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# Decorative high-pressure laminates (HPL) — Sheets based on thermosetting resins —

## Part 2 :
## Determination of properties

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

*Partie 2 : Détermination des caractéristiques*



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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 approval before their acceptance as International Standards by the ISO Council. They are approved in accordance with ISO procedures requiring at least 75 % approval by the member bodies voting.

International Standard ISO 4586-2 was prepared by Technical Committee ISO/TC 61, *Plastics*.

This second edition cancels and replaces the first edition (ISO 4586-2 : 1981), of which it constitutes a technical revision.

Users should note that all International Standards undergo revision from time to time and that any reference made herein to any other International Standard implies its latest edition, unless otherwise stated.





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# Decorative high-pressure laminates (HPL) — Sheets based on thermosetting resins —

# Part 2 : Determination of properties



## 1 Scope and field of application

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

## 2 References

ISO 48, *Vulcanized rubbers — Determination of hardness (Hardness between 30 and 85 IRHD).*

ISO 62, *Plastics — Determination of water absorption.*

ISO 4586-1, *Decorative high-pressure laminates (HPL) — Sheets based on thermosetting resins — Part 1: Specification.*

ISO 4892, *Plastics — Methods of exposure to laboratory light sources.*

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

## 3 Definition

For the purpose of this part of ISO 4586, the following definition applies:

**decorative high-pressure laminated sheet:** A sheet consisting of layers of fibrous sheet material (for example paper) impregnated with thermosetting resins and bonded together by means of heat and a pressure of not less than 5 MPa*, a layer or layers on one or both sides having decorative colours or designs.

Decorative high-pressure laminated sheet as defined in this part of ISO 4586 is made from core layers impregnated with phenolic resins and a surface layer or layers impregnated with aminoplastic resins (mainly melamine resins).

## 4 Thickness

### 4.1 Principle

Measurement of the thickness using a micrometer or a dial gauge indicator.

### 4.2 Apparatus

**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 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 should 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) a reference to this part of ISO 4586;

b) the name and type of product;

c) all values measured;

d) the location of the points at which measurements were made;

e) any deviation from the specified test method;

f) the date of the test.

* 1 MPa = 1 MN/m²

# 5 Appearance

## 5.1 Surface defects

### 5.1.1 Principle

Inspection of sheets 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 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 test 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, finger-prints, scratches, foreign particles, damage or any other form of blemish evident within the decorative surface.

The inspector shall have 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) a reference to this part of ISO 4586;

b) the name and type of product;

c) the viewing distance and any defects observed;

d) any deviation from the specified test method;

e) the date of the test.

## 5.2 Warping

### 5.2.1 Apparatus

**Straightedge,** of 1 000 mm length, with **micrometer** (see figure 1).

### 5.2.2 Test specimen

The test 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 various positions.

### 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 warp, 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 number of revolutions of the specimen required to cause a defined degree of abrasion is used as a measure of resistance to surface wear.

## 6.2 Materials

**6.2.1 Calibration plates of rolled zinc sheet,** having a thickness of 0,8 ± 0,1 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 to 100 g/m$^2$;

b) powdered aluminium oxide having a particle size such that it will pass through a sieve of aperture 100 µm and remain on a sieve having an aperture of 63 µm;

c) adhesive backing (optional).

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

## 6.3 Apparatus

**6.3.1 Testing machine** consisting of the following items (see figure 2).

**6.3.1.1 Specimen holder,** in the form of a disc (7) which rotates in a horizontal plane at a frequency of 58 to 62 r/min and to which the test specimen (6) can be clamped flat (4/5).

**6.3.1.2 Abrasive wheels** (3) : two cylindrical rubber-covered wheels of width 12,7 mm and diameter 50 mm which rotate freely about a common axis. The curved surface of the wheels, to a depth of 6 mm, shall be of rubber (2) of hardness 50 to 55 IRHD when tested according to ISO 48. The inside faces of the wheels shall be 50 to 55 mm apart, and their common axis shall be 20 mm from the vertical axis of the specimen holder. The wheels shall be positioned symmetrically in a plane containing the axis of the specimen holder.

**6.3.1.3 Holding and lifting device** (8) for the abrasive wheels, so constructed that each wheel exerts a force of 5,4 ± 0,2 N on the test specimen.

**6.3.1.4 Revolution counter.**

**6.3.1.5 Suction device,** so fitted that two nozzles are over the abraded section of the specimen under test. One nozzle shall be situated between the wheels, the other diametrically opposite. The centres of the nozzles shall be 77 mm apart and 1 to 2 mm from the surface of the test specimen. When the nozzles are closed, there shall be a vacuum of 1,5 to 1,6 kPa.

**6.3.2 Conditioning chamber,** with a standard atmosphere of 23 ± 2 °C and relative humidity (50 ± 5) %.

## 6.4 Test specimens

Each test 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 test specimens and abrasive paper

Clean the surface of the test specimens with an organic solvent which is immiscible with water, for example 1,1,1-trichloroethane. Precondition the test 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 (see 6.2.2) to each of the rubber-covered wheels using either the adhesive backing, if present, or the double-sided adhesive tape (see 6.2.3), in such a way that the cylindrical surface is completely covered, but without any overlapping of the abrasive paper [see figure 2, (1)].

### 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 (see 6.2.1) in the specimen holder (see 6.3.1.1), operate the suction device (see 6.3.1.5), 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 a further 500 revolutions, then wipe it clean and reweigh it to the nearest 1 mg. Its loss in mass shall be 130 ± 20 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 test specimen

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

Prepare sufficient abrasive wheels for the test using previously 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 that 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

The wear resistance, expressed in revolutions, for each specimen is given by the formula

$$\frac{IP + FP}{2}$$

The wear resistance of the sample under test shall be the average of the values obtained on the three test 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 wear resistance, in revolutions, of the sample under test;

d) any deviation from the specified test method;

e) 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 a test specimen and by noting the occurrence of any blistering or delamination.

The test is generally in accordance with ISO 62, 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 controlled at 50 ± 2 °C.

**7.2.3 Vessel,** containing boiling distilled water.

**7.2.4 Vessel,** containing distilled water at 23 ± 2 °C.

**7.2.5 Desiccator.**

**7.2.6 Micrometer,** thickness gauge.

**7.2.7 Suitable heating apparatus** (for example 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

Each test specimen shall be 50 ± 1 mm square, the thickness of the sheet, and cut in such a way that no appreciable heat is generated and the edges are free from cracks. Cut edges shall be smooth. Three specimens shall be used.

### 7.4 Procedure

Dry the three test specimens for 24 ± 1 h in the oven (7.2.2), controlled at 50 ± 2 °C, allow to cool in the desiccator (7.2.5) to 23 ± 2 °C, and 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 h ± 5 min, remove the specimens from the boiling water and allow to cool for 15 ± 5 min in the vessel of distilled water maintained at 23 ± 2 °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 test specimen to the nearest 0,01 mm at the same points as before ($d_5$, $d_6$, $d_7$, $d_8$).

Examine each test specimen visually for change in appearance.

### 7.5 Expression of results

The boiling water absorbed by each test 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 test specimen is given by the formulae

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

$$\frac{d_6 - d_2}{d_2} \times 100, \text{ etc.}$$

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 test 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) a reference to this part of ISO 4586;

b) the name and type of product;

c) the average percentage increase in mass of the three specimens;

d) the average percentage increase in thickness of the three specimens;

e) the effect on the surface of the specimens expressed in accordance with the following rating scale:

Degree 5: No visible change.

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

Degree 3: Moderate change of gloss and/or colour.

Degree 2: Marked change of gloss and/or colour.

Degree 1: Blistering and/or delamination.

f) any deviation from the specified test method;

g) 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.

NOTE — 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 should be used.

**8.2.2 Fine-faced wood chipboard,** 230 ± 5 mm square, 18 to 20 mm nominal thickness with a tolerance of ±0,3 mm, density 650 to 700 kg/m$^3$ and moisture content (9 ± 2) %.

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

### 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 ± 1,5 mm and an overall height of 70 ± 1,5 mm. The wall thickness shall be 2,5 ± 0,5 mm and the base thickness 2,5 $^{+0,5}_{0}$ mm.

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

**8.3.3 Suitable inorganic heat-insulating board,** of thickness about 2,5 mm and 150 mm square. Asbestos cement shall not be used.

**8.3.4 Thermometer,** range −5 °C to +250 °C.

**8.3.5 Fixed frame,** to hold the specimen flat.

**8.3.6 Stirrer.**

### 8.4 Test specimen

The test specimen shall be prepared by uniformly bonding a piece of the sheet under test to the wood chipboard (see 8.2.2) using the specified adhesive (see 8.2.3). One specimen 230 ± 5 mm square shall be used. The bonded specimen shall be preconditioned for at least 7 days at 23 ± 2 °C and (50 ± 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 (see 8.3.1) with glycerol tristearate (see 8.2.1). Fix the thermometer (see 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 °C, stirring from time to time. Transfer the vessel to the heat-insulating board (see 8.3.3) and allow the temperature to fall to 180 ± 1 °C, stirring continuously.

Immediately place the vessel of hot glycerol tristearate on the surface of the test 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:

Degree 5: No visible change.

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

Degree 3: Moderate change of gloss and/or colour.

Degree 2: Heavy change of gloss and/or colour.

Degree 1: Surface distortion and/or blistering.

d) any deviation from the specified test method;

e) the date of the test.

## 9 Dimensional stability at elevated temperatures

### 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 controlled at 70 ± 2 °C.

**9.2.2 Conditioning chamber,** with an atmosphere of relative humidity within the range 90 % to 95 % and a temperature of 40 ± 2 °C.

NOTE — This relative humidity occurs at a temperature of 40 °C in equilibrium above a saturated solution of sodium tartrate [$(CHOHCOONa)_2 \cdot 2H_2O$].

**9.2.3 Conditioning chamber,** with a standard atmosphere of 23 ± 2 °C and relative humidity (50 ± 5) %.

**9.2.4 Bedplate and mounted dial gauge,** or other apparatus capable of measuring to an accuracy of 0,02 mm.

**9.2.5 Rigid jig,** for holding the specimen straight during measurement. A typical jig is shown in figure 3.

**9.2.6 Desiccator,** of suitable size.

### 9.3 Test specimens

Each test specimen shall be 140 ± 0,8 mm long, 12,7 ± 0,4 mm wide and of the thickness of the sheet under test. The edges shall be free from cracks and shall be made smooth with fine abrasive paper or cloth. Machining and abrading operations shall be slow enough to avoid heating the material appreciably.

