INTERNATIONAL STANDARD

ISO 20492-4

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Glass in buildings — Insulating glass —

Part 4: Methods of test for the physical attributes of edge seals

Verre dans la construction — Verre isolant —

Partie 4: Méthodes d'essai pour les caractéristiques physiques des joints d'assemblage

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Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

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 20492-4 was prepared by Technical Committee ISO/TC 160, *Glass in building*, Subcommittee SC 1, *Product considerations*.

ISO 20492 consists of the following parts, under the general title *Glass in buildings — Insulating glass*:

— *Part 1: Durability of edge seals by climate tests*

— *Part 2: Chemical fogging tests*

— *Part 3: Gas concentration and gas leakage*

— *Part 4: Methods of test for the physical attributes of edge seals*

Introduction

This International Standard consists of a series of procedures for testing the performance of pre-assembled, permanently sealed insulating glass units or insulating glass units with capillary tubes that have been intentionally left open. This International Standard is intended to help ensure that

— energy savings are made, as the U value and solar factor (solar heat gain coefficient) do not change significantly;

— health is preserved, because sound reduction and vision do not change significantly;

— safety is provided because mechanical resistance does not change significantly.

This International Standard also covers additional characteristics that are important to the trade, and marking of the product (i.e. CE marking or other regulatory groups).

There are distinct markets to consider for insulating glass. Within each market there are technical differences with respect to rebate sizes, vision lines and methods of application; two approaches are included in this International Standard. Approach 1 addresses requirements for markets such as North America. Approach 2 addresses requirements for markets such as Europe. Each approach includes separate test methods and specifications pertaining to minimum requirements for durability of edge seals by climate tests.

This International Standard does not cover physical requirements of sealed glass insulating units such as appearance, thermo-physical properties, heat and light transmission, and glass displacement.

The main intended uses of the insulating glass units are installations in buildings and constructions such as in windows, doors, curtain walling, skylights, roofs and partitions where protection against direct ultraviolet radiation exists at the edges.

The use of insulating glass in cases where there is no protection against direct ultraviolet radiation at the edges, such as structural glazing systems, can be suitable. However, it can be necessary to review factors such as sealant longevity when exposed to long-term ultraviolet light and the structural properties of the sealant for these applications.

NOTE 1 For more information on the requirements for structural sealant glazing applications, reference can be made to ASTM C1369, ASTM C1249 and ASTM C1265 and CEN technical specifications.

NOTE 2 IG units whose function is artistic only are not part of this International Standard.

The test methods in this International Standard are intended to provide a means for testing the performance of the sealing system and construction of sealed insulating glass units.

Sealed insulating glass units tested in accordance with these methods are not intended for long-term immersion in water.

The options for testing apply only to sealed insulating glass units that are constructed with glass.

In certain cases such as insulating glass units containing spandrel glass or absorptive coatings, these methods might not be applicable, as these products can experience field temperatures that exceed the temperature limitations of the sealant.

Glass in buildings — Insulating glass —

Part 4:
Methods of test for the physical attributes of edge seals

1 Scope

This part of ISO 20492 specifies methods for testing the edge seal strength, and partially testing the moisture and gas permeation through sealants, of glass insulating units. Other parts of ISO 20492 designate two approaches to the standardization of insulating glass units: approach 1 is intended for use in markets such as North America; and approach 2 is intended for use in markets such as Europe.

The methods in this part of ISO 20492 are applicable only to approach 2, as defined and used in the other parts of ISO 20492.

In cases where there is no protection against direct ultraviolet radiation at the edges, such as structural sealant glazing systems, it is necessary that additional European technical specifications be followed. See References [4] and [5].

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 20492-1, *Glass in building — Insulating glass — Part 1: Durability of edge seals by climate tests*

ISO 20492-3, *Glass in building — Insulating glass — Part 3: Gas concentration and gas leakage*

ISO 9050, *Glass in building — Determination of light transmittance, solar direct transmittance, total solar energy transmittance, ultraviolet transmittance and related glazing factors*

EN 1096 (all parts), *Glass in building — Coated glass*

3 Terms, definitions and symbols

3.1 Terms and definitions

For the purpose of this document, the terms and definitions given in ISO 20492-1 and the following apply.

