;
- e) any deviation from the specified procedure;
- f) the date of the test.

17 Resistance to cigarette burns

17.1 Principle

Specimens from the sheet under test are bonded to wood chipboard to simulate service conditions and

subjected to the heat from burning cigarettes placed on their surfaces. The test result is expressed in terms of any resultant damage.

17.2 Materials

17.2.1 Fine-faced wood chipboard, 18 mm to 20 mm nominal thickness with a tolerance of $\pm 0,3$ mm, density 625 kg/m^3 to 700 kg/m^3 and moisture content $(9 \pm 2) \%$.

17.2.2 Urea-formaldehyde adhesive, containing approximately 15 % filler, or an equivalent adhesive.

17.2.3 Pale-tobacco cigarettes without filters, from each of three well known brands, each with a mass of 1,0 g to 1,1 g for a length of 70 mm and with the tobacco evenly distributed over its length. They shall be kept in the standard atmosphere (see 17.4) for at least 24 h before being used for the test.

17.2.4 Ethanol, 95 % (V/V).

17.2.5 Soft cloth.

17.3 Test specimen

The specimen shall be prepared by uniformly bonding a piece of the sheet under test to the wood chipboard (17.2.1), using the specified adhesive (17.2.2). The bonded specimen shall be kept in the standard atmosphere (see 17.4) for at least 7 days before being used for the test. One specimen $230 \text{ mm} \pm 5 \text{ mm}$ square shall be prepared.

17.4 Apparatus

17.4.1 Conditioning chamber, with a standard atmosphere of $23^\circ\text{C} \pm 2^\circ\text{C}$ and relative humidity of $(50 \pm 5) \%$.

17.5 Procedure

Ignite one cigarette from one of the brands and let it burn to consume a length of approximately 10 mm.

Place the burning cigarette in full-length contact with the horizontal surface of the specimen in a draught-free area so that the glued seam of the cigarette is not in contact with the specimen. Allow the cigarette to continue burning until an additional 20 mm length is consumed. If the cigarette goes out before this occurs, repeat the test.

Follow the same procedure with the two cigarettes from the other two brands.

Remove any superficial combustion residues with a soft cloth moistened with alcohol. Examine the surface with the naked eye, corrected if necessary, for any changes such as discolouration, cracks or blisters.

17.6 Expression of results

Express the result for each area of cigarette contact in accordance with the following rating scale:

- Rating 5: No visible change
- Rating 4: Slight change of gloss only visible at certain viewing angles and/or slight brown stain
- Rating 3: Moderate change of gloss and/or moderate brown stain
- Rating 2: Severe brown mark, but no destruction of the surface
- Rating 1: Blistering and/or cracks

17.7 Test report

The test report shall include the following information:

- a) a reference to this part of ISO 4586;
- b) the name and type of product;
- c) the brands of cigarette used;
- d) the cigarette burn resistance of the specimen, expressed as the arithmetic mean of the three individual ratings rounded to the nearest integer;
- e) any deviation from the specified procedure;
- f) the date of the test.

18 Resistance to cigarette burns (simulated test using electric heater)

18.1 Principle

Specimens taken from the sheet under test, and bonded to wood chipboard to simulate service conditions, are exposed to local radiant heat from an electric heater. The resistance of the material is assessed in terms of the duration of exposure needed to cause visible damage.

18.2 Materials

18.2.1 Fine-faced wood chipboard, 18 mm to 20 mm nominal thickness with a tolerance of $\pm 0,3$ mm, density 625 kg/m^3 to 700 kg/m^3 and moisture content $(9 \pm 2) \%$.