Twelve test 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 low humidity test and three for the high humidity test.

NOTE — If the machine direction is not known, carry out flexural strength tests at various angles. The highest value will usually be given by the test 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 ± 2 °C and (50 ± 5) % relative humidity.

### 9.4 Procedure

Make all measurements of length to the nearest 0,02 mm with the test specimen vertical in the jig (see 9.2.5), the lower end in contact with the bedplate and the upper end in contact with the foot of the dial gauge (see 9.2.4). When any test specimen is measured for the second time, take care to ensure that it is located in the jig in the same relative position as when it was first measured. Make all measurements within 5 min after removal from the conditioning atmosphere.

#### 9.4.1 Dry heat test

Measure the length of each of the six specimens and then place them in the oven (see 9.2.1) controlled at 70 ± 2 °C. At the end of 24 h, remove them and allow them to cool to ambient temperature in the desiccator (see 9.2.6) for 1 h. Again measure the length of each specimen.

#### 9.4.2 High humidity test

Measure the length of each of the six specimens and then place them in the conditioning chamber (see 9.2.2) at 40 ± 2 °C and relative humidity within the range 90 % to 95 %. After 96 ± 4 h, remove each specimen, wipe it free of surface water with a cloth, and again measure its length.

### 9.5 Expression of results

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

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

Calculate the combined dimensional change for each direction of the sheet. It is the sum of the average absolute dimensional changes in each of the low 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 combined dimensional change. The absolute figure shall be reported.

*Example* (using test specimens in one direction only):

**Dry heat test**

| Test specimen | 1 | 2 | 3 | Mean to nearest 0,05 % |
|---|---|---|---|---|
| Initial length (mm) | 139,77 | 139,85 | 139,83 | |
| Final length (mm) | 139,26 | 139,22 | 139,24 | |
| Change in length (mm) | −0,51 | −0,63 | −0,59 | |
| Change (%) | −0,36 | −0,45 | −0,42 | −0,4 |

**High humidity test**

| Test specimen | 4 | 5 | 6 | Mean |
|---|---|---|---|---|
| Initial length (mm) | 139,88 | 139,80 | 139,83 | |
| Final length (mm) | 140,33 | 140,21 | 140,31 | |
| Change in length (mm) | +0,45 | +0,41 | +0,48 | |
| Change (%) | +0,32 | +0,29 | +0,34 | +0,3 |

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

### 9.6 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 combined dimensional change for the machine direction;

d) the combined dimensional change for the cross-machine direction;

e) any deviation from the specified procedure;

f) 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 of humidity at 20 °C.

### 10.2 Apparatus

**10.2.1 Conditioning chambers,** maintaining the following three atmospheres:

20 ± 2 °C, relative humidity (32 ± 3) %

20 ± 2 °C, relative humidity (90 ± 3) %

23 ± 2 °C, relative humidity (50 ± 5) %

**10.2.2 Means for measuring lengths** of 200 mm to the nearest 0,05 mm.

### 10.3 Test specimens

Four test specimens approximately 250 mm × 50 mm shall be cut from the sheet under test in both the machine and cross-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 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 7 days in a standard atmosphere of 23 ± 2 °C and (50 ± 5) % relative humidity.

Measure the distance between the marks on all eight specimens to the nearest 0,05 mm with the specimens laid out flat.

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

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

Remeasure the distance between the marks as before within 1 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 combined dimensional change for each direction of the sheet. It 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 combined dimensional change for the machine direction;

d) the combined 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 to 20 mm nominal thickness with a tolerance of ±0,3 mm, density 650 to 700 kg/m$^3$ and moisture content (9 ± 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 case 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.

**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 4), 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 to 90 N by means of a force-setting barrel (housing).

The 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 ± 50 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 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 5), 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 test specimen and to avoid recoil following the release of the impact bolt.

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

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

### 11.4 Test specimens

Test specimens shall be prepared by uniformly bonding a piece of the sheet under test to the wood chipboard (see 11.2.1) using the specified adhesive (see 11.2.2). About ten specimens, each 200 ± 5 mm square, shall be prepared. The bonded specimens shall be preconditioned for at least 7 days at 23 ± 2 °C and (50 ± 5) % relative humidity before being used for the test.

### 11.5 Calibration of the impact tester

Suspend the tester 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) suspended from the knob used to draw back the impact bolt, ensuring that the bolt is clear of the retainer of the release unit.

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 6 for 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 parallell 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.

### 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 ± 2 °C.

Place the steel plate on a convenient rigid horizontal surface and locate the test specimen on it with its decorative surface

uppermost. Fix the impact tester in its support fixture, load the tester, place the assembly on the test 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 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 test 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 test specimen shall sustain no damage after ten successive individual impact blows with the prescribed spring force.

### 11.7 Expression of results

Enter the results of the series of tests onto an evaluation diagram (see figure 7 for example) in which they are subdivided into "Test specimen not damaged" and "Test specimen damaged", for each value of spring force used. This results in a transition range in which some specimens are damaged and some undamaged. 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.

### 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 to 20 mm nominal thickness with a tolerance of ± 0,3 mm, density 650 to 700 kg/m³ and moisture content (9 ± 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 case 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 such as PVAc.

### 12.3 Apparatus

**12.3.1 Free-fall test apparatus,** of the type shown in figure 8, or an equivalent which will produce the same results.

**12.3.2 Polished steel ball,** of mass 324 ± 5,0 g and diameter 42,8 ± 0,2 mm, having no damaged or flattened areas on its surface.

**12.3.3 Specimen clamping frame,** conforming to figure 9.

### 12.4 Test specimens

The test specimens shall be 230 ± 5 mm square. For laminates of thickness less than 2,0 mm, the specimens shall be prepared by uniformly bonding a piece of the sheet under test to the wood chipboard (see 12.2.1) using the specified adhesive (see 12.2.2). The bonded specimens shall be pre-conditioned for at least 7 days at 23 ± 2 °C and (50 ± 5) % relative humidity before being used for the test.

For laminates of thickness ⩾ 2,0 mm and < 5,0 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 ⩾ 5,0 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 ± 2 °C.

Clamp the test specimen in the clamping frame and place the assembly on the solid base of the free-fall test apparatus. 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 test 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 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 test specimen, shall be at least 50 mm. For referee purposes only one impact per test specimen shall be made.

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.

### 12.6 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 impact resistance, expressed in metres;

d) the indentation diameter;

e) any deviation from the specified test method;

f) the date of test.

## 13 Resistance to cracking (Thin laminates)

### 13.1 Principle

*Rigidly clamping a test specimen taken from the sheet under test in a steel fixture under slight curvature with the decorative face in tension. Imposition of additional stress by heating the clamped specimen at 80 °C for 20 h, and assessment of the resistance to cracking by visual examination.*

### 13.2 Apparatus

**13.2.1 Clamping device,** as shown in figure 10.

**13.2.2 Conditioning chamber,** with a standard atmosphere of 23 ± 2 °C and relative humidity (50 ± 5) %.

**13.2.3 Electrically heated oven,** provided with air circulation and capable of being controlled at 80 ± 2 °C.

**13.2.4 Hand lens,** with approximately 6 × magnification.

**13.2.5 Lighting,** of intensity 800 to 1 000 lx.

### 13.3 Test specimens

The test specimens shall be 120 ± 2 mm × 50 ± 2 mm and of the thickness of the sheet under test. The lengthwise direction of the specimen shall coincide with the direction of the greatest change in dimensions as determined according to clause 9 or 10. Two specimens shall be used.

### 13.4 Procedure

Precondition the test specimen for 48 h at 23 ± 2 °C and (50 ± 5) % relative humidity before testing.

Clamp the specimen at 23 ± 2 °C with the decorative side uppermost (i.e. in tension) in the clamping device (see 13.2.1). It is essential that the specimen does not slip in the clamp during the test.

Transfer the clamped specimen to the oven (see 13.2.3), controlled at 80 ± 2 °C, and leave for 20 ± 1 h.

After removal from the oven and cooling to ambient temperature with the test specimen still clamped in position, examine the surface with the naked eye, corrected if necessary, and under 6 × magnification (see 13.2.4) for the presence of any cracking. The light intensity during the examination shall be 800 to 1 000 lx.

Carry out the test on both specimens.

### 13.5 Expression of results

Express the result of the examination according to the following rating scale:

Degree 5: Decorative surface unchanged from as received condition, no hairline cracks.

Degree 4: Hairline cracks only visible under 6 × magnification, irregularly distributed across the surface.

Degree 3: In addition to degree 4 faults, cracks (normally parallel to the short edge of the specimen) visible to the naked eye, corrected if necessary.

Degree 2: A gaping crack which may extend right across the specimen.

Degree 1: Specimen broken into separate parts.

### 13.6 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 lower test result of the tests on the two specimens;

d) any deviation from the specified procedure;

e) 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 11), 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 test specimen. This shall rotate about a vertical axis without play and is preferably motor driven. The rotational frequency shall be 5 ± 1 r/min. Rotation by hand, within the speed range, is permissible, but uniform speed is essential.

**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 test specimen.

**14.2.1.4 Means of applying a known load** with an accuracy of ±0,01 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 ± 0,003 mm and an included angle of 90° ± 1° (see figure 12). (The diamond shall be mounted in the holder with the flat part on the leading side of the shank facing the working direction.) Diamonds for use shall be certified by the Darmstadt laboratory through the manufacturer and shall also be standardized before use as specified in 14.3.[1)]

**14.2.1.6 Clamping disc** (F), to keep the test 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 test 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 test specimen at various angles from a distance of 400 ± 10 mm. A diagram of a suitable enclosure is shown in figure 13.

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 to 1 000 lx at the specimen surface.

**14.2.3 Conditioning chamber,** with a standard atmosphere of 23 ± 2 °C and relative humidity (50 ± 5) %.

**14.2.4 Viewing mask** (see figure 14), made from thin flat opaque sheet material such as thin metal sheet or plastic card.

### 14.3 Standardization of the diamond point

Use a disc cut from poly(methyl methacrylate) cast sheet of minimum thickness 3 mm (4 mm preferred). Fasten the disc to the supporting table instead of the laminate. Apply loads of 1,5 to 4,0 N in steps of 0,5 N in turn and rotate the disc at 5 ± 1 r/min.

The high molecular weight cast poly(methyl methacrylate) shall be vacuum predried 24 h at 80 °C and shall have a Vicat softening temperature of at least 112 °C.

Make one complete revolution for each load. Measure the depth of penetration with a suitable measuring apparatus at four points spaced 90° apart on the same scratch and calculate the arithmetical mean depth for each load.

