BS EN 1096-2:2012

BSI Standards Publication

Glass in building — Coated glass

Part 2: Requirements and test methods for class A, B and S coatings

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National foreword

This British Standard is the UK implementation of EN 1096-2:2012. It supersedes BS EN 1096-2:2001 which is withdrawn.

The UK participation in its preparation was entrusted to Technical Committee B/520/1, Basic and transformed glass products.

A list of organizations represented on this committee can be obtained on request to its secretary.

This publication does not purport to include all the necessary provisions of a contract. Users are responsible for its correct application.

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Compliance with a British Standard cannot confer immunity from legal obligations.

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Glas im Bauwesen - Beschichtetes Glas - Teil 2: Anforderungen an und Prüfverfahren für Beschichtungen der Klassen A, B und S

This European Standard was approved by CEN on 3 December 2011.

CEN members are bound to comply with the CEN/CENELEC Internal Regulations which stipulate the conditions for giving this European Standard the status of a national standard without any alteration. Up-to-date lists and bibliographical references concerning such national standards may be obtained on application to the CEN-CENELEC Management Centre or to any CEN member.

This European Standard exists in three official versions (English, French, German). A version in any other language made by translation under the responsibility of a CEN member into its own language and notified to the CEN-CENELEC Management Centre has the same status as the official versions.

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EUROPEAN COMMITTEE FOR STANDARDIZATION
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EUROPÄISCHES KOMITEE FÜR NORMUNG

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Foreword

This document (EN 1096-2:2012) has been prepared by Technical Committee CEN/TC 129 “Glass in building”, the secretariat of which is held by NBN.

This European Standard shall be given the status of a national standard, either by publication of an identical text or by endorsement, at the latest by July 2012, and conflicting national standards shall be withdrawn at the latest by July 2012.

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

This document supersedes EN 1096-2:2001.

The main changes compared to the previous edition are:

— reference to the future EN 1096-5, *Test method and classification for the Self-cleaning performances of coated glass surfaces*;

— the introduction of a method to deal with toughenable / heat strengthenable and to be toughened / to be heat strengthened coated glass, see Annex A.

According to the CEN/CENELEC Internal Regulations, the national standards organizations of the following countries are bound to implement this European Standard: Austria, Belgium, Bulgaria, Croatia, Cyprus, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, Netherlands, Norway, Poland, Portugal, Romania, Slovakia, Slovenia, Spain, Sweden, Switzerland, Turkey and the United Kingdom.

1 Scope

This European Standard specifies requirements and test methods related to artificial weathering and abrasion of coatings on glass for use in buildings.

These tests are aimed at evaluating the resistance of the coating to attack by simulated natural weathering conditions as well as to abrasion. This attack can be considered as representative of that which could be found on the external and/or internal face of the glazing.

This European Standard applies to Class A, B and S coatings, as described in EN 1096-1.

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.

EN 410, *Glass in Building — Determination of luminous and solar characteristics of glazing*

EN 1096-1:2012, *Glass in building — Coated glass — Part 1: Definitions and classification*.

EN 12898, *Glass in building — Determination of emissivity*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in EN 1096-1 apply.

4 Requirements

The coated glass complying with this European Standard shall respect the requirements related to the different characteristics given in Table 1.

Table 1 — Requirements

<table>
<tr><th rowspan="2">Characteristics</th><th rowspan="2">Test Method</th><th colspan="2">Requirements</th></tr>
<tr><th>Visual Inspection</th><th>Spectrophotometric measurements</th></tr>
<tr><td>Condensation resistance</td><td>Annex B</td><td>- No defect, as defined in EN 1096-1, greater than 3 mm length
- Maximum one defect between 2 mm and 3 mm length
- Maximum five defects between 1 mm and 2 mm length
In addition, no scratches, staining of the coating or clusters of pinholes greater than 1 mm shall be allowed (see EN 1096-1).
When compared with the reference test piece, in both reflection and transmission, there shall be no significant colour change. This observation shall be made within 20 s[a] .</td><td rowspan="3">The transmittance measured at 550 nm and 900 nm shall differ by no more than ± 0,03 from the corresponding measured value on the reference test piece.