18.2.2 Urea-formaldehyde adhesive, containing approximately 15 % filler, or an equivalent adhesive.

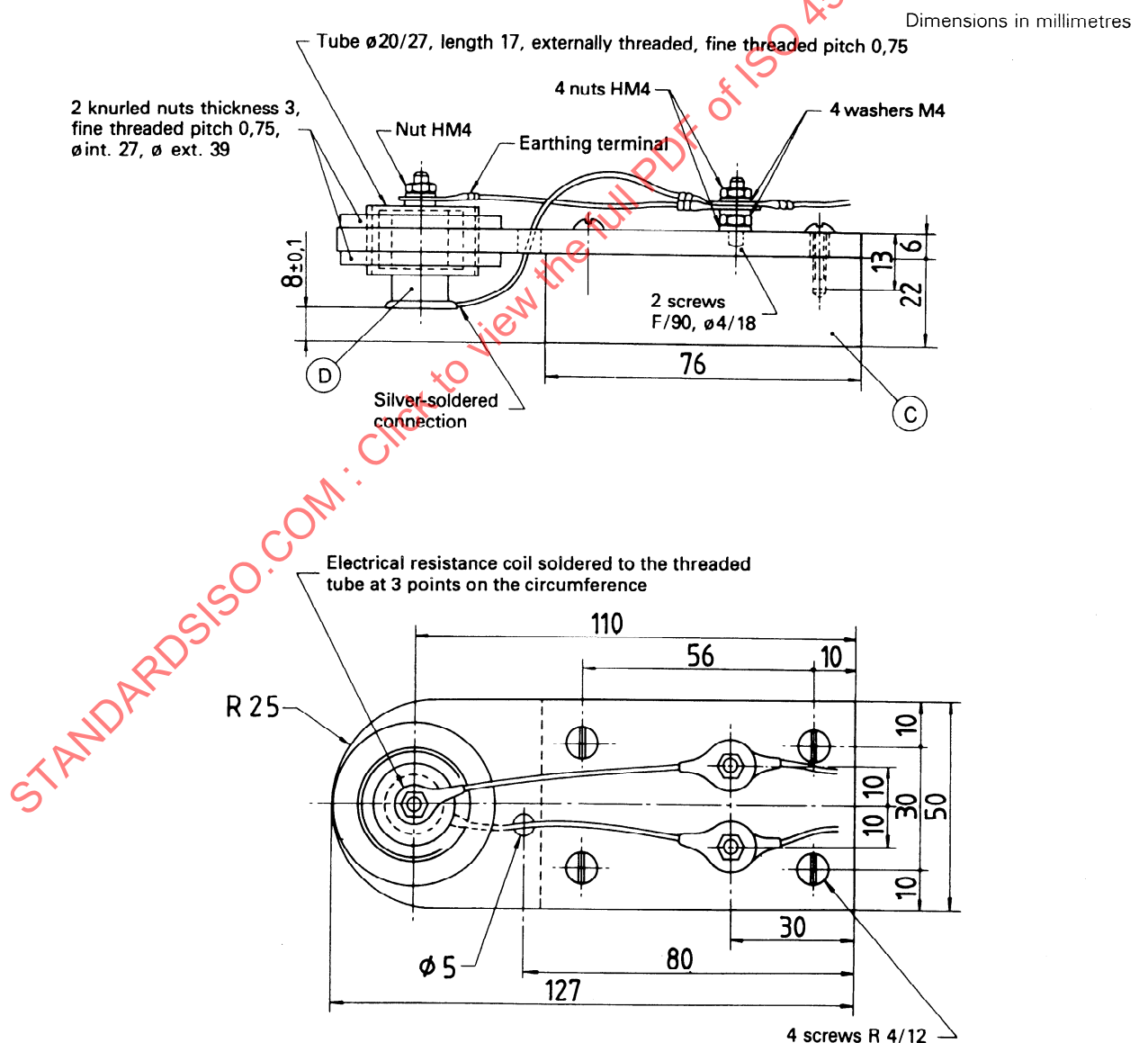
18.3 Apparatus

18.3.1 Heating-element support (C) (see figure 14), consisting of electrically non-conducting laminated sheet.

18.3.2 Heating element (D) (see figure 14), of iron-aluminium alloy, having the following characteristics:

- cross-section of flat wire: $1,6 \text{ mm} \times 0,25 \text{ mm}$;
- wire length: 480 mm;
- electrical resistance: $1,8 \Omega \pm 0,1 \Omega$.

This heating element shall be in the form of a spiral (outside diameter approximately 15 mm, external ring not included).



Materials: Electrically insulating laminate, screws and threaded tube

Figure 14 — Electric heater for cigarette test (see 18.3.1, 18.3.2 and 18.3.3)