Diamonds which give a penetration depth of 4 µm or more for a load of 4,0 N are unsatisfactory. Only diamonds which give penetration values as defined by the limit curves shown in figure 15 shall be used to test decorative laminates.

Any irregularity in the curvature of the diamond point shall cause it to be rejected and all diamond points used shall be rechecked after each 1 000 tests.

### 14.4 Test specimen

Cut a specimen of the shape and dimensions shown in figure 16 from the sheet under test.

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

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

### 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 test specimen.

Start the test with a load of 5,0 N. Place the arm (B) in a vertical position. Fix the test 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 test specimen, taking care to avoid any impact.

Start rotating the turntable anticlockwise for a complete revolution at a uniform rotational frequency of 5 ± 1 r/min.

1) Diamond points conforming with these dimensions and profile are available from: CIE WEINZ, Industrie Edelstein Fabrik — Postfach 2740 — D 6580 IDAR-OBERSTEIN (F.R.G), and certified by the Darmstadt Laboratory, MPA. Darmstadt, Fach 11094, D 6100 DARMSTADT — 11 (F.R.G).

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 test specimen concentric with the first and spaced at least 2 mm apart, decreasing the load in increments 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 increments. For loads below 1,0 N, continue testing by reducing the load in 0,10 N increments.

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.

If a large number of tracks is required to determine the end point, it may be necessary to continue the test on a second test specimen taken from the same sheet.

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 test specimen. With the mask in place on the surface of the specimen, place specimen and mask on the viewing point in the viewing enclosure 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.

NOTE — In judging the lowest load producing a continuous mark, care must 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 should 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 14.

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 materials marked with an asterisk, then it is deemed to comply with the specification for stain resistance. The other test materials are included for information only. In the case of a specific complaint, the material in question (selected from group 1, 2 or 3) shall be used to verify the quality of the laminate.

## 15.2 Staining materials

| Test material | Test conditions | Contact time |
|---|---|---|
| **Group 1**<br>*Acetone<br>Trichloroethane<br>Other organic solvents<br>Toothpaste<br>Hand cream<br>Urine<br>Alcoholic beverages<br>Natural fruit and vegetable juices<br>Lemonade and fruit drinks<br>Meats and sausages<br>Animal and vegetable fats and oils<br>Water<br>Yeast suspension in water<br>Salt (NaCl) solutions<br>Mustard<br>Lyes, soap solutions<br>Cleaning solution<br>23 % dodecylbenzolsulfonate<br>10 % alkylarylpolyglycolether<br>67 % water<br>Phenol and chloramine T disinfectants<br>Stain or paint remover based on organic solvents<br>Citric acid (10 % solution) | 15.5 Procedure A.<br>Apply test material<br>at ambient temperature. | 16 to 24 h |
| **Group 2**<br>*Coffee (120 g of coffee per litre of water)<br>Black tea (9 g of tea per litre of water)<br>Milk (all types) | 15.5 Procedure A.<br>Apply test material<br>at approximately 80 °C. | 16 h |
| Cola beverages<br>Wine vinegar<br>Alkaline-based cleaning agents diluted to 10 % concentration with water<br>Hydrogen peroxide (3 % solution)<br>Ammonia (10 % solution of commercial concentrate)<br>Nail varnish<br>Nail varnish remover<br>Lipstick<br>Water colours<br>Laundry marking inks<br>Ball point inks | 15.5 Procedure A.<br>Apply test material<br>at ambient temperature. | |
| **Group 3**[1]<br>*Sodium hydroxide (25 % solution)<br>*Hydrogen peroxide (30 % solution)<br>Concentrated vinegar (30 % acetic acid)<br>Bleaching agents and sanitary cleaners containing them<br>Hydrochloric acid based cleaning agents ( ≤ 3 % HCl)<br>Acid-based metal cleaners<br>Mercurochrome (2-7-dibromo-4-hydroxymercurifluorescein disodium salt)<br>*Shoe polish<br>Hair colouring and bleaching agents<br>Iodine<br>Boric acid<br>Lacquers and adhesives (except fast-curing materials)<br>Amidosulfonic acid scaling agents ( < 10 % solution) | 15.5 Procedure A.<br>Apply test material<br>at ambient temperature. | 10 min |
| **Group 4**<br>*Citric acid (10 % solution)<br>Acetic acid (5 % solution) | 15.5 Procedure B. | 20 min |

1) Acids and alkalies, 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 to 100 °C.

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

**15.3.4 Hot-plate** 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 to 1 000 lx.

**15.3.6 Wetting agent,** for example domestic detergent.

**15.3.7 Ethanol, 95 % (*V*/*V*), acetone, MEK, trichloroethane, etc.** (see 15.5).

**15.3.8 Soft clean cloth.**

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

### 15.4 Test specimens

Individual test 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 materials to be applied side by side, can be used. Keep the specimen flat during the test.

In case 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 test material to two specimens. The test material shall be at the temperature specified in 15.2. Cover the material on one of the two specimens with a glass cover.

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

One hour after washing, place the specimen on the inspection surface (see 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 test material to the specimen. The test material shall be at ambient temperature.

Fill the vessel (see 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 test specimen directly over the pool of test material.

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

One hour after washing, place the specimen on the inspection surface (see 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 test materials.

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) assessment of stain resistance for each test material 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

Partial exposure of a test specimen taken from the sheet under test, together with standard blue wool specimens, to the light

of a xenon arc lamp. Determination of the light dosage by the effect on the wool specimens, and assessment of the effect on the test specimen at a specified light dosage by the contrast between exposed and unexposed portions of the specimen.

The test is fully described in ISO 4892.

### 16.2 Apparatus

As specified in ISO 4892. Test conditions shall be 60 ± 5 °C, (50 ± 5) % relative humidity.

### 16.3 Test specimen

As specified in ISO 4892.

### 16.4 Procedure

Carry out the test using the single exposure method described in ISO 4892 and discontinue the exposure when Blue Wool Standard No.6 shows a contrast between exposed and unexposed portions equal to Grade 4 of the grey scale.

### 16.5 *Evaluation and expression of results*

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

Express the result in relation to the resistance to colour change of Blue Wool Standard No. 6 as one of the following:

| Specimen contrast (Grey Scale Grade No.) | Resistance to colour change (Blue Wool Standard 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) resistance of the specimen to colour change, expressed as greater than, equal to, or less than that of Blue Wool Standard No. 6;

d) any deviation from the specified procedure;

e) the date of the test.

## 17 Resistance to colour change in enclosed carbon arc light

### 17.1 Principle

Partial exposure of a test specimen taken from the sheet under test, together with standard blue wool specimens, to the light of an enclosed carbon arc lamp. Determination of the light dosage by the effect on the wool specimens, and assessment of the effect on the test specimen at a specified light dosage by the contrast between exposed and unexposed portions of the specimen.

The test is fully described in ISO 4892.

### 17.2 Apparatus

As specified in ISO 4892 without control of humidity.

### 17.3 Test specimen

As specified in ISO 4892.

### 17.4 Procedure

Carry out the test using the single exposure method described in ISO 4892, and discontinue the exposure when Blue Wool Standard No. 5 shows a contrast between exposed and unexposed portions equal to Grade 4 of the grey scale.

### 17.5 Evaluation and expression of results

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

Express the result in relation to the resistance to colour change of Blue Wool Standard No. 5 as one of the following:

| Specimen contrast (Grey Scale Grade No.) | Resistance to colour change (Blue Wool Standard No.) |
|---|---|
| > 4 | > 5 |
| 4 | 5 |
| < 4 | < 5 |

### 17.6 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) resistance of the specimen to colour change, expressed as greater than, equal to, or less than that of Blue Wool Standard No. 5;

d) any deviation from the specified procedure;

e) the date of the test.

## 18 Resistance to cigarette burns

### 18.1 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.

### 18.2 Materials

**18.2.1 Fine-faced wood chipboard** 100 ± 5 mm square, 18 to 20 mm nominal thickness ±0,3 mm, density 650 to 700 kg/m³ and moisture content (9 ± 2) %.

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

**18.2.3 Pale tobacco cigarettes without filters,** from each of three well-known brands, each with a mass of 1,0 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 18.4) for at least 24 h before being used for the test.

**18.2.4 Ethanol,** 95 % (*V*/*V*).

**18.2.5 Soft cloth.**

### 18.3 Test specimen

The test specimen shall be prepared by uniformly bonding a piece of the sheet under test to the wood chipboard (see 18.2.1) using the specified adhesive (see 18.2.2). The bonded specimen shall be kept in the standard atmosphere (see 18.4) for at least 7 days before being used for the test. Three specimens 100 ± 5 mm square shall be prepared.

### 18.4 Apparatus

**Conditioning chamber,** with a standard atmosphere of 23 ± 2 °C and relative humidity of (50 ± 5) %.

### 18.5 Procedure

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

Place one of the burning cigarettes in full length contact with the horizontal surface of a test 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 a further 20 mm length is consumed. If the cigarette goes out before this occurs, repeat the test.

Follow this same procedure with the other two cigarettes.

Examine the surface of each specimen to determine whether the combustion residue can be removed with a cloth moistened with alcohol and whether the cleaned surface reveals any changes such as discoloration, cracks or blisters.

### 18.6 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 brands of cigarette used;

d) 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 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.

e) any deviation from the specified procedure;

f) the date of the test.

## 19 Resistance to cigarette burns (Simulated test using electric heater)

### 19.1 Principle

Subjection of test specimens taken from the sheet under test, and bonded to wood chipboard to simulate service conditions, to local radiant heat from an electric heater. Assessment of the resistance of the material in terms of the duration of exposure needed to cause visible damage.

### 19.2 Materials

**19.2.1 Fine-faced wood chipboard,** 18 to 20 mm nominal thickness ±0,3 mm, density 650 to 700 kg/m³ and moisture content (9 ± 2) %.

**19.2.2 Urea-formaldehyde adhesive,** containing approximately 15 % filler, or an adhesive with equivalent characteristics.

### 19.3 Apparatus

**19.3.1 Heating element support** (C) (see figure 17), consisting of electrically non-conducting laminated sheet.

**19.3.2 Heating element** (D) (see figure 17), of iron-aluminium alloy, having the following characteristics:

— cross-section of flat wire: 1,6 mm × 0,25 mm;

— wire length: 480 mm;

— electrical resistance: 1,8 ± 0,1 Ω.

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

**19.3.3 Adjustable mounting,** for the heating element (see figure 17), consisting of an externally threaded brass sleeve located vertically by two knurled brass nuts.