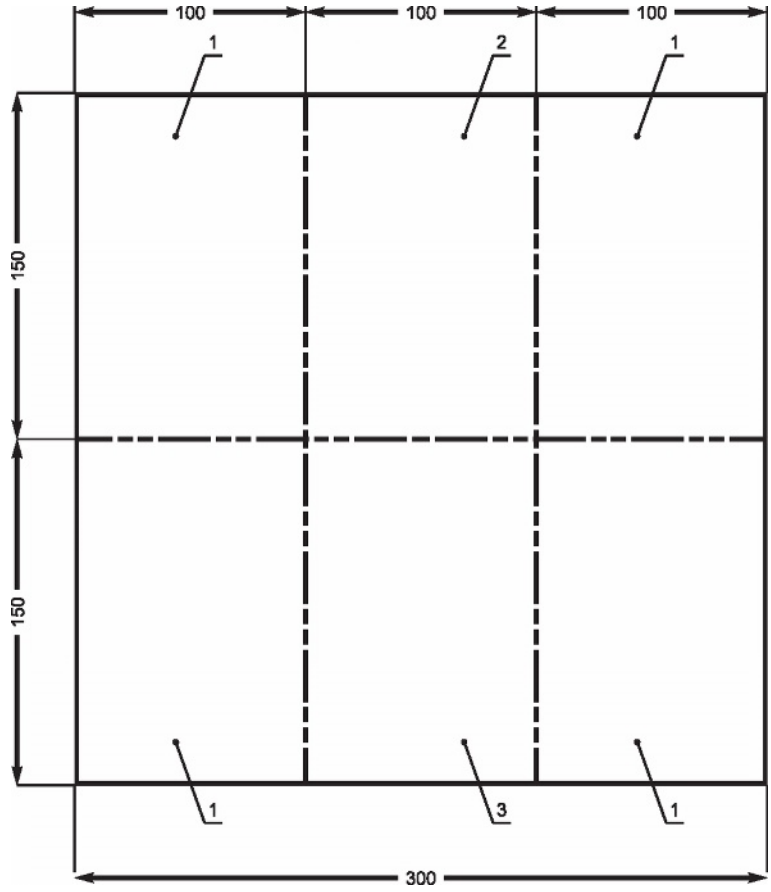
For a glass claimed to have a low emissivity coating the reflectance at 8 µm shall decrease by no more than 0,02.</td></tr>
<tr><td>Acid resistance</td><td>Annex C</td><td>No requirements</td></tr>
<tr><td>Neutral salt spray resistance</td><td>Annex D</td><td>- No defect, as defined in EN 1096-1, greater than 3 mm length
- Maximum one defect between 2 mm and 3 mm length
- Maximum five defects between 1 mm and 2 mm length
In addition, no scratches, staining of the coating or clusters of pinholes greater than 1 mm shall be allowed (see EN 1096-1).
When compared with the reference test piece, in both reflection and transmission, there shall be no significant colour change. This observation shall be made within 20 s[a] .</td></tr>
<tr><td>Abrasion resistance</td><td>Annex E</td><td>No requirement other than to ensure that the abraded area is uniform</td><td>Total (diffuse plus direct) transmittance measured at 550 nm and 900 nm shall differ by no more than ± 0,05 from the corresponding value measured for the reference test piece.</td></tr>
<tr><td colspan="4">[a] The time for observation is fixed to 20 s in order to have a reference period which can influence the visual inspection.</td></tr>
</table>

5 Samples and test pieces

5.1 Preparation

5.1.1 Coated annealed glass

A sample of 300 mm x 300 mm is needed for each test. For the three chemical durability tests, the test pieces are obtained by cutting the sample as shown in Figure 1. The abrasion test is undertaken on a 300 mm x 300 mm test piece. It is recommended that a spare sample be supplied in the event of one sample not being defect free.



Key

1. test pieces
2. reference test piece for visual inspection
3. reference test piece for spectrophotometric measurement

Figure 1 — Plan for cutting a sample into test pieces

5.1.2 Thermally treated coated glass

For the thermally treated coated glass, defined in EN 1096-1:2012, 3.1.8 to 3.1.11, as the test pieces cannot be cut from test samples, a special procedure has to be employed to obtain the test pieces (see Annex A).

5.1.3 Coated toughened or heat strengthened glass

Use coated annealed glass samples for testing this type of coated glass.

5.2 Storage

The test pieces shall be stored inside a room at a temperature of (23 ± 5) °C with a relative humidity less than 80 %. Storage shall prevent dust, chemicals or condensation reacting with the test pieces.

The test pieces shall not be stored for more than three months before performing the test.

5.3 Marking

The test pieces shall be marked on the uncoated glass surface. The following information shall be marked:

— manufacturers' coating reference

— test pieces number 1 to 4

— code for test

Glasses with coating on both surfaces shall be marked without damaging the coating. The two reference test pieces shall be marked as the test pieces plus "ref".

6 Initial evaluation of test pieces

6.1 Preparation

All test pieces shall be cleaned with demineralised water and with a soft tissue. Drying shall also be done with a soft tissue. If necessary this cleaning procedure can be repeated.

6.2 Visual inspection

The test pieces shall be subjected to a visual inspection under an artificial sky in accordance with EN 1096-1. The inspection shall take place in both transmission and reflection.

The test pieces shall be observed at a distance of 600 mm. All test pieces shall be defect free. No scratches or pinholes shall be observed. If a test piece contains defects it shall be replaced.

NOTE The replacement of test pieces is to avoid any misinterpretation of the testing results.

6.3 Spectrophotometric measurements

6.3.1 Coated annealed glass

A measurement sample shall be cut from the centre of the reference test piece. The actual size shall be dependent on the type of equipment being used for the measurements. The transmittance of the measurement sample shall be measured with radiation of normal incidence at the following wavelengths:

— 550 nm (representative wavelength for light and solar transmittance);

— 900 nm (representative wavelength for solar transmittance).

For glass claiming to have a low emissivity coating a measurement of the reflectance shall be made at 8 µm using radiation of nearly normal incidence.

6.3.2 Toughened or heat strengthened coated glass

As the measurement sample cannot be cut from the reference test piece, a special procedure has to be employed to make the measurement (see Annex A).

7 Duration of the tests

The durations of the tests are set out in Table 2.