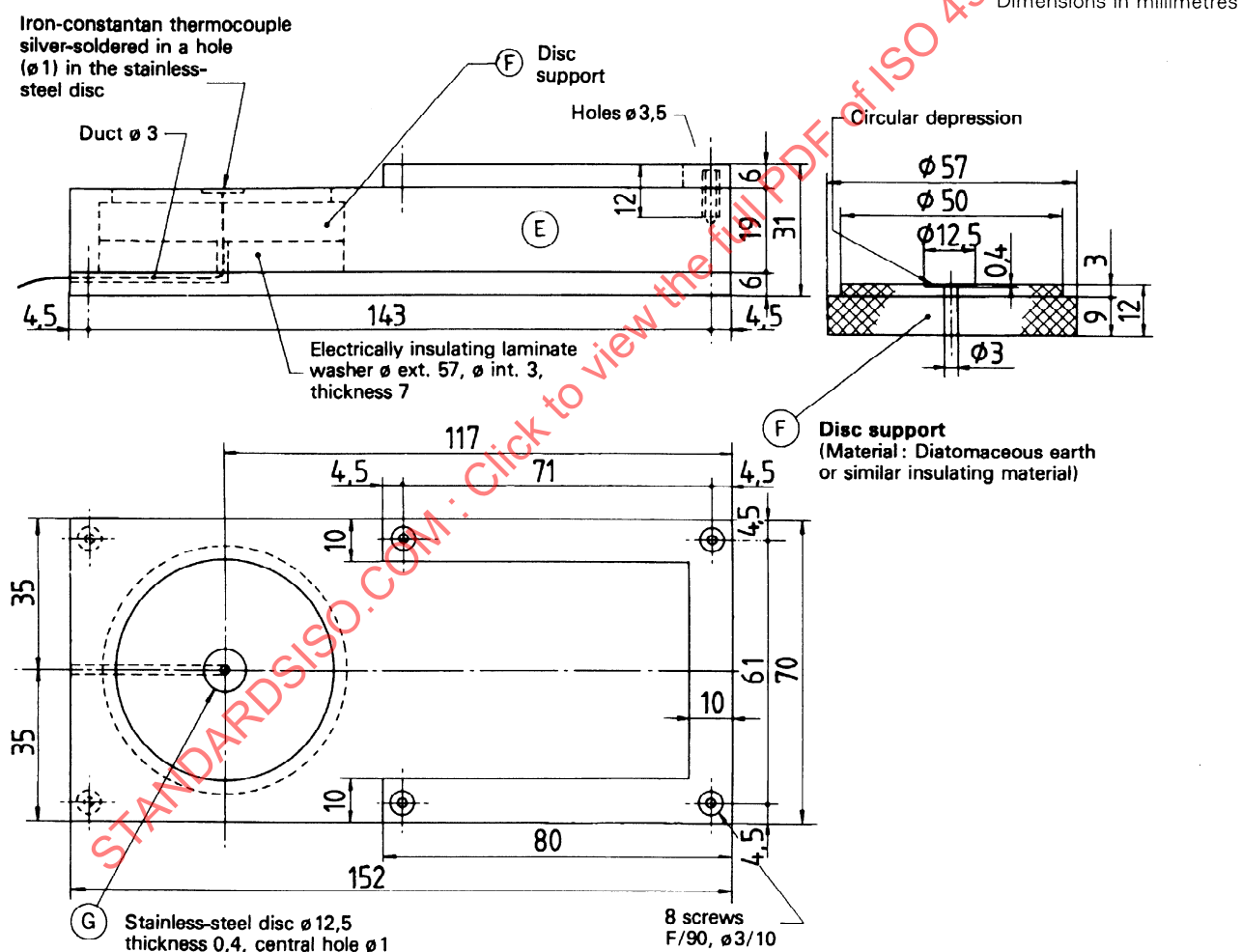
18.3.3 Adjustable mounting, for the heating element (see figure 14), consisting of an externally threaded brass sleeve located vertically by two knurled brass nuts.

18.3.4 Calibration block (E) (see figure 15), of electrically insulating laminate, on which are mounted:

- a) A disc support (F), made from homogeneous heat-insulating diatomaceous-earth sheet material of bulk density 512 kg/m^3 to 576 kg/m^3 , and

of thermal conductivity $0,10 \text{ W/(m}\cdot\text{K)}$ to $0,12 \text{ W/(m}\cdot\text{K)}$ in the temperature range 0°C to 300°C .

- b) A stainless-steel disc (G), to the bottom of which is silver-soldered an iron-constantan thermocouple. The surface of the disc shall be highly polished and flat, and shall be in the same plane as the surface of the disc support. The disc shall be clamped firmly on its support.



Material: Electrically insulating laminate

Figure 15 — Calibration block (E) for cigarette test (see 18.3.4)

18.3.5 Glass-windowed cover (H) (see figure 16).

18.3.6 Stopwatch.

18.3.7 Power source, producing a constant current for the heating element.

This source may be

- a) either a series of well charged accumulators with elements in good condition, able to provide the heating element with a power greater than 20 W,
- b) or an electrical unit powered from the mains supply.

18.3.8 Control circuit (J), to adjust and maintain the power consumption of the heating element with an accuracy of $\pm 0,1\%$. Measurements are made by means of a voltmeter and an ammeter. A circuit for use with a 115 V supply is shown in figure 17.

18.3.9 Potentiometer, for measuring the temperature of the stainless-steel disc.

18.3.10 Cotton wick, saturated with liquid paraffin.

18.3.11 Conditioning chamber, with a standard atmosphere of $23\text{ }^{\circ}\text{C} \pm 2\text{ }^{\circ}\text{C}$ and relative humidity of $(50 \pm 5)\%$.