**19.3.4 Calibration block** (E) (see figure 18), of electrically insulating laminate, on which are mounted:

a) a disc support (F), made from homogeneous heat insulating diatomaceous-earth/asbestos sheet material of bulk density 512 to 576 kg/m$^3$, and thermal conductivity 0,10 to 0,12 W/(m·K) in the temperature range 0 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.

**19.3.5 Glass windowed cover** (H), (see figure 19).

**19.3.6 Stopwatch.**

**19.3.7 Power source,** producing a constant current for the heating element. This source may be either:

a) a series of well-charged accumulators with elements in good condition, able to provide the heating element with a power greater than 20 W, or

b) an electrical unit powered from the mains supply.

**19.3.8 Control circuit** (J), to adjust and maintain the power consumption of the heating element with an accuracy of ±0,1 %. Measurements are made by means of a voltmeter and an ammeter. A circuit for use with a 115 V mains supply is shown in figure 20.

**19.3.9 Potentiometer,** for measuring the temperature of the stainless steel disc.

**19.3.10 Cotton wick,** saturated with liquid paraffin.

**19.3.11 Conditioning chamber,** with a standard atmosphere of 23 ± 2 °C and relative humidity of (50 ± 5) %.

## 19.4 Test specimens

The test specimen shall be prepared by uniformly bonding a piece of the sheet under test to the wood chipboard (see 19.2.1) using the specified adhesive (see 19.2.2). The bonded specimen shall be kept in the conditioning chamber (see 19.3.11) for at least 7 days before being used for the test. Three specimens, 230 ± 2 mm × 80 ± 1 mm, shall be prepared.

## 19.5 Procedure

### 19.5.1 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 ± 0,1 mm (without including the edging ring).

Stand the heating block 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 on the calibration block so that the heating spiral covers the disc.

Cover the assembly to exclude draughts.

Allow the heating element to warm the disc for 10 min so as 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 block 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 ± 0,5 °C, then replace the heating element 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 ± 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 ± 0,5 °C).

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

### 19.5.2 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 ± 0,7 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 further 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.

### 19.6 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".

### 19.7 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, etc;

e) any deviation from the specified procedure;

f) the date of test.

## 20 Formability (Method A)

### 20.1 Principle

The test specimen is subjected to radiant heat on its decorative face until the reverse side reaches a predetermined 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 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.

### 20.2 Apparatus

**20.2.1 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 test specimen is laid across the trough, the test specimen is at a distance of 76 ± 1,0 mm above the heating elements. A windscreen enclosure to surround three sides and the top is advisable.

**20.2.2 Variable output transformer,** to control the potential difference across the heater (input voltage) with a suitable voltmeter to check the applied voltage.

**20.2.3 Temperature indicators** (thermal crayons, waxes or lacquers covering the required range of temperatures).

**20.2.4 Stopwatch,** or other suitable timer.

**20.2.5 Forming apparatus** (see figure 21), 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 or spindle of the press used in conjunction with these blocks.

**20.2.6 Conditioning chamber,** with a standard atmosphere of 23 ± 2 °C and relative humidity of (50 ± 5) %.

**20.2.7 Strips** of solid-colour white laminate conforming to the specifications for HGP given in ISO 4586-1, measuring 200 mm × 50 mm and with the major axis in the machine direction of the fibrous sheet material (for example paper) from which the laminate was made, to be used for calibration purposes. The non-decorative surface of each strip shall be sanded.

### 20.3 Test specimens

The test specimens shall have dimensions approximately 200 mm × 50 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 (for example paper) 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 ± 2 °C and (50 ± 5) % relative humidity before testing.

### 20.4 Procedure

#### 20.4.1 Calibration of test apparatus

Turn on the heating element 0,5 h prior to conducting the test, with the variable transformer at full-line voltage.

Use a temperature indicator with a melting point of 163 °C to make several marks about 100 mm long near the centre of the sanded surface of several calibration strips.

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 ±2 s.

After three or more consecutive calibration strips reach 163 °C within the prescribed time ±2 s, begin the test and maintain and record the voltage setting.

#### 20.4.2 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 (20.2.5).

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 test specimen.

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

Remove the specimen when the temperature indicator is completely melted in the area to be formed, stop the timer, 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 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.

### 20.5 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 radius of the male forming block;

d) whether the decorative face is inside or outside the bend;

e) the direction of the major axis of the test specimen, longitudinal (machine direction, L) or transverse (at right angles to the machine direction, T);

f) any failure: defects, for example cracks and their extent, blisters, delamination or discoloration;

g) any deviation from the specified procedure;

h) the date of the test.

## 21 Formability (Method B)

### 21.1 Principle

A specimen from the sheet under test is subjected to infrared radiation until the heated face reaches a predetermined 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 inside of the bend. The formability is assessed in terms of the success or failure of the forming process at the specified radius.

The method (very close to industrial practice) allows for adjustment of all the test variables in order to establish the optimum conditions for the forming of individual materials, and it is to be expected that different laminate types, thicknesses and colours/patterns, even from the same manufacturer, will require different conditions for satisfactory forming. 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.

### 21.2 Apparatus

**21.2.1 Radiant heater element**[1], fitted with a reflector[2], the distance and orientation relative to the test sample being adjustable (see figure 22).

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

**21.2.2 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, 9, 10, 11, 12 mm).

**21.2.3 Clamping device,** for the test sample.

**21.2.4 L-shaped forming bar,** with a handle.

**21.2.5 Temperature indicators,** covering the range 135 to 191 °C (thermal crayons or waxes).

**21.2.6 Stopwatch,** or other timer.

**21.2.7 Thickness gauge** (ratchet-type micrometer) (see 4.2).

**21.2.8 Conditioning chamber,** with a standard atmosphere of 23 ± 2 °C and relative humidity of (50 ± 5) %.

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

2) For example, Elstein Type REO 250 mm.

### 21.3 Test specimens

The test 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 (for example paper) from which the laminate was made, and six at right angles to this direction.

The specimens shall be conditioned for 24 h at 23 ± 2 °C and (50 ± 5) % relative humidity before testing.

### 21.4 Procedure

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

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

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

#### 21.4.1 Calibration of test apparatus

Clamp a specimen on the forming jig.

Using a 163 °C temperature indicator crayon (see 21.2.5), make a mark on the upper face in the area to be formed.

Lower the heating element over the test specimen and start the timer immediately. The time to reach 163 °C shall be 30 ± 5 s.

Move the heating element quickly to the rear.

If the time to reach 163 °C is not 30 ± 5 s, adjust the height of the heating element relative to the test sample until the setting is found where the indicator melts in this time.

#### 21.4.2 Test procedure

Clamp the test specimen on the forming jig.

Make a mark on the upper face in the area to be formed, using a temperature indicator crayon (see 21.2.5) in the temperature range recommended by the laminate manufacturer.

Lower the heating element over the test sample, and start the timer immediately.

Watch the temperature indicator crayon mark for signs of melting. When it melts completely, stop the timer, which indicates the heating time required for the test specimen to reach the forming temperature.

Move the heating element quickly to the rear.

Using the handle, lower immediately but smoothly the forming bar. The forming time should not exceed 1 s.

Keep the bar lowered for 1 min to allow the formed specimen to cool in the forming apparatus.

Raise the bar, and release and remove the formed specimen.

Carry out the test on specimens cut in both the machine and cross directions, and with the decorative face on both the inside and outside of the bend, to obtain three results under the conditions specified.

If the dimensions of the equipment permit, several test specimens can be formed side by side simultaneously.

Observe the formed specimens with the naked eye, corrected if necessary.

### 21.5 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 thickness of the laminate tested;

d) the radius of the forming jig used;

e) the heating time before forming;

f) any failure: defects, for example cracks and their extent, blisters, delamination or discoloration;

g) any deviation from the specified procedure;

h) the date of the test.

A material has failed if one or more of the twelve test samples does not form to the prescribed minimum forming radius or shows cracking, blistering, crazing or discoloration.

## 22 Resistance to blistering (Method A)

### 22.1 Principle

This test measures the ability of postforming-type high-pressure decorative laminate to resist blistering during the forming process. This is a companion test to that described in clause 20.

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

### 22.2 Apparatus

The same as in 20.2 plus an additional timer.

### 22.3 Test specimens

The test specimens shall measure approximately 200 mm × 50 mm, shall be of the thickness of the sheet under test and shall be cut from the right edge, centre and left edge of the sheet as manufactured. The non-decorative surface of each test specimen shall be sanded.

Three test specimens shall be tested, one from each of the sections of the sheet as stated.

The specimens shall be conditioned for at least 24 h at 23 ± 2 °C and (50 ± 5) % relative humidity before testing.

### 22.4 Procedure

#### 22.4.1 Calibration of test apparatus

Calibrate the apparatus as specified in 20.4.1.

#### 22.4.2 Test procedure

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 sanded surface and near the centre of the test specimen.

Place the test specimen on the heating trough so that the heat is applied to the decorative side, and start both timers immediately.

Watch the temperature indicator marks on the test specimen for signs of melting. When they have melted completely, stop the first timer. Allow the second timer to run until blistering occurs and then stop it. Blistering is detected visually or audibly or both.

Remove the specimen and allow it to cool in air; record the times, in seconds, and reset the timers.

### 22.5 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 thickness of the sheet;

d) the melting point of the temperature indicator used;

e) the average time to reach this temperature (first timer), $t_1$;

f) the average time to blistering (second timer), $t_2$;

g) the average time from the melting point of the temperature indicator to blistering, $t_2 - t_1$;

h) any deviation from the specified procedure;

i) the date of the test.

## 23 Resistance to blistering (Method B)

### 23.1 Principle

This test measures the ability of postforming-type high-pressure decorative laminate to resist blistering.

### 23.2 Apparatus

The same as in 21.2 plus an additional timer.

### 23.3 Test specimens

Test specimens shall be approximately 180 mm × 180 mm and of the thickness of the sheet under test.

Three test specimens shall be tested.

The specimens shall be conditioned for 24 h at 23 ± 2 °C and (50 ± 5) % relative humidity before testing.

### 23.4 Procedure

Any forming jig radius can be used.

#### 23.4.1 Calibration of test apparatus

Calibrate the apparatus as specified in 21.4.1.

#### 23.4.2 Test procedure

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

Clamp a test specimen on the forming jig, decorative face up. Raise the slotted support bar (see figure 23) to support the free end of the specimen and prevent it from warping during the test.

Make a mark on the upper face in the bending area using a temperature indicator crayon (see 21.2.5) corresponding to the forming temperature recommended by the laminate manufacturer.

Lower the heating element over the test specimen and start the two timers immediately.