Table 2 — Duration of the tests

Test	Test duration for class		
	A	B	S
Condensation resistance	21 days	4 days	14 days
Acid resistance	5 cycles	1 cycle	5 cycles
Neutral salt spray	21 days	10 days	[a]
Abrasion resistance	500 strokes	50 strokes	500 strokes

[a] The neutral salt spray test is excluded for Class S coatings as they are subject to frequent cleaning in the applications for which they are used in accordance with EN 1096-1.

8 Test methods

8.1 General

The coated glass complying to this part of the European Standard shall pass the tests given in Annexes B, C, D and E which are designed to verify the chemical and mechanical characteristics of the coating.

The tests are as follows:

— condensation resistance test (see Annex B)

— acid resistance test (see Annex C)

— neutral salt spray test (see Annex D)

— abrasion resistance test (see Annex E)

These tests are evaluated by their effect on the visual quality of the product and its spectrophotometric properties. Whilst it would be feasible to evaluate the spectrophotometric properties across the entire spectrum, a number of representative wavelengths have been selected. These wavelengths represent transmission of light and energy, together with reflectance relating to emissivity, where appropriate.

Each test shall be carried out without interruption. The only exception is the acid resistance test which can be interrupted after each cycle. However, any interruption shall not exceed three days.

Testing shall start as soon as possible after the test pieces have been cleaned. The exception is the abrasion resistance test where testing shall commence within 30 min of the test piece being cleaned.

Care shall be taken to ensure the test pieces are clean and uncontaminated.

8.2 Positioning of test pieces in the test cabinets

The test pieces shall have their coated side oriented upwards, the pieces presenting an angle of (15 ± 5)° with the vertical, and the coated side shall face away from the door.

For consistent results, a certain quantity of glass shall be present. For 300 l cabinet the total weight of the glasses shall be (7,5 ± 0,5) kg. An insufficient quantity of coated glass shall be compensated with uncoated clear glasses.

In the centre of the test pieces a piece of 6 mm clear glass is placed, with the reference thermocouple attached (see Figure 2).

The following spacing shall be maintained:

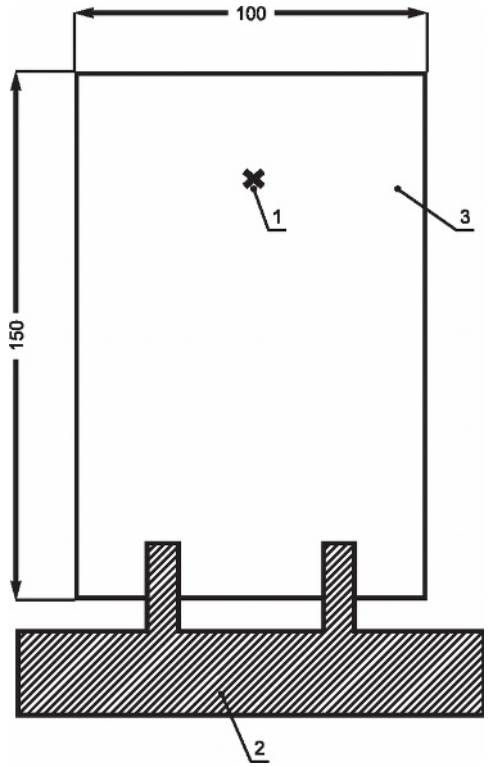
— distance from the walls — not less than 100 mm

— distance between bottom of the test pieces and water — not less than 200 mm

— spacing between adjoining test pieces — not less than 20 mm
not more than 40 mm

Where there is an insufficient quantity of coated glass for testing, it is required to use uncoated clear glasses to fill up a cabinet.

Dimensions in millimetres



Key

1. position of the thermocouple
2. substrate holder
3. 6 mm clear glass used for temperature control inside cabinet

Figure 2 — Description of the reference thermocouple position

9 Final evaluation of test pieces

9.1 General

Test pieces having completed the specified length of time under the test conditions, for the appropriate class, shall be cleaned and if necessary have their surfaces polished before undergoing final evaluation. Dependent on the class, evaluation shall consist of visual inspection and measurement of spectrophotometric properties.

9.2 Cleaning

All test pieces shall be cleaned with demineralised water and with a soft tissue. Drying shall also be done with a soft tissue. If necessary this cleaning procedure can be repeated.

The non-coated surface of the glass might have been damaged during the tests. If this deterioration would affect the evaluation of the degradation of the coated surface it is permissible to polish the non coated surface.

The polishing can be undertaken using fine abrasive powder e.g. cerium oxide and/or alumina. Care shall be taken to ensure that the polishing compound does not contaminate the coated surface.

Coated glasses with coatings on both surfaces shall not be polished.

9.3 Visual Inspection

The test pieces to be examined shall be subjected to a visual inspection under an artificial sky according to EN 1096-1. The examination shall be in both transmission and reflection.

Inspection of the test samples shall be from a distance of 600 mm. A band 15 mm wide around the edge of the test pieces shall be excluded from the inspection. All defects shall be noted.

The requirements for the acceptance of the coated glass related to the different classes are given in Table 1.

9.4 Spectrophotometric measurements

9.4.1 Coated annealed glass

The four test pieces which have been subjected to each chemical durability test (condensation resistance test, acid resistance test, neutral salt spray test) shall be cut so that measurement samples are obtained for the spectrophotometric measurements.