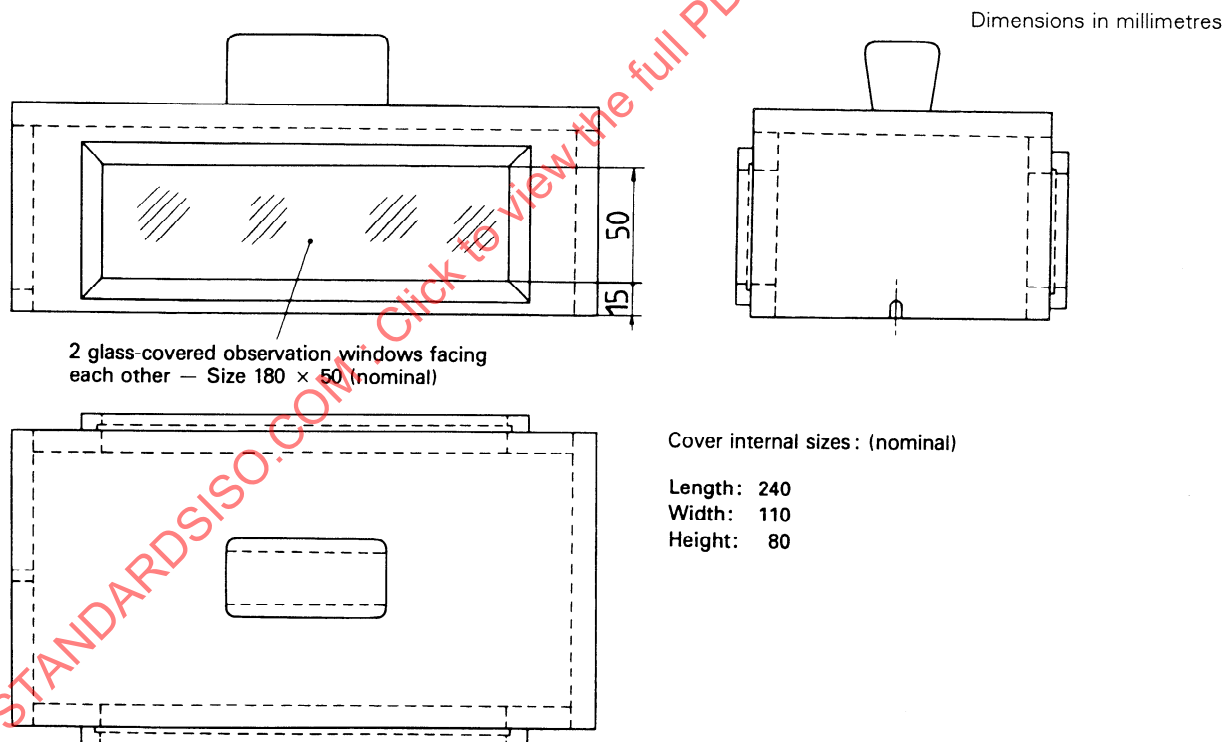
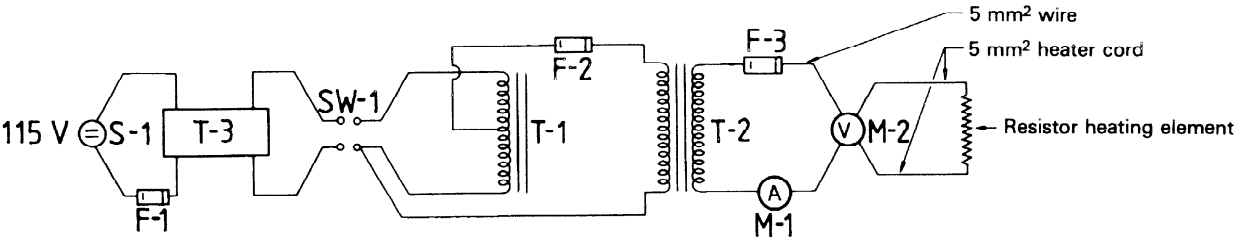


Figure 16 — Apparatus cover (H) for cigarette test (see 18.3.5)



List of items

Symbol	Function	Description
F-1	Line fuse Line fuse mounting	5 A
F-2	Control fuse Control fuse mounting	1 A Extractor post
F-3	Power fuse Power fuse mounting	10 A Extractor post
M-1	Ammeter	0 to 10 A alternating current
M-2	Voltmeter	0 to 6 V alternating current (452/V)
S-1	Line connector	Male connector
SW-1	Line switch	DPST toggle switch
T-1	Autotransformer	Primary: 115 V; secondary: 0,130 V; 5 A
T-2	Power transformer	Primary: 115 V; secondary: 5,25 V; 22 A
T-3	Voltage stabilizer	100 V·A ; 115 V output ± 1 %

Figure 17 — Wiring diagram of control circuit (J) for cigarette test (see 18.3.8)

18.4 Test specimens

Each specimen shall be prepared by uniformly bonding a piece of the sheet under test to the wood chipboard (18.2.1), using the specified adhesive (18.2.2). The bonded specimens shall be kept in the conditioning chamber (18.3.11) for at least 7 days before being used for the test. Three specimens measuring (230 ± 2) mm × (80 ± 1) mm shall be prepared.