Watch the temperature indicator crayon mark for signs of melting. When it melts completely, stop the first timer. Allow the second timer to run until blistering occurs and stop it immediately. Blistering is detected visually or audibly or both.

Move the heating element to the rear.

Remove the test specimen, and allow the forming jig to cool before clamping the next specimen.

### 23.5 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 thickness of the sheet;

d) the melting point of the temperature indicator used;

e) the average time to reach this temperature (first timer), $t_1$;

f) the average time to blistering (second timer), $t_2$;

g) the average time from the melting point of the temperature indicator to blistering, $t_2 - t_1$;

h) any deviation from the specified procedure;

i) the date of the test.

## 24 Resistance to steam

### 24.1 Principle

A specimen from the sheet under test is held in place over the neck of a flask containing boiling water, so that the decorative surface of the specimen is exposed to the steam. After 1 h, the specimen is removed and allowed to recover for 24 h in normal ambient conditions before examination for any change in appearance.

### 24.2 Materials

**24.2.1 Erlenmeyer flask,** wide-necked, of capacity 250 ml.

**24.2.2 Specimen holder** and **heat-resistant screen** (see figure 24).

**24.2.3 Non-fibrous filter paper**

**24.2.4 Hand lens** with 6 × magnification.

**24.2.5 Electric hot-plate** or other suitable heat source.

### 24.3 Test specimen

One test specimen, measuring 100 mm × 100 mm × the thickness of the sheet under test, is required.

### 24.4 Procedure

Place approximately 200 ml of water in the flask (see 24.2.1) and bring it to the boil on the electric hot-plate (24.2.5). Place the heat-resistant screen (24.2.2) in position around the neck of the flask, and place the test specimen, decorative face down, centrally over the mouth of the flask and fix it in position by the wire specimen holder (see figure 24).

NOTE — The specimen holder should be heavy enough to prevent the specimen from curling away from the mouth of the flask.

After the decorative face has been exposed for 1 h to the steam from the boiling water, remove the specimen and use the non-fibrous filter paper (24.2.3) to remove excess water from the surface of the specimen.

Allow the test specimen to recover for 24 h in normal ambient conditions and then examine the central area of the specimen with the naked eye, corrected if necessary, and under 6 × magnification using the hand lens (24.2.4) for any change in appearance.

### 24.5 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. Blistering and/or delamination.

d) any deviation from the specified procedure;

e) the date of the test.

## 25 Reaction to fire

Test under consideration.

See ISO 4586-1, sub-clause 5.2, "Notes on requirements for reaction to fire", and sub-clause 6.5, table 4, "Property requirements".

## 26 Resistance to crazing (Thick laminates)

### 26.1 Principle

A specimen from the sheet under test is placed in dry heat at 80 °C for 20 h and resistance to crazing is then assessed by visual examination after cooling.

### 26.2 Apparatus

**26.2.1 Specimen holder,** to hold specimens vertically during the test and prevent contact with other specimens or the oven.

**26.2.2 Electrically heated oven,** provided with air circulation and capable of being controlled at 80 ± 2 °C.

**26.2.3 Hand lens,** with approximately 6 × magnification.

**26.2.4 Lighting** of intensity 800 to 1 000 lx.

**26.2.5 Conditioning chamber,** with a standard atmosphere of 23 ± 2 °C and relative humidity of (50 ± 5) %.

### 26.3 Test specimens

The test specimens shall be 250 ± 2 mm square and of the thickness of the sheet under test and shall be sanded smooth at the edges to remove any hairline cracks.

Two specimens shall be used and shall be conditioned for at least 72 h at 23 ± 2 °C and (50 ± 5) % relative humidity before testing.

### 26.4 Procedure

Place the specimens in the holder (26.2.1) and then place the holder in the oven (26.2.2), controlled at 80 ± 2 °C, and leave for 20 ± 1 h.

At the end of 20 ± 1 h, remove the holder and specimens and allow to cool for 3 h at ambient temperature. After the cooling period, examine the surfaces and edges with the naked eye, corrected if necessary, and under 6 × magnification using the hand lens (26.2.3) to determine the presence and extent of any cracking. The light intensity during the examination shall be 800 to 1 000 lx.

### 26.5 Expression of results

The result of the examination shall be expressed in accordance with the following rating scale:

Rating 5. Decorative surfaces and edges unchanged from "as received" condition, no hairline cracks.

Rating 4. Hairline cracks irregularly distributed across the surface and/or edges; on the surface, only visible under 6 × magnification.

Rating 3. Surface cracks visible to the naked eye and/or moderate edge cracking.

Rating 2. A gaping crack which may extend right across the specimen and/or severe edge cracking.

Rating 1. Specimen broken into separate parts.

### 26.6 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 lower result of the tests on the two specimens, expressed in accordance with the above rating scale;

d) any deviation from the specified procedure;

e) the date of the test.

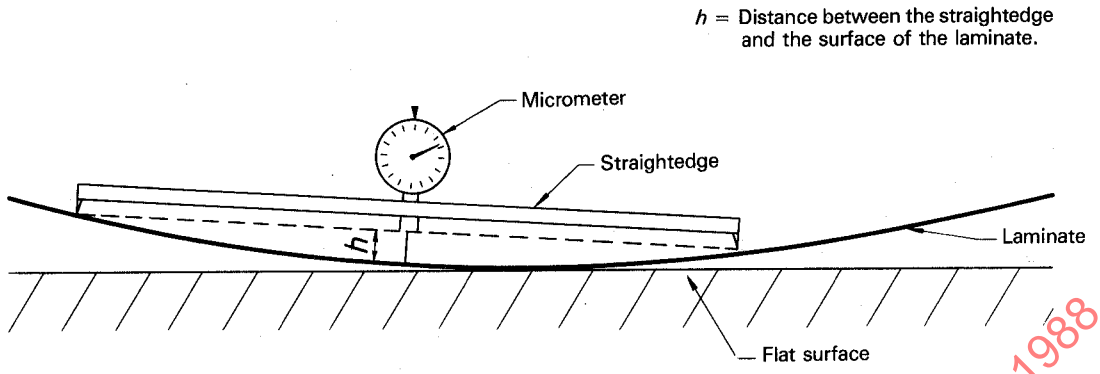



**Figure 1 — Example of measuring equipment for warping** (see 5.2.1)

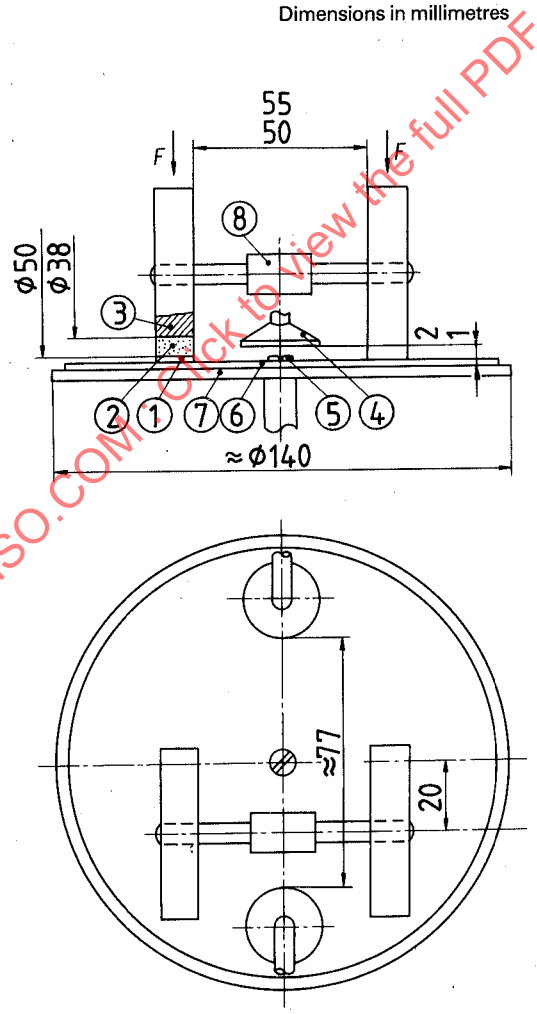
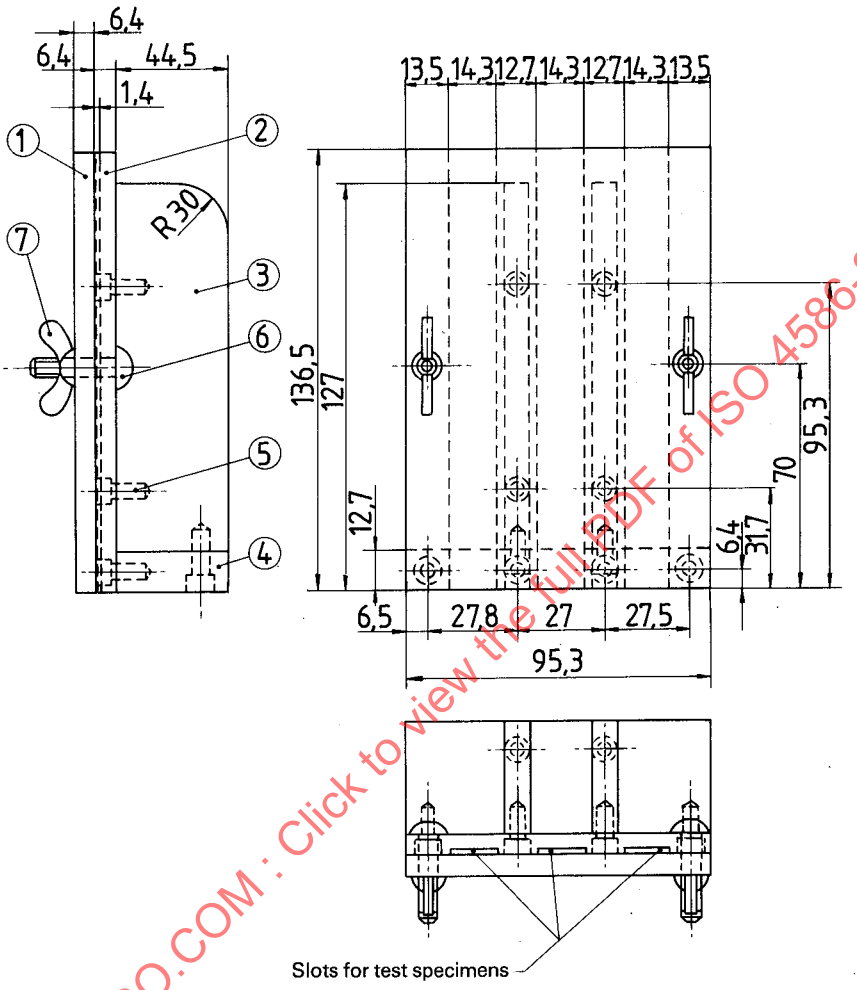