The actual size of the measurement sample shall be dependent on the equipment being used for the measurement. The measurement samples shall be cut from the centre of the test piece.

The test piece which has been subjected to the abrasion resistance test shall be cut so that measurement samples can be obtained for spectrophotometric measurement. The actual size of the measurement samples shall be dependent on the equipment being used for the measurement. The pattern of the cutting of measurement samples is shown in Figure E.2.

The transmittance of the measurement sample shall be determined with radiation of normal incidence of the following wavelengths:

— 550 nm (representative wavelength for light and solar transmittance)

— 900 nm (representative wavelength for solar transmittance)

For glasses claiming to have a low emissivity coating a measurement of the reflectance shall be made at 8 µm with radiation of nearly normal incidence.

The requirements for the acceptance of the coated glass related to the different classes are given in Table 1.

9.4.2 Thermally treated coated glass

For the thermally treated coated glass, defined in EN 1096-1:2012, 3.1.8 to 3.1.11, as the measurement samples cannot be cut from the test pieces a special procedure has to be employed to make the measurements (see Annex A).

10 Test report

The test report shall state the following information:

a) general:

1) reference to this European Standard;

2) identification of the manufacturer;

3) identification of the coating (class and commercial name);

4) type of coated glass;

5) for toughened or heat-strengthened coated glass the method of spectrophotometric measurement;

b) for each test:

1) number of samples tested;

2) test date;

3) results of the initial inspection;

4) results of the final inspection;

5) test results;

6) comments (if any);

c) additional information relating to specific tests:

1) condensation test requiring

— total area of pieces tested at the same time;

— daily temperature (reference thermocouple and room);

— weekly pH;

— observation of water condensation on the reference glass piece (every working day);

2) acid test requiring

— total area of pieces tested at the same time;

— daily temperature in the high temperature phase of the test (reference thermocouple and room);

— pH at the end of the cycle;

— interruption time between cycles;

3) neutral salt spray requiring

— total area of pieces tested at the same time;

— daily temperature (reference thermocouple and room);

4) abrasion test requiring

— uniformity of abraded area;

— number of strokes and frequency of strokes and rotation.

NOTE An example of summary of test report is given in Annex G.

Annex A
(normative)

Special procedures for thermally treated coated glass

A.1 General

This annex applies to the following coated glass types:

— to be toughened;

— toughenable;

— to be heat strengthened;

— heat strengthenable.

A.2 Samples and test pieces for chemical and abrasion tests

A sample of the coated glass representative of the production shall be taken. The test pieces are cut from the sample and shall then be toughened or heat strengthened under the same conditions. The following test pieces are required:

— chemical tests: 18 test pieces: 100 mm wide x the shortest length, not less than 150 mm, which can be manufactured;

— abrasion test: one test piece 300 mm x 300 mm or the nearest size to those which can be manufactured.

A.3 Spectrophotometric measurements

A.3.1 Samples and test pieces for spectrophotometric measurements

For the measurement of the emissivity according to EN 12898, and the radiation properties according to EN 410, small test specimens, not larger than 80 mm x 80 mm, are required.

The manufacture of such small samples of thermally treated coated glass is not always possible on a normal production machine. For thermally toughened glass with a coating, the glass cannot be cut after toughening because it fragments into small particles. However, the tempering process influences the properties of the coating, which develops its final properties only after the tempering process.

NOTE Heat strengthened glass can be measured via island fragments (see A.3.2.3).

A.3.2 Procedures

A.3.2.1 General

Any of the following procedures is suitable for producing test specimens, provided the test specimens are representative of production. It is the responsibility of the manufacturer to select the procedure to be used.

A.3.2.2 Procedure A

Test specimens of approximately 80 mm x 80 mm are manufactured in a laboratory oven (prototype production). The laboratory production parameters shall be traceable to the parameters used in the production line.

NOTE Attention should be given to the relationship of the temperature, time and heat flow to the surface of the coating.

A.3.2.3 Procedure B

The production of test specimens is carried out using the normal series production facility, not as thermally toughened glass, but as heat strengthened glass (the heating process is the same, but the cooling process is different i.e. slower). The test specimen is then broken (shattered) and the measurement is carried out on suitable glass fragments, i.e. islands. When this procedure is used, the manufacturer shall demonstrate that the coating properties and durability are not changed between heat-strengthening / thermally toughening / heat-soaked thermally toughening of the coated glass.

A.3.2.4 Procedure C

Measure the relevant data on large samples from the normal production line, using equipment adapted if necessary for measuring on large samples.

Annex B
(normative)

Determination of the condensation resistance

B.1 General

This test consists of subjecting the coated glass to a water saturated atmosphere at constant temperature. The samples have condensation continually forming on them and it is this condensation that may cause surface degradation.

B.2 Procedure

The four test pieces shall be mounted in a test piece holder and placed in the test cabinet as defined in 8.2.

The water tank shall be filled with demineralised water, having conductivity lower than 30 µS and a pH higher than 5. The internal temperature of the cabinet shall be controlled by means of the reference thermocouple (see Figure 2); keeping a temperature of the reference glass piece of 40°C ± 1,5°C.

The test cabinet shall be in a room with an ambient temperature of (23 ± 3)°C. Care shall be taken to ensure that draughts, dust, moisture and solar radiation do not interfere with the test cabinet.

