INTERNATIONAL STANDARD

ISO 4586-2

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

Part 2: Determination of properties

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

Partie 2: Détermination des caractéristiques

Reference number
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Contents

Page

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.

International Standards are drafted in accordance with the rules given in the ISO/IEC Directives, Part 2.

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

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights.

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

This fifth edition cancels and replaces the fourth edition (ISO 4586-2:1997), of which it constitues a minor revision intended

a) to combine the 1997 edition with its amendments (Amendments 3 to 8) to give a single document;

b) to reintroduce a previously deleted method (determination of resistance to colour change in light from an enclosed carbon-arc lamp) (see 17.3).

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

— *Part 1: Classification and specifications*

— *Part 2: Determination of properties*

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

Part 2: Determination of properties

1 Scope

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

The precision of the test methods specified in Clauses 4, 7 and 11 of this part of ISO 4586 is not known because inter-laboratory data are not available. When inter-laboratory data are obtained, precision statements will be added to the test methods at the following revision. As all the other test methods have an end point determination based on subjective judgement, it is not meaningful to make a statement of precision in these cases.

2 Normative references

The following referenced documents are indispensable for the application of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

ISO 105-A02, *Textiles — Tests for colour fastness — Part A02: Grey scale for assessing change in colour*

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

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

ISO 4586-1:2004, *High-pressure decorative laminates — Sheets made from thermosetting resins — Part 1: Classification and specification*

ISO 4892:1981, *Plastics — Methods of exposure to laboratory light sources*[1)]

ISO 4892-1, *Plastics — Methods of exposure to laboratory light sources — Part 1: General guidance*

ISO 4892-2:1994, *Plastics — Methods of exposure to laboratory light sources — Part 2: Xenon-arc sources*

ISO 6506-1, *Metallic materials — Brinell hardness test — Part 1: Test method*

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

ISO 9370, *Plastics — Instrumental determination of radiant exposure in weathering tests — General guidance and basic test method*

CIE Publication No. 85:1989, *Solar spectral irradiance*

1) Withdrawn, but still used in certain Asian countries.

3 Terms and definitions

For the purposes of this document, the definition of high-pressure decorative laminate(s) given in 3.1 of ISO 4586-1:2004 applies.

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

4 Thickness

4.1 Principle

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

4.2 Apparatus

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

4.3 Test specimen

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

4.4 Procedure

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

4.5 Test report

The test report shall include the following information:

a) 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.

5 Appearance

5.1 Surface defects

5.1.1 Principle

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

5.1.2 Apparatus

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

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

5.1.3 Test specimen

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

5.1.4 Procedure

Place the sheet, decorative face uppermost, on the inspection table. Wipe it free of any loose contamination, if necessary, with a soft cloth. Inspect it from the distance required by ISO 4586-1:2004 for defects such as smudges, smears, fingerprints, scratches, foreign particles, damage or any other form of blemish evident within the decorative surface.

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

5.1.5 Test report

The test report shall include the following information:

a) 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 Flatness

5.2.1 Apparatus

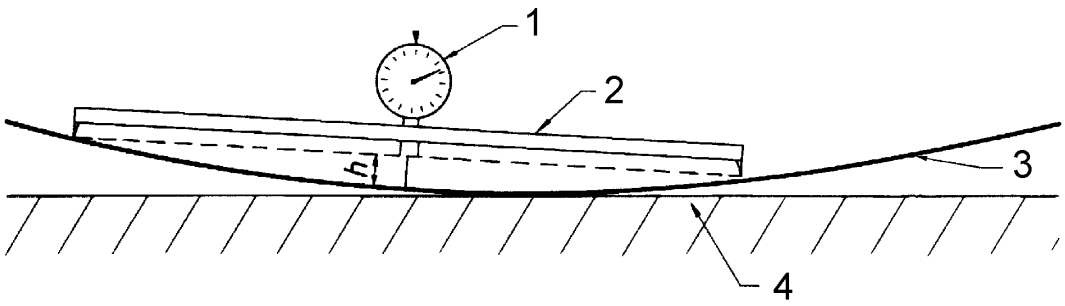
5.2.1.1 Straightedge, of 1 000 mm length, with optional **dial gauge** (see Figure 1).

5.2.2 Test specimen

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

5.2.3 Procedure

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



Key

1 dial gauge
2 straightedge
3 laminate
4 flat surface
h distance between the straightedge and the surface of the laminate

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

5.2.4 Test report

The test report shall include the following information:

a) a reference to this part of ISO 4586;

b) the name and type of product;

c) the maximum deviation, in millimetres;

d) any deviation from the specified test method;

e) the date of the test.