18.5 Procedure

18.5.1 Calibration

The bottom of the heating element shall be flat.

Adjust the heating element so that the distance between its lower side and the disc is 8 mm ± 0,1 mm (without including the edging ring).

Stand the heating-element support (18.3.1) on its end and adjust the power input to approximately 20 W.

Allow to heat for 30 min.

Blacken the stainless-steel disc with the flame from the burning paraffin-saturated wick to produce a uniform coating of carbon. The insulating support shall be kept clean.

Place the heating-element support on the calibration block so that the heating element covers the disc.

Cover the assembly to exclude draughts.

Allow the heating element to warm the disc for 10 min in order to produce a final temperature of approximately 285 °C.

It is not necessary to record the intermediate temperatures. If the final temperature is not 285 °C, adjust the power input. Lift up the heating-element

support without disconnecting the power supply and stand it in the vertical position.

Keep the calibration block under the cover until the disc cools to $40\text{ °C} \pm 0,5\text{ °C}$, then replace the heating-element support on the calibration block and cover immediately.

Start the stopwatch when the heating-element support and the calibration block touch. Measure and record the temperature at 1 min intervals, for a period of 10 min.

The calibration curve shall be within the following limits:

Time (min)	Temperature (°C)
0	$40 \pm 0,5$
1	215 ± 3
2	251 ± 3
3	265 ± 3
4	274 ± 3
5	279 ± 3
6	282 ± 3
7	284 ± 3
8	285 ± 3
9	286 ± 3
10	287 ± 3

During the calibration, the current shall not fluctuate. If necessary, adjustment shall be made and further calibration carried out until the desired curve is obtained (each time allowing the calibration block to cool to $40\text{ °C} \pm 0,5\text{ °C}$).

When the calibration curve is obtained, proceed with the test.

18.5.2 Test

Position the heater on the specimen so that the resistance coil is at least 40 mm from the nearest edge, start the timer at the same time, and cover the assembly with the enclosure within 2 s.

Continue the test until the specimen fails or for 10 min. Failure is defined for this purpose as blistering, charring, permanent discolouration or crazing. If failure occurs in less than 10 min, record the time of failure.

The test shall be invalid if

- a) the heating element is moved during the test or is not positioned $8\text{ mm} \pm 0,1\text{ mm}$ above the surface of the specimen;

- b) the power input to the heating element does not remain constant at the level of last calibration;
- c) the cover is removed at any time during the test.

Repeat the test on additional specimens to obtain three valid results.

The calibration of the heating element shall be checked at least once per hour, and at any time that irregular results or an unsteady power input are observed.

18.6 Expression of results

Report the result as the average of the three times to failure, in seconds.

If one or two tests are discontinued without failure, their results shall be taken as 600 s for the purpose of calculating the average. If all three tests are discontinued without failure, the result shall be recorded as "no failure in 600 s".

18.7 Test report

The test report shall include the following information:

- a) a reference to this part of ISO 4586;
- b) the name and type of product;
- c) the average time to failure, or a statement that failure did not occur in 600 s;
- d) the type of failure, for example blistering, crazing;
- e) any deviation from the specified procedure;
- f) the date of the test.

19 Formability (Method A)

19.1 Principle

A test specimen is subjected to radiant heat on its decorative face until the reverse side reaches a pre-determined temperature. It is then formed in a jig to a specified radius and angle, and cooled before examining for signs of failure on the bend line.

The test is carried out with specimens cut in the longitudinal and transverse directions of the sheet and with the decorative face on both the outside and the inside of the bend.

This method is an alternative test method to be used when so designated by the national authority or by agreement between supplier and purchaser.

19.2 Apparatus

19.2.1 Radiant heater, consisting of two electrically heated sheathed elements of 1 500 W total rating, mounted parallel and in a horizontal plane in a metal-lined trough approximately 110 mm wide and 125 mm deep (inside dimensions), the height of the heating elements above the bottom of the trough being such that, when a specimen is laid across the trough, the specimen is at a distance of $76 \text{ mm} \pm 1,0 \text{ mm}$ above the heating elements. A windscreen enclosure to surround three sides and the top is advisable.

19.2.2 Variable-output transformer, with a voltage indicator, to control the voltage applied to the heater.

19.2.3 Temperature indicators (thermal crayons or waxes), with melting points covering the required range of temperatures. Other types of temperature indicator with equal or better precision may also be used (e.g. infra-red thermometers, colour-change indicators).

19.2.4 Stopwatch, or other suitable timer.

19.2.5 Forming apparatus (see figure 18), with forming blocks machined from straight-grained wood.

It is recommended that a fitting be placed on top of the male forming blocks which can be securely attached to the ram of the press used in conjunction with these blocks.