The reference temperature shall be reached within 2 h of commencing heating. Condensation shall be seen to form on the glass pieces. The test is continued without interruption for the required time. Both the internal reference and the external air temperature shall be regularly checked.

B.3 Test cabinet

A vapour-tight climatic cabinet is essential for a test in a warm and humid atmosphere.

The materials used for the inner walls shall be corrosion-resistant and shall not affect the test pieces.

NOTE 1 Experience has shown that preferable corrosion-resistant materials are stainless steel and glass: they help to maintain pH at a level higher than 5 and do not generate emissions.

The climatic cabinet shall be equipped with a floor which acts as the receptacle for the quantity of water. The test cabinet shall be conditioned only by heating the water on the floor.

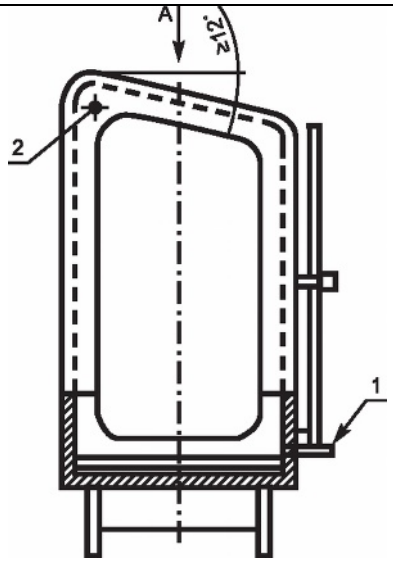
In order to give good reproducibility, the volume of the climatic cabinet shall be 300 l.

The temperature measurement on the central reference glass piece shall control the heating constancy of the bath.

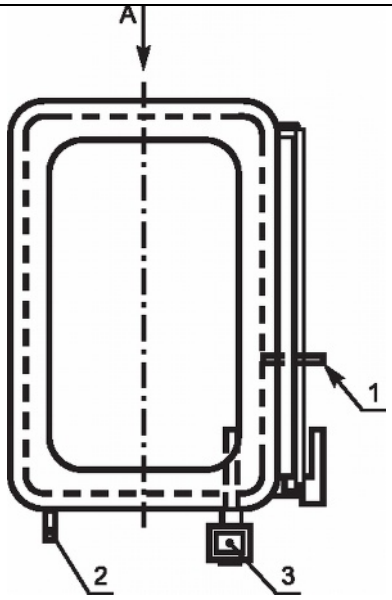
The climatic cabinet shall be provided with a suitable door or other aperture capable of being closed, which allows the test cabinet to be charged with test pieces, to be ventilated and to be visually observed.

An example of a cabinet device is shown in Figure B.1.

NOTE 2 Condensation on the cover should not generate drips on the glass pieces, nor on the objects present in the cabinet.



Side view



Key

1. vacuum relief valve and gas inlet nozzle
2. pressure relief valve
3. temperature control device

Figure B.1 — Typical test cabinet

Annex C
(normative)

Determination of the resistance to acid

C.1 General

This test consists of subjecting the coated glass to a sulphur dioxide saturated atmosphere at constant temperature. The samples shall have condensation continually forming on them. It is this condensation together with the quantity of sulphur dioxide that may cause surface degradation.

C.2 Procedure

The four test pieces shall be mounted in a test piece holder and placed in the test cabinet as defined in 8.2.

The test cabinet contains 2 l of demineralised water having conductivity lower than 30 µS.

When the cabinet is closed 0,2 l of SO_2 shall be added and the heating system switched on.

The test consists of a repetition of 24 h cycles.

Each cycle consists of high temperature plus condensation period and an ambient temperature without condensation period.

The details of the cycle are shown in Figure C.1.

The temperature shall be controlled by means of the reference thermocouple (see Figure 2).

The temperature shall increase to 40°C ± 1,5°C in less than 1,5 h. During the next 6,5 h the test pieces shall be subjected to condensation in the SO_2 atmosphere. After the high temperature period the heating system is switched off and the cabinet is ventilated.

The temperature should drop to ambient temperature within 1,5 h of the heater being switched off.

When the SO_2 atmosphere is being ventilated the cabinet shall be placed in a fume cupboard or a suitable extraction system shall be installed.

The cabinet shall be prepared before each cycle.

C.3 Test cabinet

A vapour-tight climatic cabinet is essential for a test in a warm and humid acidic atmosphere. The material used for the inner walls shall be corrosion-resistant and shall not affect the test pieces.

The climatic cabinet shall be equipped with a floor which acts as the receptacle for the quantity of water. The test cabinet shall be conditioned only by heating the water on the floor.

