International Standard 4586/2

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Plastics — Decorative laminated sheets based on thermosetting resins — Part 2 : Determination of properties

Plastiques — Plaques de stratifié décoratif à base de résines thermodurcissables — Partie 2 : Détermination des caractéristiques

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Foreword

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Draft International Standards adopted by the technical committees are circulated to the member bodies for approval before their acceptance as International Standards by the ISO Council.

International Standard ISO 4586/2 was developed by Technical Committee ISO/TC 61, *Plastics*, and was circulated to the member bodies in August 1978.

It has been approved by the member bodies of the following countries :

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Austria	India	South Africa, Rep. of
Belgium	Iran	Spain
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The member bodies of the following countries expressed disapproval of the document on technical grounds :

France
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Plastics — Decorative laminated sheets based on thermosetting resins — Part 2 : Determination of properties

1 Scope and field of application

This part of ISO 4586 specifies methods of test for determination of the properties of decorative laminated sheets as defined in clause 3. These methods are primarily intended for testing sheets for conformity with the requirements of 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/R 878, *Plastics — Determination of resistance of plastics to colour change upon exposure to light of the enclosed carbon arc.*

ISO/R 879, *Plastics — Determination of resistance of plastics to colour change upon exposure to light of a xenon lamp.*

ISO 4586/1, *Plastics — Decorative laminated sheets based on thermosetting resins — Part 1 : Specification.*

ISO 6506, *Metallic materials — Hardness test — Brinell test.*[1)]

3 Definition

For the purpose of this International Standard, the following definition applies.

decorative 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[2)], the outer layer or layers on one or both sides having decorative colours or designs.

NOTE — Decorative laminated sheet as defined in this International Standard 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 indicator.

4.2 Apparatus

Thickness gauge (ratchet-type micrometer or dial 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 20 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 state

a) all values measured;

b) the location of the points at which measurements were made.

5 Appearance

5.1 Principle

Inspection of sheets for surface appearance under standardized conditions of lighting and viewing.

1) At present at the stage of draft. (Revision of ISO/R 79-1968, ISO/R 191-1971, and ISO/R 403-1964.)

2) 1 MPa = 1 MN/m^2

5.2 Apparatus

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

5.2.2 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.

5.3 Test specimen

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

5.4 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.

5.5 Test report

The test report shall state the viewing distance and any defects observed.

6 Resistance to surface wear

6.1 Principle

Determination of 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 using a ball of diameter 5 mm and a load of 306 N.

6.2.2 Abrasive paper strips, of width 12 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 size 100 µm and remain on a sieve having an aperture size of 63 µm;

c) adhesive backing (optional).

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

6.3 Apparatus

6.3.1 Testing machine, consisting of the following items :

6.3.1.1 Specimen holder, in the form of a disc which rotates in a horizontal plane at a frequency of 58 to 62 min^{-1} and to which the test specimen can be clamped flat.

6.3.1.2 Abrasive wheels : two cylindrical rubber-covered wheels of width 12 mm and diameter 50 mm, which rotate freely about a common horizontal axis. The curved surface of the wheels, to a depth of 6 mm, shall be of rubber of hardness 50 to 55 IRHD when tested in accordance with 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, 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, relative humidity 50 ± 5 %.

6.4 Test specimens

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

6.6.2 Calibration of abrasive paper

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

Weigh a zinc plate (6.2.1) to the nearest 1 mg and clamp it in the specimen holder (6.3.1.1). Lower the abrasive wheels on to the zinc plate and operate the suction device (6.3.1.5). Allow the zinc plate to rotate for 500 revolutions and then 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 (see 6.5).

Prepare sufficient abrasive wheels for the test using previously unused abrasive paper. Fit two wheels to the machine and set the revolution counter (6.3.1.4) 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, worn, or after 500 revolutions, whichever occurs 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 colour paper appears and the sub-layer becomes exposed. 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.

Carry out the test on each of the three test specimens.

6.7 Expression of results

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

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

Report the wear resistance of the sample under test as the average of the values obtained from the three test specimens, rounded to the nearest 50 revolutions.

6.8 Test report

The test report shall state the wear resistance of the sample under test, in revolutions.

7 Resistance to immersion in boiling water

7.1 Principle

Immersion of a test specimen in boiling water for 2 h and determination of the increase in mass and thickness of a test specimen and examination for 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 requirements 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 an electric hot plate).