**Figure 2 — Type of apparatus for measuring abrasion resistance** (see 6.3.1)

Dimensions in millimetres




**List of items**

| Item | Material | Name | Dimensions (mm) | Number required |
|---|---|---|---|---|
| 1 | Stainless steel | Face plate | 6,4 × 95,3 × 135,5 | 1 |
| 2 | Stainless steel | Back plate | 6,4 × 95,3 × 135,5 | 1 |
| 3 | Stainless steel | Brace | 6,4 × 44,5 × 114,3 | 2 |
| 4 | Stainless steel | Base | 12,7 × 44,5 × 95,3 | 1 |
| 5 | Brass | Cheese head screw | | 10 |
| 6 | Brass | Round head screw | | 2 |
| 7 | Brass | Wing nut | | 2 |

**Figure 3 — Typical holding jig for determination of dimensional change** (see 9.2.5)

Dimensions in millimetres

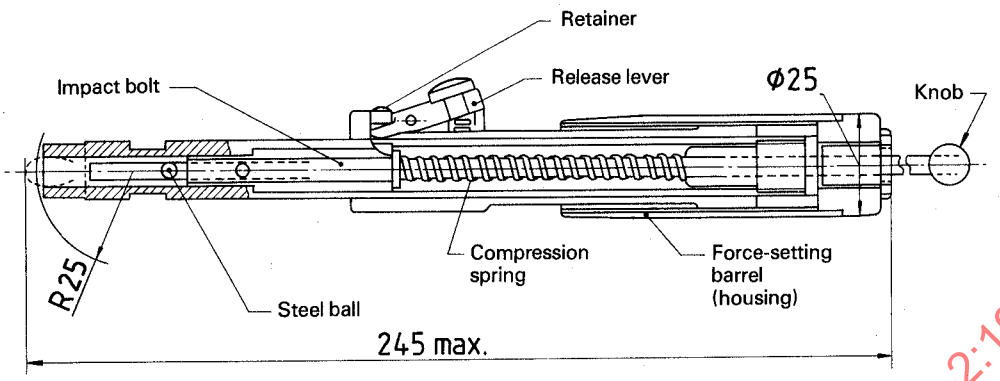



**Figure 4 — Impact tester (shown with spring compressed)** (see 11.3.1)



Dimensions in millimetres

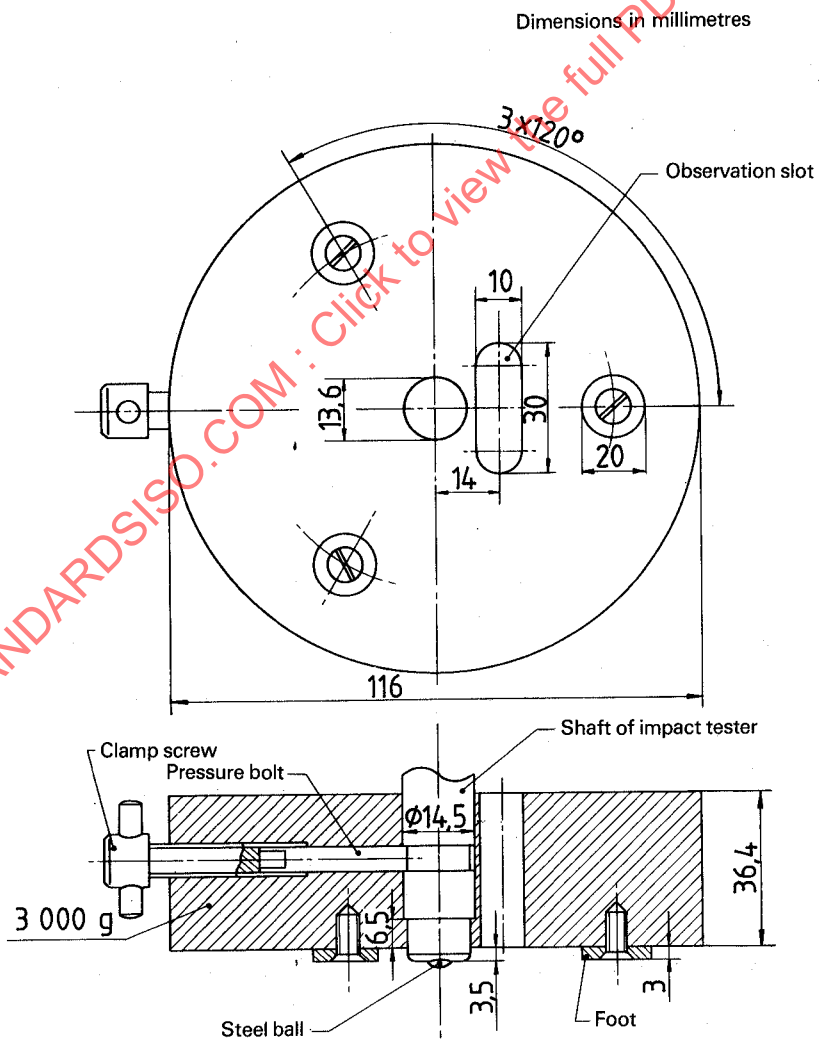



**Figure 5 — Support fixture for impact tester** (see 11.3.3)

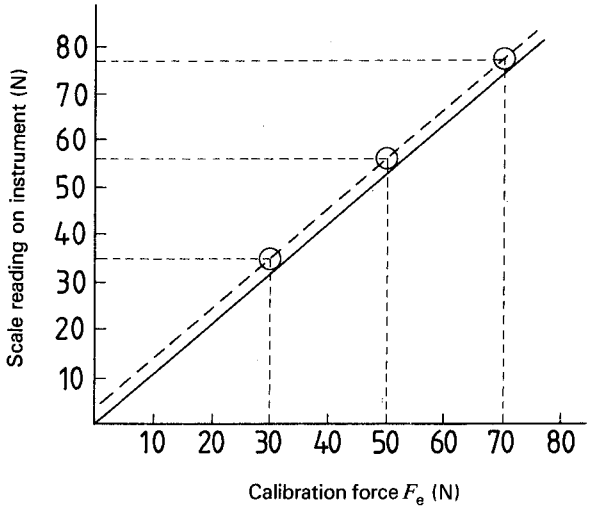
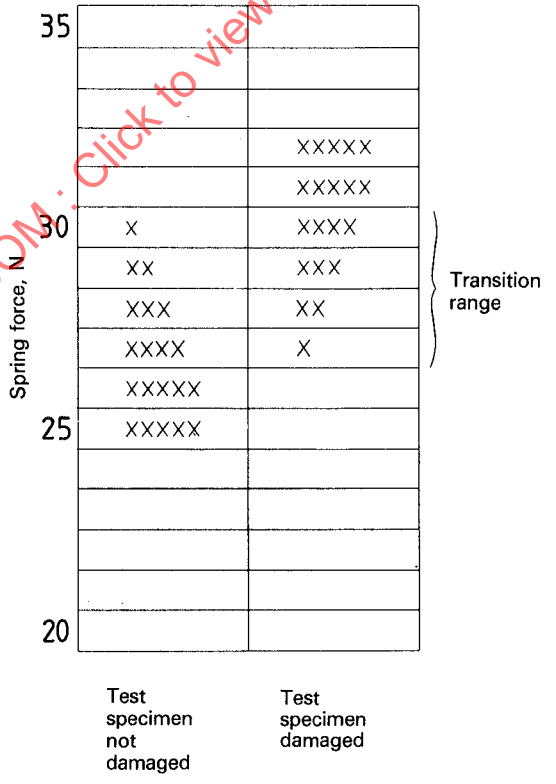