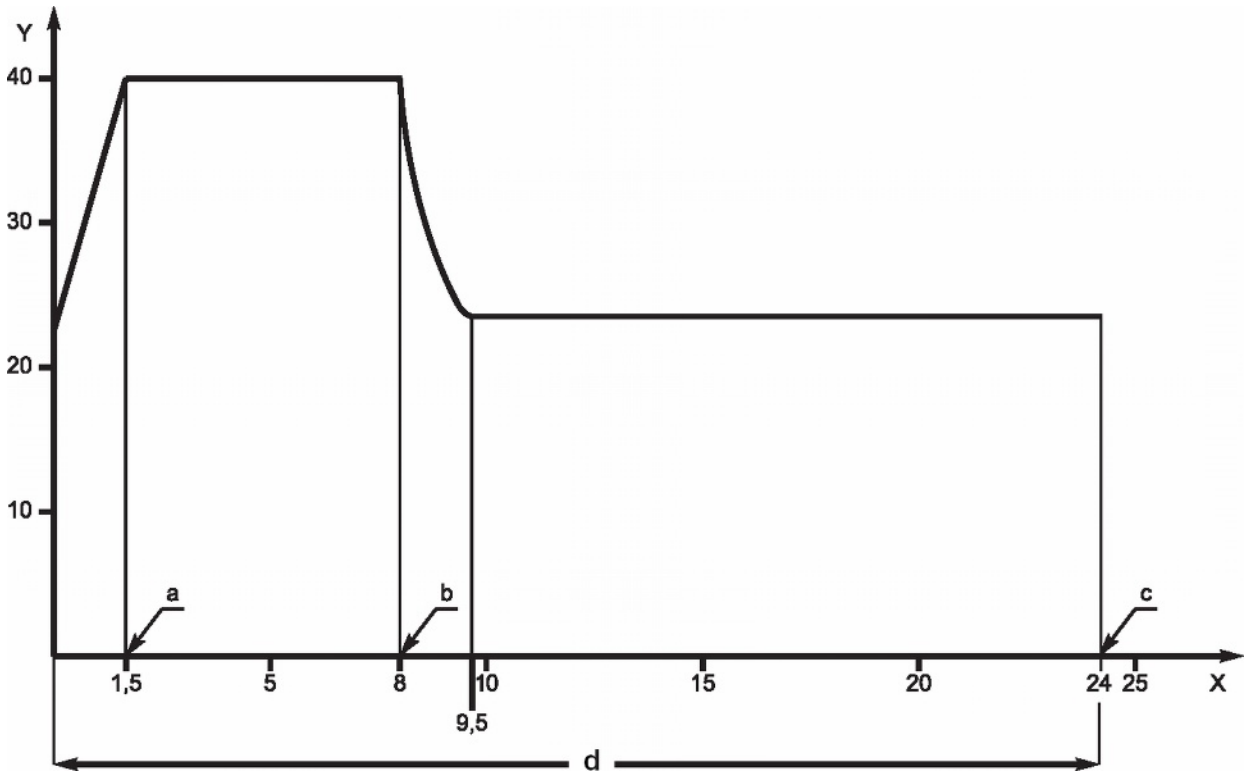
In order to give good reproducibility, the volume of the climatic cabinet shall be 300 l.

The temperature measurement on the central reference glass piece shall control the heating constancy of the bath.

The climatic cabinet shall be provided with a suitable door or other aperture capable of being closed, which allows the test cabinet to be charged with test pieces, to be ventilated and to be visually observed.

An example of a cabinet device is shown in Figure B.1.

NOTE condensation on the cover should not generate drips on the glass pieces, nor on the objects present in the cabinet.



Key

x. time (h)

y. temperature (°C)

a. maximum time to reach 40°C

b. cessation of heating the cabinet and ventilation of the cabinet

c. solution removal rinsing of cabinet

d. 1 cycle (24 hours)

Figure C.1 — Temperature cycle for acid resistance test

Annex D
(normative)

Determination of the resistance to neutral salt spray

D.1 General

This test consists of subjecting the coated glass to neutral, water saline atmosphere at constant temperature. It is the water saline spray that may cause surface degradation.

All components in contact with the spray or the test solution shall be made of materials resistant to corrosion by the sprayed solution and which do not influence the corrosivity of the sprayed test solutions.

The four test pieces shall be mounted in a rack which is supported by two collectors and placed in the test cabinet as defined in 8.2.

D.2 Apparatus

The apparatus shall include the following components:

D.2.1 Spray cabinet

Cabinet volume shall not be less than 0,4 m^3. Care should be taken to ensure homogeneous distribution of the sprayed solution. Design of the cabinet shall be so that drops of sprayed solution formed on its surfaces shall not fall on the test pieces being tested. The level of the salt solution in the salt reservoir shall be automatically maintained to ensure uniform spray delivery throughout test. A description of a typical spray cabinet is shown in EN ISO 9227:2006, Annex A.

The test cabinet shall be prepared and run for a minimum period of 24 h before the test pieces are placed within it. The neutral salt solution is made up by dissolving NaCl, in demineralised water having conductivity lower than 30 µS, to produce a concentration of 50 g/l ± 5 g/l at 25 °C ± 2 °C.

D.2.2 Heater and temperature control

An appropriate system maintains the cabinet and its components at a specified temperature. The temperature shall be measured at least at a distance of 100 mm from any wall.

D.2.3 Spraying device

The device for spraying the salt solution comprises a clean air supply, of controlled pressure and humidity, a reservoir to contain the solution to be sprayed, and one or more spray nozzle.

The compressed air supplied to the spray nozzle shall be passed through a filter to remove all traces of oil or solid matter and shall be at an absolute pressure of 70 kPa to 170 kPa through a saturator at 40 °C ± 1,5 °C. The spray nozzle shall be made of inert material, with baffles to prevent direct impact of spray on the test pieces.