3.1.1
moisture vapour transmission rate
steady moisture vapour flow in unit time through unit area of a body, normal to specific parallel surfaces, under specific conditions of temperature and humidity at each surface

3.1.2
standard room conditions
ambient temperature of (23 ± 2) °C and a relative humidity of (50 ± 5) % relative humidity

3.2 Symbols

For the purpose of this document, the symbols given in ISO 20492-1 and the following apply.

ε extension of bond expressed as a percent

σ stress applied to the bond during extension

θ moisture vapour transmission rate

ΔP_{H_2O} difference in water vapour pressure across a membrane

4 Requirements

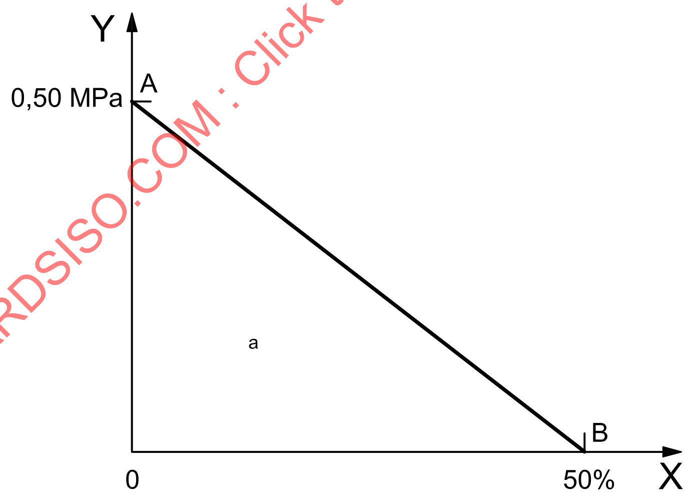
4.1 Edge seal strength

All edge seals shall have sufficient adhesive and cohesive strength to allow the extension of seals such that any rupture of the seal occurs outside the area 0AB of Figure 1.

If, during the strength test of the glass-sealant-glass joint, as seen from the side view, loss of adhesion or cohesion extends through the whole depth of the sealant within the area 0AB of Figure 1, then the sealant test specimen has failed (see Figure 2). The principle of light transmission through the defect can be applied to determine pass or failure.

Breakage of the glass during testing does not constitute failure, providing that a sufficient number of joints is tested in order that a successful average result can be obtained.

For comparisons of the seal strength required for substituting sealants, see Annex B.



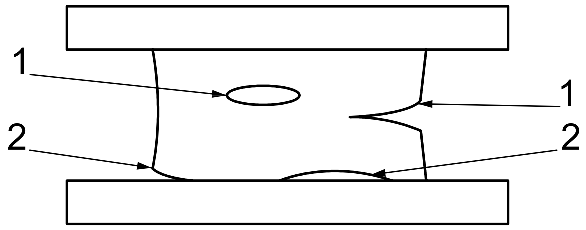
Key

X strain in the sealant, ε

Y stress in the sealant, σ

[a] No breakage is allowed before and after ageing in area 0AB.

Figure 1 — Stress/strain triangle



Key

1 loss of cohesion

2 loss of adhesion

Figure 2 — Illustration of the extension of loss of adhesion or cohesion through the whole depth

4.2 Compliance with the definition of insulating glass units

4.2.1 General

A test report shall be available of the concerned insulating glass outer sealant according to Clause 6 (which summarizes the test report in which the edge seal strength is recorded) with a moisture penetration test report in accordance with ISO 20492-1 and, in case of gas-filled units, also with a gas leakage rate report in accordance with ISO 20492-3, and fulfils the requirement to demonstrate the conformity with the definition of insulating glass units.

In the case of sealing the insulating glass unit with a coating that is not intended to be stripped in accordance with EN 1096 (all parts), a test report in accordance with Annex D shall be made available for inclusion in with the other test reports.

NOTE Although only clear float glass is referred to in this part of ISO 10492, it is the responsibility of the insulating glass manufacturer to ensure that the edge sealant is capable of bonding to all glasses that are used. The requirements for the use of coated glasses in accordance with EN 1096 (all parts) are detailed in Annex D.