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

7.3 Test specimens

The 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 (7.2.3) containing boiling distilled water. 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 (7.2.4) containing distilled water maintained at 23 ± 2 °C. Take the specimens out of 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 out of 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 blisters or delamination.

7.5 Expression of results

The boiling water absorbed by each test specimen, expressed as a percentage by mass, is given 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, d_4 are the thicknesses measured before immersion;

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

Report the percentage by mass of boiling water absorbed by the sample under test as the average of the values obtained from the three test specimens.

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

7.6 Test report

The test report shall state

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

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

c) whether any test specimens have blistered or delaminated.

8 Resistance to dry heat

8.1 Principle

Subjection of a specimen taken from the sheet under test, bonded to wood chipboard to simulate service conditions, to dry heat by contact with a vessel of defined heat capacity, initially at 180 °C but cooling during the 20 min of contact. Assessment of resistance to the test conditions 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.

NOTE — The same glycerol tristearate 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 glycerol tristearate shall be used.

8.2.2 Fine-faced wood chipboard, 230 ± 5 mm square, 19 ± 1,5 mm thick, of density 600 to 680 kg/m^3 and having a moisture content of 9 ± 2 % (m/m).

8.2.3 Urea-formaldehyde adhesive, containing approximatively 15 % (m/m) of filler, or an adhesive with equivalent characteristics.

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 (8.3.1) uniformly.

8.3.3 Asbestos or suitable inorganic heat-insulating board, of thickness about 25 mm and 150 mm square. Asbestos cement shall not be used.

WARNING — In view of the health hazard, care must be taken when cutting or machining asbestos to avoid inhaling any dust.

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

8.3.5 Fixing frame, to hold the test 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 (8.2.2) using the specified adhesive (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.

NOTE — 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 should be bonded to chipboard.

8.5 Procedure

Place 400 ± 10 g of the glycerol tristearate (8.2.1) in the vessel (8.3.1). Fix the thermometer (8.3.4) centrally in the vessel with its bulb about 6 mm from the bottom. Raise the temperature of the glycerol tristearate to approximately 185 °C, stirring from time to time. Transfer the vessel to the heat-insulating board (8.3.3) and allow the temperature to fall to 180 ± 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, discoloration or loss in gloss visible to the naked eye, allowing the light to fall on the specimen at various angles of incidence.

8.6 Test report

The test report shall state whether the specimen shows any change of appearance.

9 Dimensional change at elevated temperatures

9.1 Principle

Measurement of the lateral dimensional changes of specimens taken 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 40 ± 2 °C and relative humidity within the range 90 to 95 % .

NOTE — This relative humidity occurs at a temperature of 40 °C in equilibrium above a saturated solution of sodium tartrate [$(CHOH\text{-}COONa)_2.2H_2O$].

9.2.3 Conditioning chamber, with a standard atmosphere of 23 ± 2 °C and a relative humidity of 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 1.

9.2.6 Desiccator, of suitable size.

9.3 Test specimens

The 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 appreciably heating the material.

Twelve test specimens shall be tested, six of them with their major axes parallel to the machine direction of the 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 (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 1 min after removal from the conditioning atmosphere.

9.4.1 Low humidity test

Measure the length of each of the six specimens and then place them in the oven (9.2.1), controlled at 70 ± 2 °C. After 24 h, remove them and allow them to cool to ambient temperature in the desiccator (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 (9.2.2) at 40 ± 2 °C and relative humidity 90 to 95 %. After 96 ± 4 h, remove each specimen, wipe it free of surface water with a cloth, and again measure its length. Note whether any specimen shows any change of appearance.

9.5 Expression of results

Calculate the change as a percentage of the initial length for 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) :

Low humidity 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 : combined dimensional change = (0,3 + 0,4) % = 0,7 %.

9.6 Test report

The test report shall state :

a) the combined dimensional change for the machine direction;

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

c) whether the test specimens show any change of appearance.

10 Dimensional change at 20 °C

10.1 Principle

Measurement of the lateral dimensional changes of specimens taken 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-machine directions of the papers 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 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.

Note whether any specimen shows crazing, delamination or change in surface appearance.

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 state

a) the combined dimensional change for the machine direction;

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

c) whether any specimens show any change of appearance.

11 Resistance to impact by spring-loaded bolt

11.1 Principle

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

11.2 Materials

11.2.1 Fine-faced wood chipboard, 19 ± 1,5 mm thick, of density 600 to 680 kg/m³ and moisture content 9 ± 2 % (*m*/*m*).

11.2.2 Urea-formaldehyde adhesive, containing approximatively 15 % (*m*/*m*) filler, or an adhesive with equivalent characteristics.