Annex E
(normative)

Determination of resistance to abrasion

E.1 General

This test consists of subjecting the coated surface of the coated glass to rubbing with a felt pad in dry conditions. It is the type of pad, the loading on it and the number of strokes that may cause surface degradation.

E.2 Apparatus

E.2.1 General

The test equipment[1)] consists of the following:

— a rotating wheel,

— a metal finger,

— felt pad holder and rotation device,

— test piece support.

The equipment is shown in Figure E.1.

E.2.2 Metal finger

The metal finger shall be approximately 15 mm to 20 mm in diameter and shall be driven so as to produce a frequency of 60 strokes/min ± 6 strokes/min alternating forwards and backwards. The stroke length shall be 120 mm ± 5 mm. The strokes shall be parallel and ensure a constant pressure over the zone to be tested.

E.2.3 Abrasive felt

The abrasive felt pad shall have the following characteristics:

— a density of 0,52 g/cm^2 ± 0,052 g/cm^2 ;

— a thickness of 10 mm ± 1 mm ;

— a circle shape with a diameter of 14,5 mm ± 0,5 mm ;

1) The abrasion tester can be obtain from Voortman Steuerungstechnik, Voortman GmbH, Postfach 1143 . 47635 Issum, Germany. This information is given for the convenience of users of the standard and does not constitute an endorsement by CEN of the product named. Equivalent products may be used if they are shown to lead to the same results.

— and is cut or punched in such a way that the intersections of the abrasion surface and the edges are perpendicular.

The pad is fixed to the metal finger. The felt pad shall rotate continuously at 6 r/min or it shall rotate by an angle of between 10° and 30° at the end of each stroke.

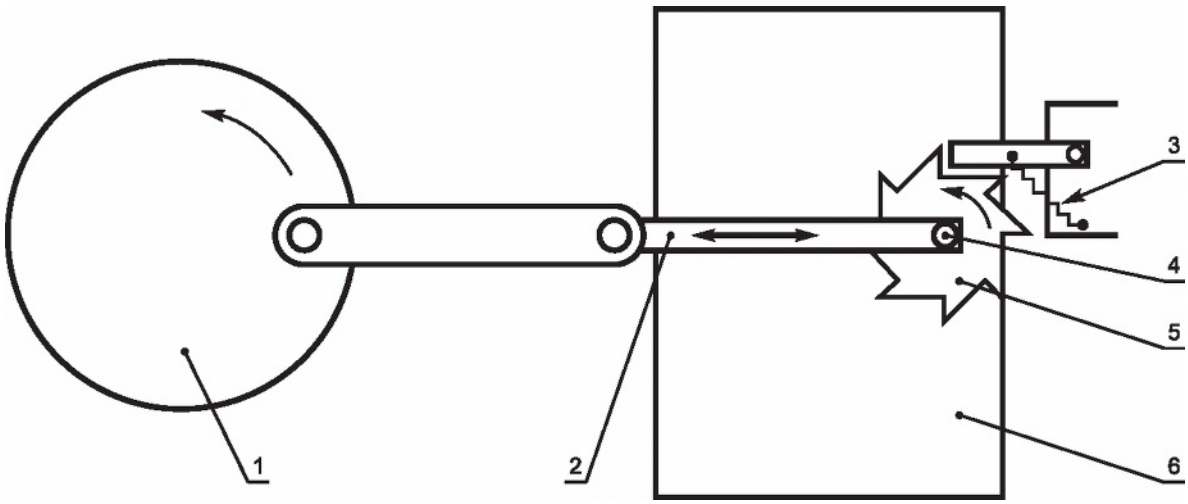
E.3 Test piece

The test piece shall be cleaned in accordance with 6.1 prior to commencement of the test. The test sequence shall commence within 30 min of the sample being cleaned.

E.4 Test procedure

The test piece shall be mounted in the equipment in such a way that movement is not possible. The metal finger containing the felt pad shall be lowered on to the glass surface and a load of 4 N applied perpendicular to the glass surface via the felt pad.

The appropriate number of strokes, as given in Table 2, shall be applied. A minimum of four tests shall be done on the sample (see Figure E.2). Each test shall be done using a fresh felt pad.

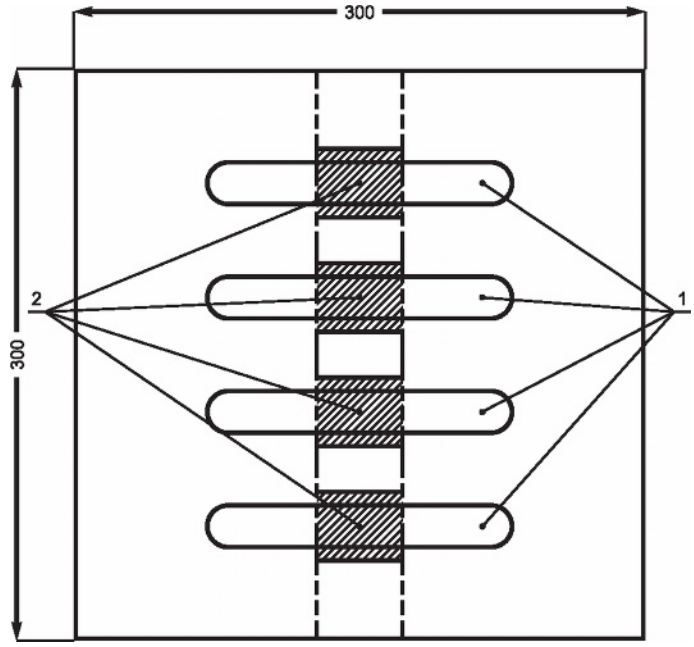


Key

1. rotating wheel
2. finger
3. spring
4. felt
5. felt rotating wheel
6. glass specimen