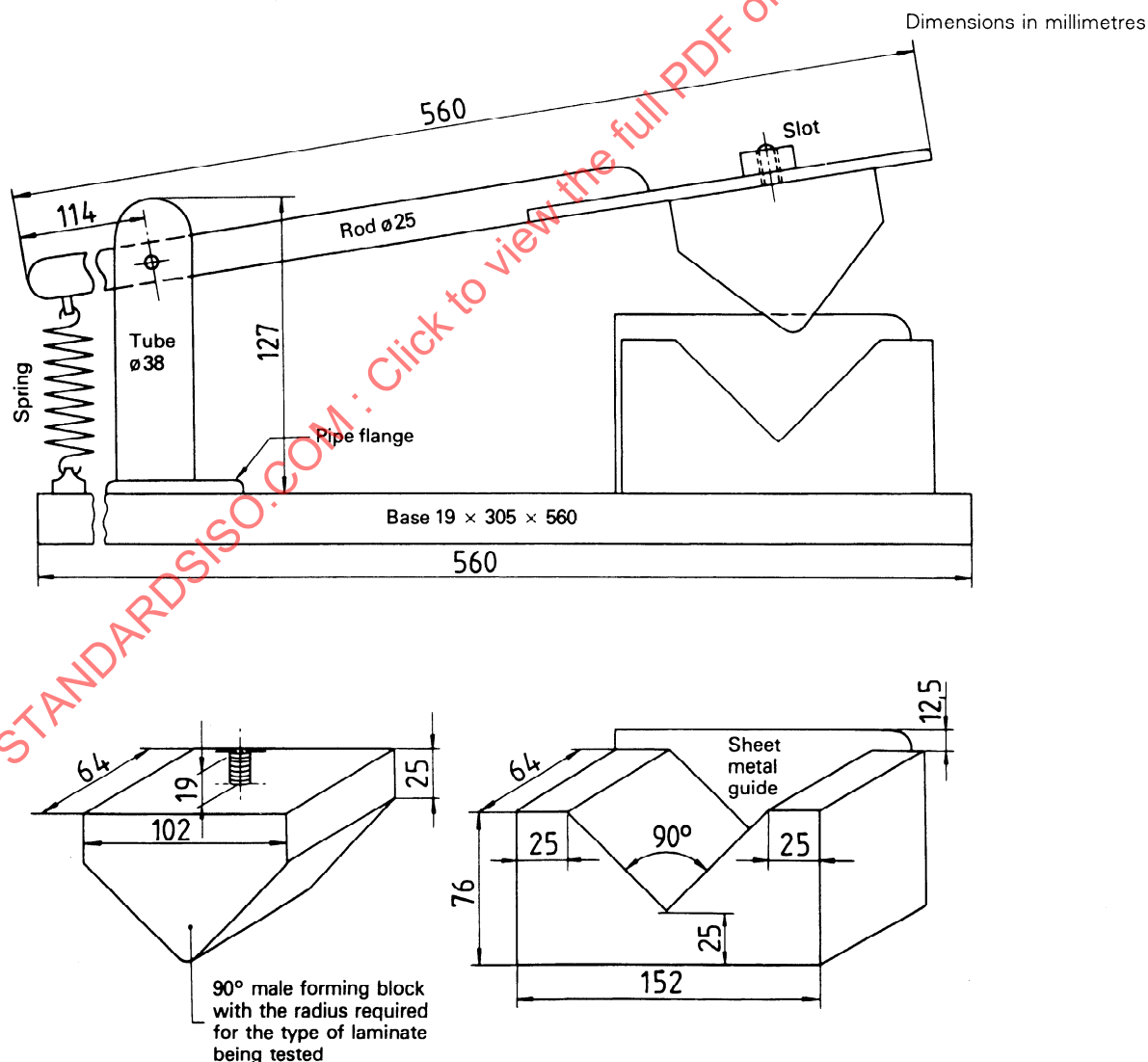


Figure 18 — Forming apparatus (radiant heat test) (Method A) (see 19.2.5)

19.2.6 Conditioning chamber, with a standard atmosphere of $23\text{ °C} \pm 2\text{ °C}$ and relative humidity of $(50 \pm 5)\%$.

19.2.7 Strips of plain-colour white laminate conforming to the specifications for HGP given in ISO 4586-1, measuring $200\text{ mm} \times 50\text{ mm}$ and with the major axis in the machine direction of the fibrous sheet material from which the laminate was made, to be used for calibration purposes.

19.3 Test specimens

The specimens shall have dimensions of approximately $200\text{ mm} \times 50\text{ mm}$, shall be of the thickness of the sheet under test and shall be sanded smooth at the long edges to remove hairline cracks.

Eight specimens shall be tested, four with their major axis in the machine direction of the fibrous sheet material from which the laminate was made, and four at right angles to this direction.