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

11.3 Apparatus

11.3.1 Impact tester (see figure 2), consisting of an impact bolt with a 5 mm steel ball mounted at one end, which is projected once against the surface under test by the release of a compression spring. The spring compression force before release can be adjusted continuously from 0 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 3), which clamps to the shaft of the impact tester and provides a convenient mounting of sufficient mass for the tester to be held at right angles to the surface of the test specimen and to avoid recoil following the release of the impact bolt.

11.3.4 Steel plate, approximately 300 mm × 300 mm × 50 mm.

11.3.5 Hand lens, with approximatively X 6 magnification (optional).

11.4 Test specimens

The specimens shall be prepared by uniformly bonding a piece of the sheet under test to the wood chipboard (11.2.1) using the specified adhesive (11.2.2). About ten specimens, each 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.

NOTE — 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.

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 P_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 P_x on the scale of the instrument corresponding to the calibration force P_e.

Repeat this calibration procedure for various values of P_e in the range required, and draw a graph relating values of the scale reading P_x to values of the calibration force P_e (see figure 4 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 scale-pan). Draw a second line passing through the origin and parallel to the first line. This second line is the calibration graph for the instrument and shall be used to correct every indicated force P_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 graphite or talcum (depending on the colour of the decorative surface). A magnifier with X 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 5 for example), in which they are subdivided into "test specimens not damaged" and "test specimens 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 state the impact strength of the material, in newtons.

12 Resistance to impact by falling ball

12.1 Principle

Subjection of the decorative surface of an unbonded test specimen taken from the sheet under test, resting on the end of a hollow cylindrical support, to the impact of a 12,7 mm steel ball mounted on the end of a weighted striker which is allowed to fall from a known height. The energy of the minimum impact needed to cause breakage of the specimen is used as a measure of its resistance to impact.

12.2 Apparatus

Falling weight machine, consisting essentially of the following :

a) **Heavy rigid base,** fitted with levelling screws.

b) **Specimen support,** in the shape of a hollow steel cylinder of internal diameter 50,80 ± 0,05 mm, external diameter not less than 57,2 mm and height not less than 25,4 mm. The support shall be so fixed to the base that its axis coincides with the line of fall of the striker. A soft shock-absorbing disc of thickness approximately 6 mm shall be placed inside the cylinder and shall rest on the base.

c) **Rigid superstructure,** for carrying the release mechanism and, if used, guides for the striker.

d) **Weighted striker,** with a hardened hemispherical striking surface of diameter 12,7 ± 0,05 mm. The striking surface shall be free from flats or any other imperfections.

e) **Plumb line** or other devices, for ensuring that the striker is directly above the centre of the specimen support.

f) **Appropriate set of weights,** that can be firmly attached to the striker and which will give the increments of energy specified in tables 1 and 2. The combined mass of the weights and striker shall be known to within 3 g or 5 %, whichever is the smaller.

g) **Release mechanism,** such that the striker can fall 305 ± 1 mm for test specimens of thickness greater than 1,0 mm and 100 ± 1 mm for test specimens of 1,0 mm thickness or less.

The striker may fall between guides or without guides, but in either case the point of impact of the striker with the specimen shall be not more than 2,5 mm from the axis of the specimen support. If guides are used the fall shall be substantially without friction. If guides are not used and the striker is supported electromagnetically, the magnetic flux should be reduced to the minimum necessary to support the loaded striker.

The machine shall stand on a rigid foundation.

A machine of suitable form and incorporating guides is shown in figure 6.

12.3 Test specimens

The test specimen shall be a piece 60 ± 3 mm square and the thickness of the sheet under test. Twenty specimens shall be used, or more if required. No specimen shall be struck more than once.

12.4 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.

Measure the thickness of the test specimen as described in clause 4. Set the release mechanism to allow the height of fall appropriate to the specimen thickness [see 12.2 g)]. Place the specimen at the centre of its support.

12.4.1 Trial run

Load the striker with weights so that the product of the height of fall and the combined mass of weights and striker is equal to the expected impact strength of the material under test. The striker shall be held in position by the release mechanism.

Operate the release mechanism so that the striker falls on to the specimen.

If the specimen is unbroken or cracked on one surface only, record it as "unbroken". If the specimen is broken or shows a crack or tear extending from one surface to the other, record it as "broken".