4.2.2 Possibility to substitute the sealant

4.2.2.1 Limits of application

The possibility of substituting for the sealant is applicable only in the case of insulating glass units with a hollow metal spacer. For other systems, no experience is available for setting up the substitution rules.

4.2.2.2 Air-filled insulating glass units

Available test reports in accordance with Clause 6 allow for the substitution of the sealant without repeated moisture penetration testing in accordance with ISO 20492-1 in the following cases.

a) For units with an I value below 0,1, the substituting sealant

— shall be applicable with the same production equipment,

— has been previously applied in insulating glass units that have been demonstrated to comply with ISO 20492-1; the demonstrated compliance may have been obtained separately using units of different construction and, therefore, the test report numbers may vary,

— has a moisture vapour transmission rate that is not more than 20 % higher than that of the initial sealant,

— has a stress/strain curve comparison that satisfies the requirement in Annex B,

— shall have the relevant parts of the factory production control (periodic test, mixing ratio, hardness test, etc.) carried out.

b) For units with an I value between 0,1 and 0,2, the list under a) applies however with the exception that the moisture vapour transmission rate through membrane of the substitute sealant shall be the same or lower than the initial sealant.

4.2.2.3 Gas-filled insulating glass units

Available test reports in accordance with Clause 6 allow the substitution of the sealant without repeated gas loss rate testing according to ISO 20492-3 in the following cases.

a) For units with a gas loss rate, L_i, below 0,8 % a^{-1}, the substituting sealant

— is allowed for limiting the moisture vapour penetration in accordance with 4.2.2.2,

— has been previously applied in insulating glass units that have been demonstrated to comply with ISO 20492-3; the demonstrated compliance may have been obtained separately using units of different construction and, therefore, the test report numbers may vary,

— has a gas permeation that is not more than 20 % higher than that of the initial sealant.

For units with a gas loss rate, L_i, between 0,8 % a^{-1} and 1,0 % a^{-1}, the list under a) applies, however with the exception that the gas permeation of the substitute sealant shall be the same or lower than the initial sealant.

4.2.3 Possibility of substitute the coated glass, coatings not intended to be removed

Available test reports in accordance with Annex D allow for the substitution of the coated glasses in accordance with EN 1096 (all parts) when the coating is not intended to be stripped from the area where the insulating glass is sealed without repeated moisture penetration testing according to ISO 20492-1 and, in case of gas-filled units, without repeated gas loss rate testing in accordance with ISO 20492-3, when the provisions set out in Annex D are followed.

5 Test methods

5.1 Adhesion

5.1.1 Principle

The test consists of preparing a number of glass-sealant-glass joints, some of which are unaged and some are subjecting to ageing regimes as outlined in 5.1.3 before testing under tensile load.

The test specimen shapes and bond preparations shall be as specified in Annex A. For insulating glass units with systems that cannot apply Annex A, the test specimen shall be 50 mm cut from the edge seal of an insulating glass unit. The shape of the samples shall be as similar as possible. Their cross-sections shall have a cross-section as near as possible to the test specimen described in Annex A. The number of joints is seven per exposure condition.

After manufacturing, ageing where relevant and conditioning for 24 h to 48 h at standard room conditions, the test specimens shall be measured accurately for width, depth and height prior to being placed in an extensiometer with an accuracy equal to or better than 2 %.