The specimens shall be conditioned for at least 24 h at $23\text{ °C} \pm 2\text{ °C}$ and $(50 \pm 5)\%$ relative humidity before testing.

19.4 Procedure

19.4.1 Calibration of test apparatus

Turn on the heater (19.2.1) 30 min prior to conducting the test, with the variable transformer (19.2.2) at full-line voltage.

Use a temperature indicator (19.2.3) with a melting point of 163 °C to make several marks about 100 mm long near the centre of the non-decorative surface of several calibration strips (19.2.7).

Place a calibration strip on the heating trough so that the heat is applied to the decorative face. Adjust the input voltage by means of the variable transformer so that the time taken to reach 163 °C is 1 s per 0,025 mm of calibration strip thickness, accurate to within $\pm 2\text{ s}$.

After three or more consecutive calibration strips reach 163 °C within the prescribed time $\pm 2\text{ s}$, begin the test and maintain and record the voltage setting.

19.4.2 Test procedure

Place the male forming block with radius as recommended by the laminate manufacturer, or as required by ISO 4586-1, into the forming apparatus (19.2.5).

Measure the thickness of the sheet as specified in clause 4 and record.

Use a temperature indicator with a melting point as recommended by the laminate manufacturer to make several marks about 100 mm long on the surface that will be the inside of the bend and near the centre of each specimen.

Place a specimen on the heating trough so that the heat is applied to the side opposite the side marked with the temperature indicator.

Remove the specimen when the temperature indicator is completely melted in the area to be formed, place the specimen within 5 s in the bending jig and carry out the forming test.

The closing time of the male forming block after the initial contact with the specimen shall be 0,5 s to 1 s. Allow the specimen to cool in the closed bending jig.

Remove and inspect the specimen after allowing it to cool for not less than 60 s. Failure to form satisfactorily shall be defined by the presence of cracks, blisters or delamination.

Carry out the test to assess the formability in both the longitudinal and transverse directions of the sheet and with the decorative face on both the inside and the outside of the bend, testing two specimens in each case.

19.5 Test report

The test report shall include the following information:

- a reference to this part of ISO 4586;
- the name and type of product;
- the thickness of the laminate;
- the forming radius;
- the direction of the major axis of the specimen;
- whether the decorative face is inside or outside the bend;
- any failure: defects, for example cracks and their extent, blisters, delamination or discolouration;
- any deviation from the specified procedure;
- the date of the test.

20 Formability (Method B)

20.1 Principle

A specimen from the sheet under test is subjected to infrared radiation until the heated face reaches a pre-determined temperature. It is then formed on a jig made of wood (for example premachined chipboard) to a specified radius, allowed to cool and examined for signs of failure. The test is repeated with specimens cut in each direction of the sheet and with the decorative face on both the outside and the inside of the bend. The formability is assessed in terms of the success or failure of the forming process at the specified radius.

This method is an alternative test method which is close to industrial practice and allows for adjustment of all the test variables in order to establish the optimum conditions for the forming of individual materials. It is possible that different laminates, even from the same manufacturer, may require different forming conditions. The conditions shall be specified by the laminate manufacturer, and the requirements shall be considered to be satisfied if the forming operation is successful under these conditions.

20.2 Apparatus

20.2.1 Radiant heater element³⁾, fitted with a reflector⁴⁾, the distance and orientation relative to the test specimen being adjustable (see figure 19).

This heater unit is mounted on a hinged support allowing it to be quickly moved away to the rear.

20.2.2 Forming jig, of wood, chipboard or other material having a similar thermal conductivity, the front of which is rounded to a specified radius. The jig is easily replaceable, and it is possible to use a series of forming jigs machined to specified radii (for example 8 mm, 9 mm, 10 mm, 11 mm, 12 mm) (see figure 19).

20.2.3 Clamping device, for the test sample (see figure 19).

20.2.4 L-shaped forming bar, with a handle (see figure 19).

20.2.5 Temperature indicators (thermal crayons or waxes), with melting points covering the required range of temperature. Other types of temperature indicator with equal or better precision may also be used (e.g. infra-red thermometers, colour-change indicators).

20.2.6 Stopwatch, or other suitable timer.

20.2.7 Thickness gauge (ratchet-type micrometer) (see 4.2.1).

20.2.8 Conditioning chamber, with a standard atmosphere of $23\text{ °C} \pm 2\text{ °C}$ and relative humidity of $(50 \pm 5)\%$

20.3 Test specimens

The specimens shall measure approximately 180 mm × 90 mm and be of the thickness of the sheet under test. They shall be sanded smooth at the edges to remove any hairline cracks.

At least twelve specimens shall be prepared, six with their major axes in the machine direction of the fibrous sheet material from which the laminate was made, and six at right angles to this direction.