**Figure 6 — Example of calibration graph relating actual force to scale value** (see 11.5)






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

**Figure 7 — Example of evaluation diagram for assessing the effect of impact blows with an impact tester** (see 11.7)

Dimensions in millimetres

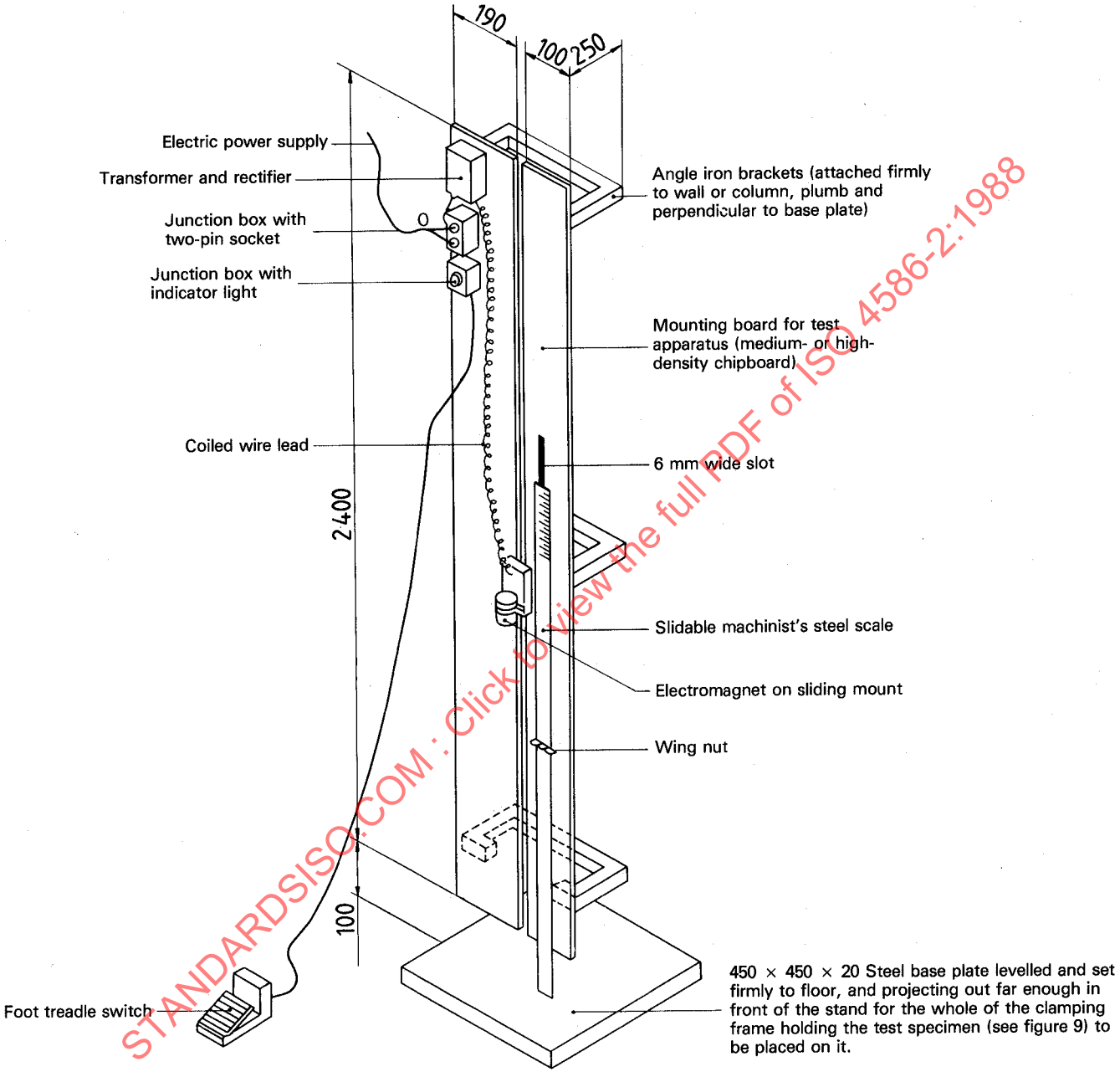





**Figure 8 — Resistance to impact by large-diameter ball** (see 12.3.1)

Dimensions in millimetres

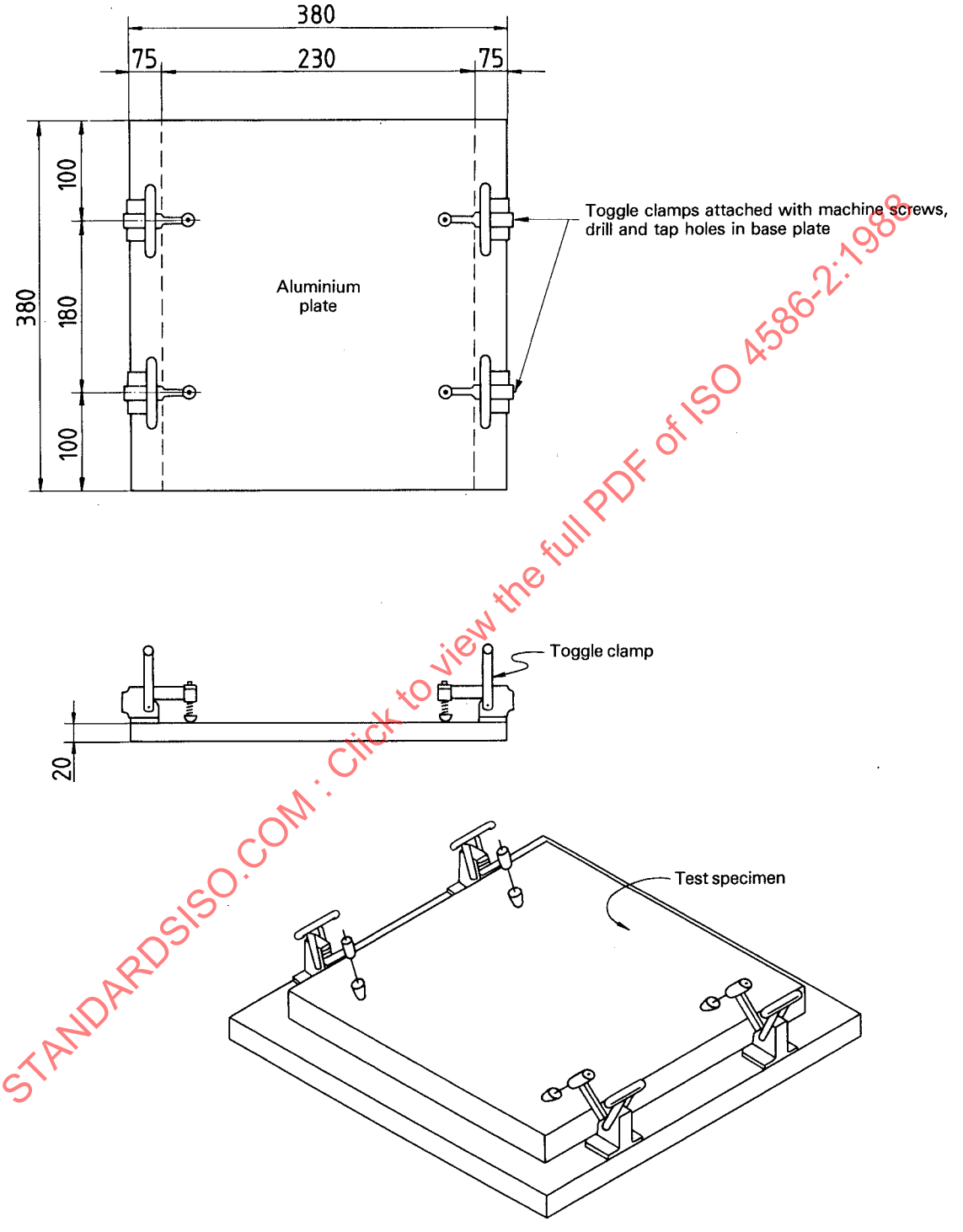



**Figure 9 — Clamping frame** (see 12.3.3)

Dimensions in millimetres

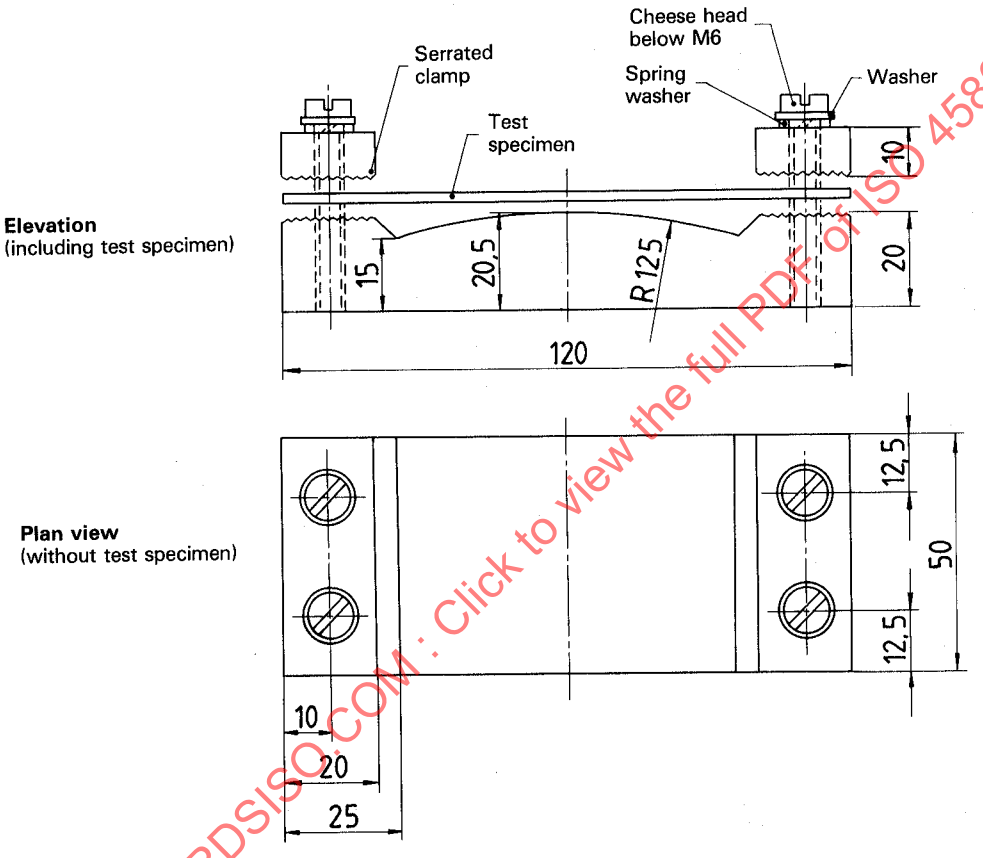



**Figure 10 — Steel clamping device for testing resistance to cracking**
(coefficient of linear thermal expansion = 11 × $10^{-6}$ $K^{-1}$) (see 13.2.1)