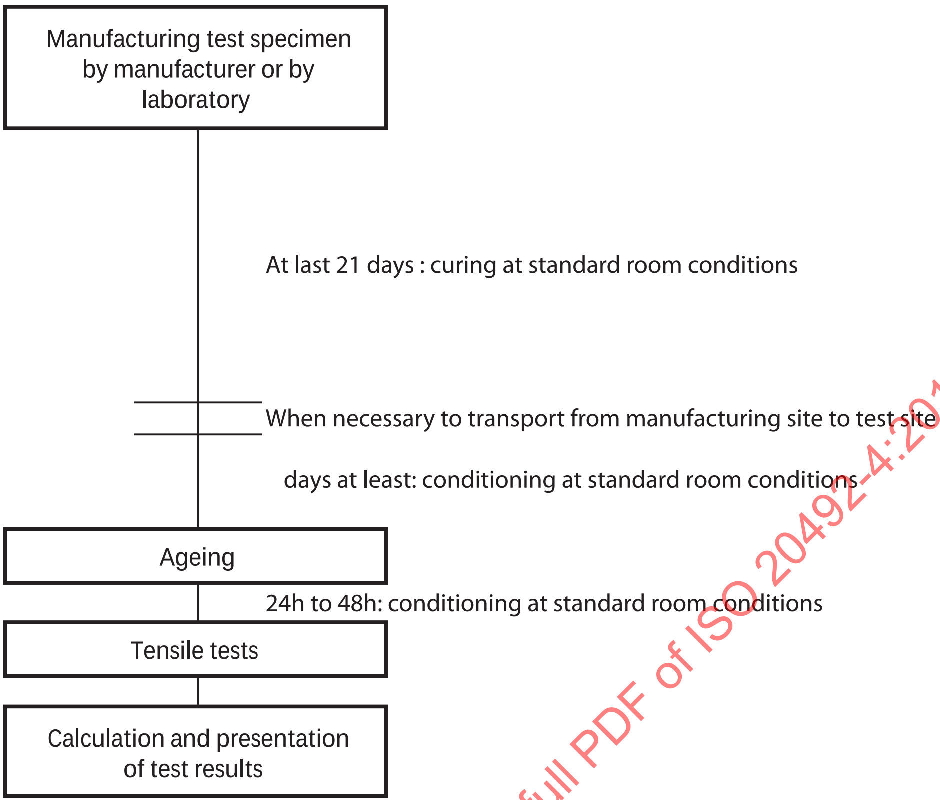


Figure 3 — Schematic presentation of test order for adhesion — Flow from top to bottom

The speed of separation is in case of polymer-based edge sealants (5 ± 0,25) mm/min, and in case of metallic edge seals (12,5 ± 0,5) mm/min. See Figure 3 for the schematic presentation of the order of the preparation and tests.

Where the glass continuously breaks, a bond stiffener can be bonded to the glass immediately prior to testing but after ageing. Stiffening can be accomplished by the addition of a second piece of glass or other material bonded, for example, with a cyanoacrylate adhesive.

5.1.2 Calculation of stress and expression of results

The stresses are calculated from the mean of the contact areas between the sealant and the glass in one test specimen. In case of metal seal, the contact area is fixed on 100 mm^2 (see Figure A.2).

The results are expressed as the average values of the stress and strain when the stress/strain curves cross the line AB of Figure 1. The highest and lowest values are ignored so that the average values are calculated on the five remaining measured stress and strain values.

5.1.3 Procedures

5.1.3.1 Initial cure test

After initial cure (see Annex A) and conditioning at standard room conditions of at least seven days, seven test specimens not subjected to any ageing regime are subjected to tensile load.

5.1.3.2 Heat exposure

After initial cure and conditioning at standard room conditions of at least seven days, the seven test specimens for heat ageing shall be aged in a closed oven at (60 ± 2) °C for (168 ± 5) h. Where the sealant shows plastic flow at 60 °C, the spacers shall be retained between the two glass pieces to prevent bond deformation.

5.1.3.3 Water immersion

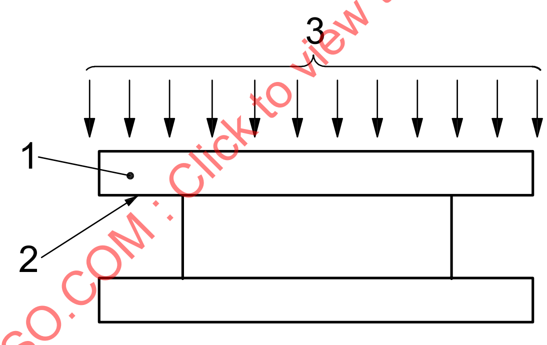
After initial cure and conditioning at standard room conditions of at least seven days, all seven test specimens for water immersion shall be immersed in 1 l to 2 l of distilled or deionized water for (168 ± 5) h, at standard room condition. Fresh new water shall be used for each test. The conductance of the fresh water shall be equal to or less than 30 µS.

5.1.3.4 UV exposure

After initial cure and conditioning at standard room conditions of at least seven days, seven test specimens for UV exposure shall be subject (96 ± 4) h to UV irradiation, which shall be perpendicular to the glass at an intensity in the UVA range in accordance with ISO 9050 of (40 ± 5) W/m^2. Refer to Figure 3 for the radiation orientation and to Annex F for an example of a UV radiation source.