6 Resistance to surface wear

6.1 Principle

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

6.2 Materials

6.2.1 Calibration plates of rolled zinc sheet (Taber S-34 or equivalent), having a thickness of 0,8 mm ± 0,1 mm and a Brinell hardness of 48 ± 2 when tested in accordance with ISO 6506-1, except that the ball diameter shall be 5 mm and the load 360 N.

6.2.2 Abrasive paper strips (Taber S-42 or equivalent), of width 12,7 mm ± 0,1 mm and length about 160 mm, having the following composition:

a) paper of grammage 70 g/m^2 to 100 g/m^2;

b) open coated 180 grit powdered aluminium oxide (Al_2O_3) 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, required only if the abrasive paper has no adhesive backing.

6.3 Apparatus

6.3.1 Test machine, as specified in ISO 9352.

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

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

6.4 Test specimens

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

6.5 Preparation of specimens and abrasive paper

Clean the surface of the specimens with a non-hazardous organic solvent which is immiscible with water. Using a suitable marker pen, mark the surface of each specimen with two lines at right angles to each other so that the surface area is divided into quadrants. Precondition the specimens and the abrasive strips for at least 72 h in the conditioning atmosphere (see 6.3.2) before testing. After preconditioning, seal the paper strips in suitable polyethylene bags (maximum 10 strips per bag) until required for immediate use.

6.6 Procedure

6.6.1 Preparation of abrasive wheels

Bond a strip of preconditioned unused 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 preconditioned unused strips of abrasive paper from the batch to be used for testing (see 6.6.1).

Clamp a zinc plate (6.2.1) in the specimen holder, start the suction device, set the revolution-counter to zero, lower the wheels 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 preconditioned unused strips from the same batch, clamp the same zinc plate in the specimen holder, lower the abrasive wheels and operate the suction device. Abrade the zinc plate for an additional 500 revolutions, then wipe it clean and reweigh it to the nearest 1 mg. Its loss in mass shall be 130 mg ± 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 specimen

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

Prepare two wheels with preconditioned unused abrasive paper from the same batch previously approved by calibration. Fit the 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, start the suction device and begin abrading the specimen. Examine the specimen for wear after each 25 revolutions and examine the abrasive paper for clogging with abraded particles. Replace the abrasive paper if it becomes clogged, or after 500 revolutions, whichever happens first.

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

The initial wear point (IP) is the point at which the first clearly recognizable wear-through of the print, pattern, plain colour coating or solid paper appears and the sub-layer becomes exposed in three quadrants, with areas of at least 0,6 mm^2 wear-though in each of the three 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.[2) 3)]

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

6.7 Expression of results

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

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

where

IP is the initial wear point, expressed as a number of revolutions;

FP is the final wear point, expressed as a number of revolutions.

Average the value of the initial wear point (IP) of three specimens tested.

Average the value of the wear resistance of three specimens tested, rounded to the nearest 50 revolutions.

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2) A full-colour photographic visual aid, known as the IP poster, is available to assist correct interpretation, and increase repeatability and reproducibility in the determination of the initial wear point (IP). The poster is available from SIS Förlag AB, SE-11880 Stockholm, Sweden; Tel. +46 8 555 523 10, Fax. +46 8 555 523 11 (order reference 21990 IP1 poster).

3) Also available is a dirt size estimation chart. The use of this chart is recommended to determine precisely the size, in square millimetres, of the wear-through area. It is available from TAPPI, Technology Park/Atlanta, P.O. Box 105113, Atlanta, GA 30348-5113, USA; Tel. +1 770 446 1400, Fax. +1 770 446 6947 (order reference TAPPI — Dirt size estimation chart).

These are examples of suitable products available commercially. This information is given for the convenience of users of this part of ISO 4586 and does not constitute an endorsement by ISO of these products.

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 average initial wear point (IP) of the sample under test, in revolutions;

d) the average surface wear resistance of the sample under test, in revolutions;

e) any deviation from the specified procedure;

f) the date of the test.

7 Resistance to immersion in boiling water

7.1 Principle

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

The test is generally in accordance with ISO 62:1999, Method 2, except for a longer period of immersion in the boiling water and the requirement for thickness measurements.