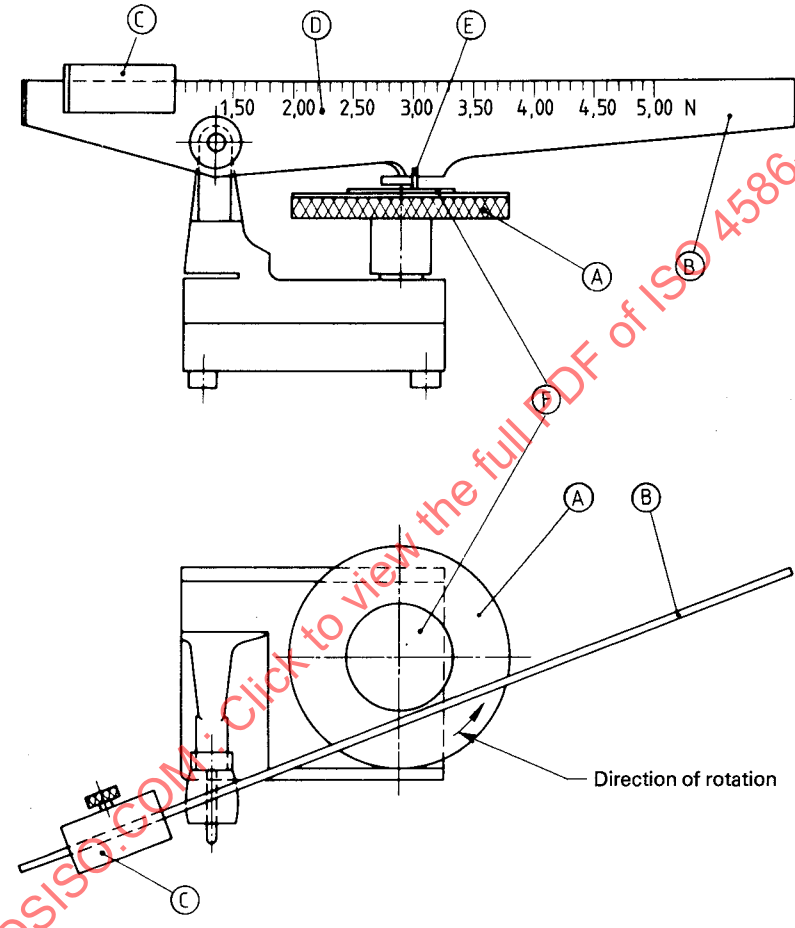
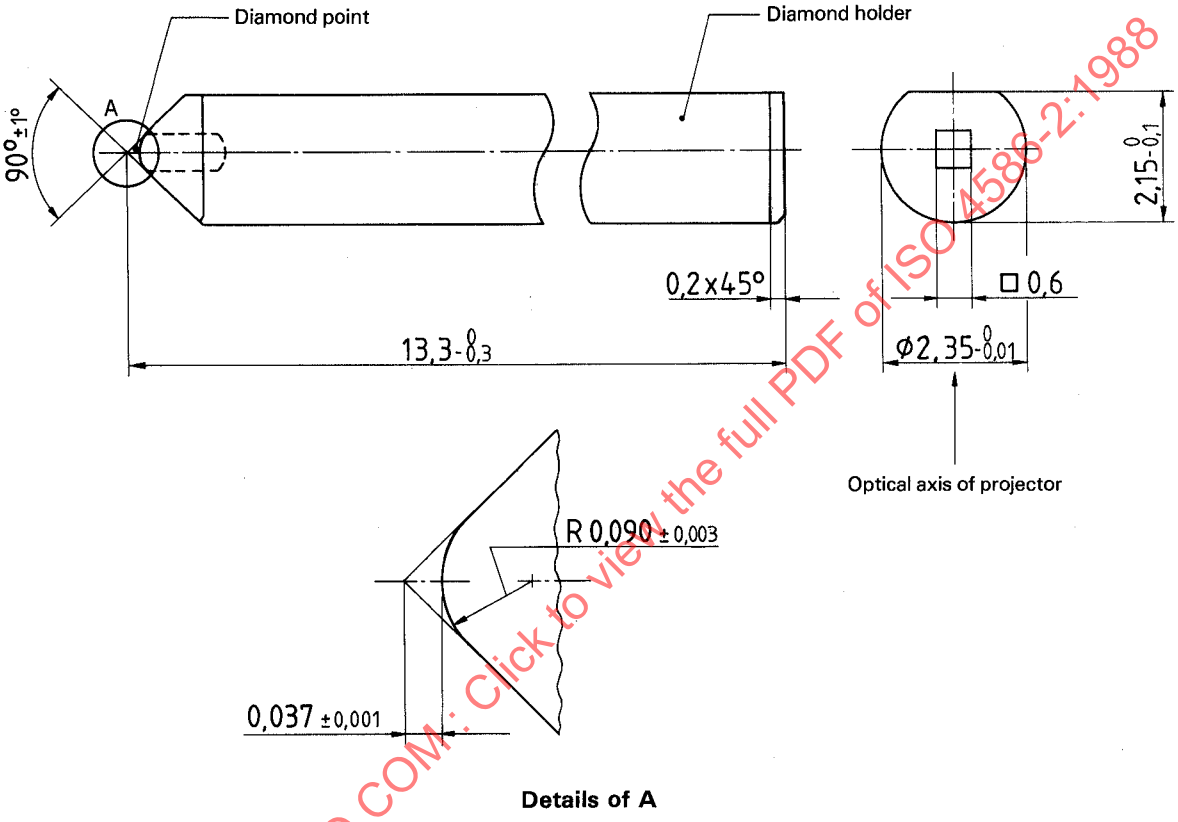



**Figure 11 — Type of apparatus for measuring the resistance to scratching** (see 14.2.1)

Dimensions in millimetres




**Details of A**

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

**Figure 12 — Scratching point** (see 14.2.1.5)

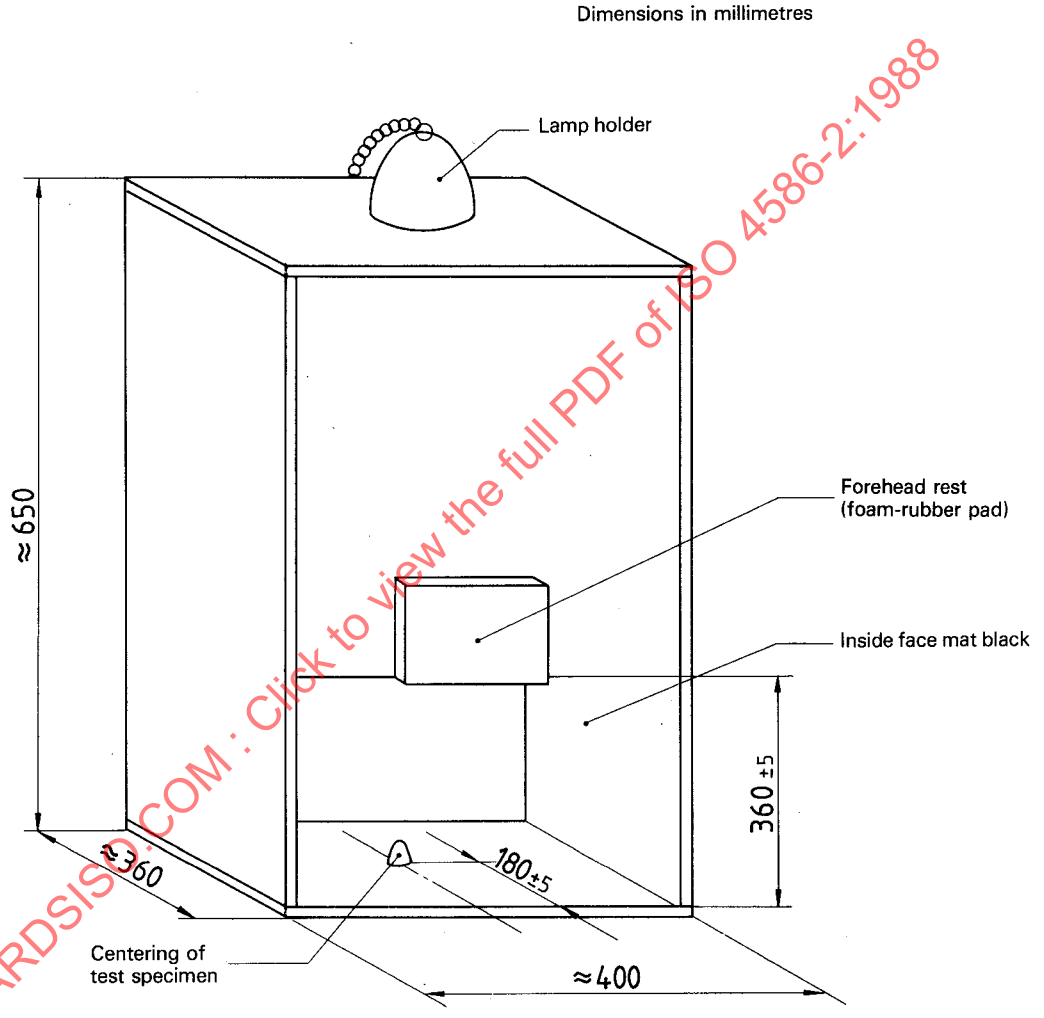
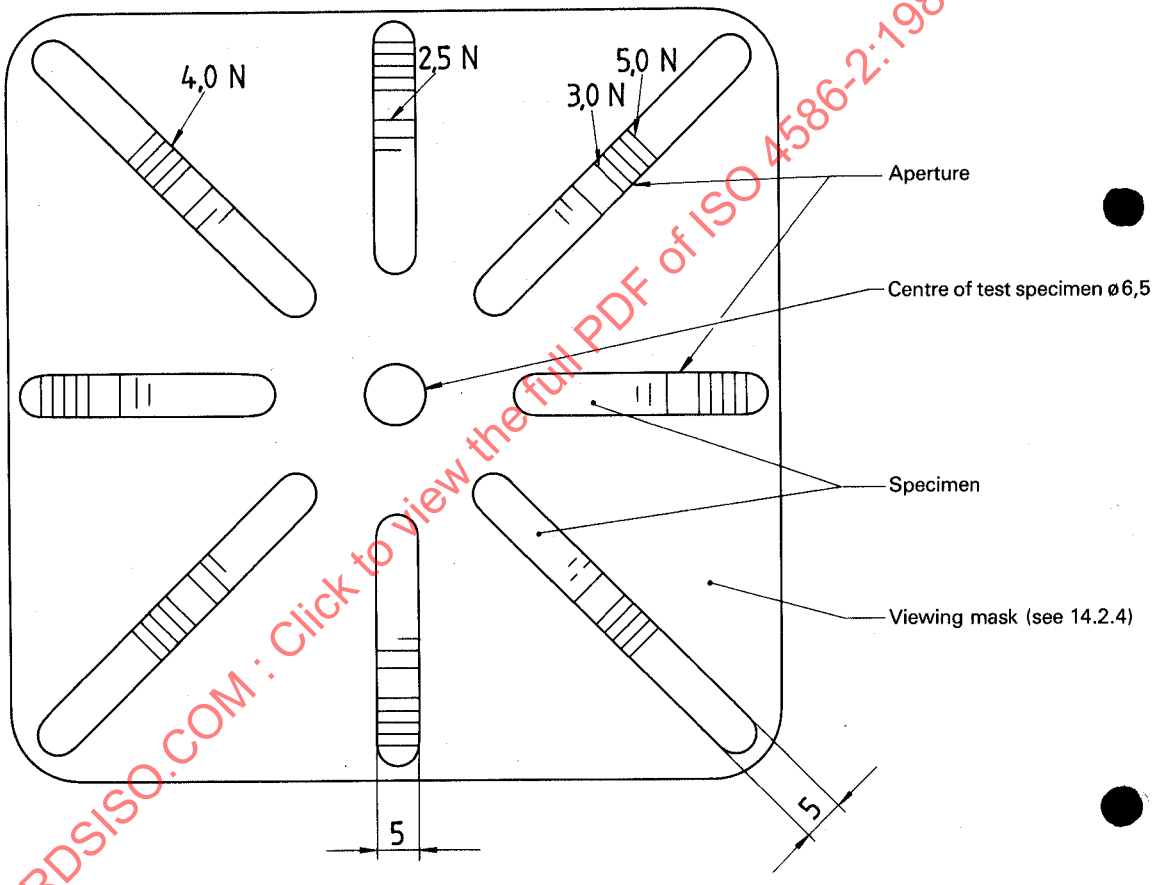



**Figure 13 — Example of suitable viewing enclosure** (see 14.2.2)

Dimensions in millimetres




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

**Figure 14 — Example of scratching test**