Figure E.1 — An illustration of a principle of an abrasion equipment

Dimensions in millimetres



Key

1. typical wear tracks
2. areas from which the four samples, to be submitted to spectrophotometric measurements shall be cut

Figure E.2 — Tracks of abrasion on the sample

Annex F
(normative)

Criteria to demonstrate equivalence of coatings

F.1 General

The manufacturer can demonstrate that class A, B and S coatings are insensitive or negligibly sensitive to attack by simulated natural weathering conditions as well as to abrasion using the tests according to this standard.

The manufacturer may also demonstrate that these coatings can be approved without testing using the following criteria.

F.2 Composition of coatings

The manufacturer shall provide a list of the layers forming the coating. For each individual layer such list shall report either the full definition or the manufacturer's internal code. A given layer is defined by its deposition technique.

F.3 Previous test reports

The manufacturer shall provide copies of all test reports relating to coated glasses tested in accordance with this European Standard.

F.4 Evaluation

Pairs of adjacent layers obtained with the same deposition technique and previously tested can be accepted. Therefore they do not have to be retested.

Layers or pairs of adjacent layers either obtained with different deposition technique and/or not previously tested can not be accepted. Therefore they will have to be tested according to this standard.

F.5 Examples

The manufacturer has submitted for evaluation three coatings that may meet the standard without testing. The following information has been submitted:

1) Composition of coatings

Coating I	[glass] - [layer 1-layer 2-layer 3] - [atmosphere]
Coating II	[glass] - [layer 4-layer 2-layer 1] - [atmosphere]
Coating III	[glass] – [layer 1-layer 2-layer 4] – [atmosphere]

NOTE The numbers identify a given type of layer, the position is defined by the order in which numbers are reported. Atmosphere can be air, argon or any other fill gases.

2) Available test reports:

report 1 [glass] - [layer 1-layer 2-layer 1] - [atmosphere]

report 2 [glass] - [layer 4-layer 2-layer 3] - [atmosphere]

3) Evaluation

One may conclude:

Coating I Accepted because of

- [glass] – [layer 1 - layer 2 ...] accepted (report 1)
- [... layer 2 - layer 3] - [atmosphere] accepted (report 2)

Coating II Accepted because of

- [glass] – [layer 4 - layer 2 ...] accepted (report 2)
- [... layer 2 - layer 1] - [atmosphere] accepted (report 1)

Coating III Not acceptable because of

- [glass] – [layer 1 – layer 2 ,,,] accepted (report 1)
- [,,, layer 2 – layer 4] – [atmosphere] not accepted (no report)

Annex G
(informative)

Summary of test report

It is recommended that the test report includes the following summary.

Name of test house, its address and eventually logo.

For conformity purposes: Public part
Summary of report n°..... Date: .....
Coated glass - A, B and S coatings - Durability according to EN 1096-2
For details, see the test report

Company: Name: .....
Address: .....
.....

Name of the coating: ..... Thermal treatment (when applicable)……..

Coating:	A	B	S	(delete whichever is not applicable)
Low emissivity coating:	YES	NO		(delete whichever is not applicable)

Photometric measurements	Reference test piece (1)	Exposed test piece (2)	Difference (3)=(1) - (2)	Difference limit value
Condensation resistance				
- transmittance at 550 nm				± 0,03
- transmittance at 900 nm				± 0,03
- reflectance at 8 µm (low e glass)				≤ 0,02
Acid resistance				
- transmittance at 550 nm				± 0,03
- transmittance at 900 nm				± 0,03
- reflectance at 8 µm (low e glass)				≤ 0,02
Neutral salt spray resistance				
- transmittance at 550 nm				± 0,03
- transmittance at 900 nm				± 0,03
- reflectance at 8 µm (low e glass)				≤ 0,02
Abrasion resistance				
- transmittance at 550 nm				± 0,05
- transmittance at 900 nm				± 0,05

Visual inspection: Deviations caused by

- condensation resistance	NONE	YES	(delete whichever is not applicable)
- neutral salt spray	NONE	YES	(delete whichever is not applicable)

When YES, use a separate sheet for the description
Overall comments: When applicable, use a separate sheet.
Conclusion of the photometric measures:

The results conform to the criteria:	YES	NO	(delete whichever is not applicable)

.....
Name and signature

Name of test house, its address and eventually logo.

For conformity purposes: Confidential part
Summary of report n°..... Date: .....
Coated glass - A, B and S coatings - Durability according to EN 1096-2
For details, see the test report

Company: Name: .....
Address: .....
.....

Name of the coating: .....

Layer specification:
(the layers may be indicated by full name composition or by a manufacturer's code)

Number of layer	Composition or code	Additional information
1 (base layer on glass)		
2		
3		
4		
5		
6		

Further information when relevant:

Bibliography

[1] EN ISO 9227:2006, *Corrosion test in artificial atmospheres — salt spray tests (ISO 9227:2006)*

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