7.2 Apparatus

7.2.1 Balance, accurate to 1 mg.

7.2.2 Oven, capable of being maintained at 50 °C ± 2 °C.

7.2.3 Vessel, containing boiling distilled water.

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

7.2.5 Desiccator.

7.2.6 Micrometer thickness gauge, as described in 4.2.1.

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

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

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

7.3 Test specimens

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

7.4 Procedure

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

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

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

After 2 h $\pm$ 5 min, remove the specimens from the boiling water and allow to cool for 15 min $\pm$ 5 min in the vessel of distilled water maintained at 23 °C $\pm$ 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 specimen to the nearest 0,01 mm at the same points as before (d_5, d_6, d_7, d_8).

Examine each specimen visually for change in appearance.

7.5 Expression of results

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

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

where

m_1 is the mass of the specimen before immersion;

m_2 is the mass of the specimen after immersion.

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

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

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

etc.,

where

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

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

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

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

7.6 Test report

The test report shall include the following information:

a) 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:

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

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. The aluminium alloy block specified in ISO 4211-3 has been found to be suitable.

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

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

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

8.3 Apparatus

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

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

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

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

8.3.5 Fixed frame, to hold the specimen flat.

8.3.6 Stirrer.

8.4 Test specimen

The specimen shall be prepared by uniformly bonding a piece of the sheet under test to the wood chipboard (8.2.2), using the specified adhesive (8.2.3). One specimen 230 mm ± 5 mm square shall be used. The bonded specimen shall be preconditioned for at least 7 days at 23 °C ± 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 (8.3.1) with sufficient glycerol tristearate (8.2.1) so that at 180 °C the level is about 15 mm from the top. Fix the thermometer (8.3.4) centrally in the vessel with its bulb about 6 mm from the bottom. Raise the temperature of the glycerol tristearate to approximately 185 °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 °C ± 1 °C, stirring continuously.

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

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

8.6 Test report

The test report shall include the following information:

a) a reference to this part of ISO 4586;

b) the name and type of product;

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

   Rating 5: No visible change

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

   Rating 3: Moderate change of gloss and/or colour

   Rating 2: Marked change of gloss and/or colour

   Rating 1: Surface damage and/or blistering

d) any deviation from the specified test method;

e) the date of the test.

9 Resistance to wet heat

9.1 Principle

A specimen taken from the laminate under test (bonded to wood chipboard, if necessary, to simulate service conditions) is subjected to wet heat by contact for a specified period with a vessel containing hot water placed in a pool of boiling water which has been poured onto the surface of the specimen. Resistance to the test conditions is assessed by visual examination.

9.2 Materials

9.2.1 Distilled or de-ionized water.

9.2.2 Sheet of fine-faced wood particleboard, (230 ± 5) mm square, with a nominal thickness of 18 mm to 20 mm ($\pm$ 0,3 mm), a density of (680 ± 20) kg/m^3 and moisture content of (10 ± 3) %.

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

9.2.4 Supply of clean, soft, white cloth.

9.3 Apparatus

9.3.1 Cylindrical aluminium or aluminium-alloy vessel, without a lid, the bottom of which has been machined flat. It shall have an external diameter of $(100 \pm 1{,}5)$ mm and an overall height of $(70 \pm 1{,}5)$ mm. The wall thickness shall be $(2{,}5 \pm 0{,}5)$ mm and the base thickness $2{,}5^{+0{,}5}_{0}$ mm.

9.3.2 Heat source, for heating the vessel (9.3.1) uniformly.

9.4 Test specimen

Prepare one specimen by uniformly bonding a piece (230 ± 5) mm square of the laminate under test to the particleboard (9.2.2), using the specified adhesive (9.2.3) evenly spread at 80 g/m^2 to 120 g/m^2. Condition the bonded specimen for at least 72 h at (23 ± 2) °C and (50 ± 5) % relative humidity before 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 particleboard.

9.5 Procedure

Fill the vessel (9.3.1) to 12 mm from the rim with distilled or de-ionized water, and heat it until the water boils vigorously.

As water boils and evaporates, dissolved minerals are left behind and will adhere to the vessel walls, forming scale which is an effective insulator. Any such scale shall be removed periodically or the accuracy of the test may be compromised. The use of distilled or de-ionized water will minimize this problem.

Using tongs, or other suitable means, carefully remove the vessel from the hotplate, pour approximately 10 ml of boiling water onto the horizontal surface of the test specimen and immediately place the vessel containing the remainder of the boiling water on the surface in the pool of water.

Allow the vessel to remain in place for 20 min.

At the end of this period, remove the vessel and wipe the surface of the specimen dry, using a clean, soft cloth (9.2.4) to remove any residual contaminants. Allow the specimen to cool for a period of 45 min.

Examine the specimen surface for 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.