Proceed as follows :

a) If the first specimen breaks, test a second specimen but with an impact energy less by an amount $\Delta_1 E$ than that of the blow applied to the first specimen, where $\Delta_1 E$ is as shown in table 1. If the second specimen also breaks, test a further specimen in the same manner but with an energy less by an amount $\Delta_1 E$[1)] than that of the blow applied to the second specimen. Continue this sequence of operations until a specimen does not break.

b) If the first specimen does not break, test a second specimen with an impact energy greater by an amount $\Delta_1 E$ than that of the blow applied to the first specimen. If the second specimen also does not break, test a further specimen in the same manner but with an energy greater by an amount $\Delta_1 E$[1)] than that of the blow applied to the second specimen. Continue this sequence of operations until a specimen breaks.

Table 1 — Relationship between increments of energy for trial run and energy of blow immediately preceding increment

Energy of blow immediately preceding increment		Increment $\Delta_1 E$ of energy for trial run
Greater than	Up to and including	
J	J	J
5,4	—	2,7
2,7	5,4	1,4 ± 0,14
1,4	2,7	0,54 ± 0,14
0,7	1,4	0,27 ± 0,07
0,35	0,7	0,14 ± 0,07
	0,35	⩽ 0,05

The trial run comprises the first blow and subsequent blows preceded by an energy change of $\Delta_1 E$. The minimum number of blows in the trial run is 2.

12.4.2 Testing run

After completing the procedure in 12.4.1 a) or 12.4.1 b) as appropriate, test the remaining specimens, the energy of the blow applied to any specimen being less by an amount $\Delta_2 E$ than that for the previous specimen if that specimen was broken, or greater by an amount $\Delta_2 E$ if the previous specimen was unbroken, where $\Delta_2 E$ is as shown in table 2.

The testing run comprises the blows which are preceded by an energy change of $\Delta_2 E$. The maximum number of blows in the testing run is 18, and the minimum number is 12. If less than twelve specimens remain following the trial run, more shall be prepared.

Table 2 — Relationship between increments of energy for testing run and energy of last blow of trial run

Energy of last blow of trial run		Increment $\Delta_2 E$ of energy for testing run
Greater than	Up to and including	
J	J	J
5,4	—	⩾ 1,4
2,7	5,4	0,8 ± 0,14
1,4	2,7	0,3 ± 0,1
0,7	1,4	0,14 ± 0,04
0,35	0,7	0,06 ± 0,03
—	0,35	⩽ 0,03

1) During the trial run, the value of $\Delta_1 E$ should be varied as specified in table 1.

12.5 Expression of results

Report the impact strength of the material as the average energy of the blows struck during the testing run. It shall be expressed in joules.

12.6 Test report

The test report shall state

a) the impact strength of the material, in joules;

b) the thickness of the sheet under test.

13 Resistance to cracking

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 7.

13.2.2 Conditioning chamber, with a standard atmosphere of 23 ± 2 °C, 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 X 6 magnification.

13.2.5 Lighting, of intensity 800 to 1 000 lx.

13.3 Test specimens

The test specimen 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 greatest change in dimensions as determined according to clauses 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 (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 (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 and under X 6 magnification (13.2.4) for the presence and extent 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 grades of susceptibility given in table 3.

Table 3 — Grades of susceptibility to cracking

Grade of susceptibility to cracking	Result of testing according to 13.4
0	Decorative surface unchanged from as received condition; no hairline cracks.
1	Hairline cracks only visible under X 6 magnification, irregularly distributed across the surface.
2	In addition to grade 1 faults, cracks visible to the naked eye (normally parallel to the short edge of the specimen).
3	A gaping crack which may extend right across the specimen.
4	Specimen broken into separate parts.

13.6 Test report

The test report shall state the lower result (i.e. the higher numbered grade) of the tests on the two specimens.

14 Resistance to scratching

Test under consideration.

15 Resistance to domestic staining

15.1 Principle

Leaving test specimens taken from the sheet under test for 16 to 24 h in contact with a series of liquid stains and solvents which are likely to be encountered in everyday use. Assessment of resistance to the liquids by the presence and difficulty of removal of any marks produced.

15.2 Materials

15.2.1 Staining materials and solvents for the test :

15.2.1.1 Tea, prepared by pouring boiling water on to Indian or Ceylon tea in a hot vessel, stirring occasionally, and decanting from the leaves after infusion for 5 min. Use 9 g of tea per litre of water.