The specimens shall be conditioned for 24 h at $23\text{ °C} \pm 2\text{ °C}$ and $(50 \pm 5)\%$ relative humidity before testing.

20.4 Procedure

Measure the thickness of the specimens as specified in clause 4.

Use the forming jig corresponding to the radius specified in ISO 4586-1.

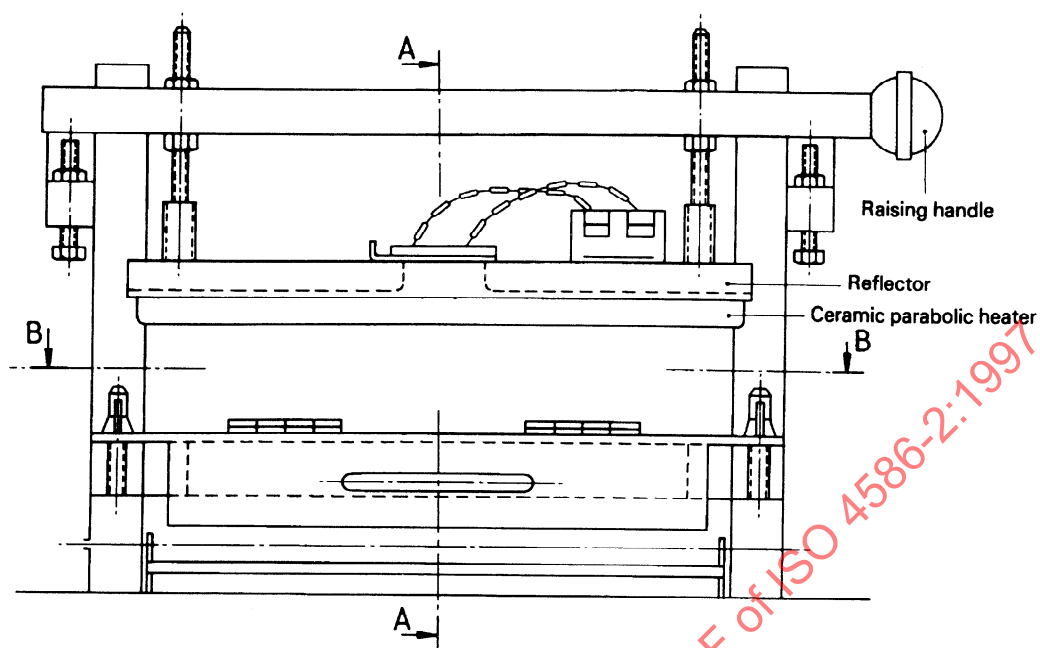
Turn on the heater element at least 20 min prior to starting the test.

3) For example, Elstein Type FSR 650 W - 220 V (245 mm × 60 mm).

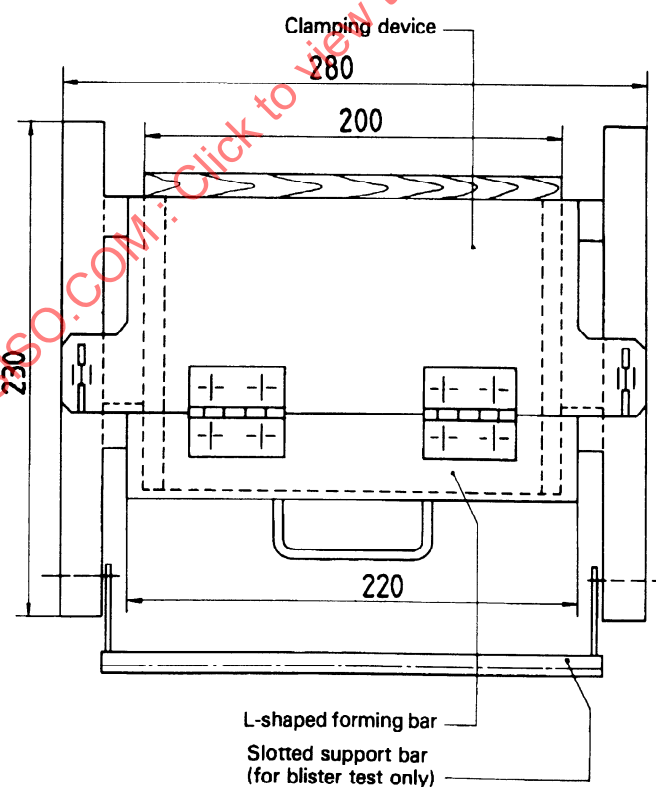
4) For example, Elstein Type REO 250 mm.

These are examples of suitable products available commercially. This information is given for the convenience of users of this International Standard and does not constitute an endorsement by ISO of these products.

Dimensions in millimetres



a) Profile



b) Plan view B-B

Figure 19 — Forming apparatus (Method B) (see 20.2)