The height of the UV source shall be adjusted to ensure all joint assemblies are subjected to the minimum intensity.

The irradiation intensity shall be measured at the beginning and end of each test. When the minimum irradiation can no longer be achieved, a new UV source shall be installed.



Key

1 clear float glass

2 tested surface, which can be coated

3 ultraviolet radiation

Figure 4 — Orientation of the surface being tested to the ultraviolet radiation

5.2 Moisture vapour transmission rate

5.2.1 General

The information on the moisture vapour transmission rate is requested only when sealant comparisons are made for the purpose of change.

5.2.2 Principle

The moisture vapour transmission rate, θ, when determined, shall be measured on a 2 mm thick film as outlined in 5.2.3.

5.2.3 Procedure

5.2.3.1 Film preparation

It is advisable to prepare films from the dispensing machines used by the insulating glass unit manufacturer. Hand mixing or small-scale heating, where appropriate, can give erratic results.

5.2.3.2 Applicable tests

There is a wide variety of tests for moisture vapour transmission rates. They vary by film thickness, ΔP_{H_2O} across the film and temperature of test.

For comparison, the method defined in the Annex C shall be used with the following criteria.

— Film thickness shall be (2 ± 0,1) mm.

— Test temperature shall be (23 ± 1) °C.

— ΔP_{H_2O} shall be from equal or less than 5 % (desiccant) to equal or more than 90 % relative humidity (test chamber) across the membrane.

5.3 Gas permeation test on film

5.3.1 General

The information on the gas permeation is requested only when sealant comparisons are made for the purpose of change.

5.3.2 Principle

This test is not relevant where the sealant manufacturer clearly states that the sealant is not intended for use in gas-filled insulating glass units.

The gas permeation rate, when determined, shall be measured on a 2 mm thick film as outlined in 5.3.3.

5.3.3 Procedures

The gas permeation test shall be carried out using similar apparatus and the same test conditions as those specified in ISO 20492-3. A gas cell shall be introduced in place of the test unit in the line using the film as a membrane. Argon gas shall be used as a test gas. A pressure not exceeding 10 mbar shall be applied to the test gas side of the film. Helium gas shall be used as carrier gas.

The area shall be recorded and shall not be less than 10 cm^2. The shape can be circular as well as square, and shall be recorded. The value of the gas permeation, expressed in grams per square metre per hour, through the film shall be determined when a steady state condition is achieved.

6 Test report

The test report shall evaluate the test in detail and shall include the information shown in Figure 5.

Name of the test house, its address and logo

Summary of report No. .... Date ....

Insulating glass — Seal properties results in accordance with ISO 20492-4

For details, see the test report

Company: Name: ....

Address: ....

....

....

Plant: Name: ....

Address: ....

....

....

Sealant specification: ....

Sealant in IGU positively tested in accordance with ISO 20492-1, report No.: ....

Glass specification when float glass is not used: ....

Seal strength test	At intersection with line A-B *(ISO 20492-4, Figure 1)*:		Type of failure observed *(if any)*				
Adhesion:	Average stress σ_{av} in MPa	Average extension ε_{av} in %	C = cohesive			A = adhesive	
			1	2	3	4	5
Initial cure							
After water immersion							
After heating 60 °C							
After UV radiation							

NOTE It is recommended to include the stress/strain curves (informative test E.1) with this report.

Figure 5 (*continued*)

Moisture vapour transmission rate (*when applicable for substituting sealant*):

Film thickness .... mm

ΔP_{H_2O} .... % relative humidity difference across the membrane

Temperature .... °C

θ .... grams per $H_2O \cdot m^{-2}$ per 24 h

Gas permeation rate (*when applicable for substituting sealant and when sealant serves for gas-filled insulating glass units*):

Film thickness .... mm

Surface: .... m^2 - Shape: circular/square (*delete whichever is not applicable*)

Permeation rate: .... $g \cdot m^{-2} \cdot h^{-1}$

Overall comments (*when applicable, use a separate sheet*):

Conclusion of seal strength test:

The sealant conforms to the test criteria: YES NO (*delete whichever is not applicable*)

....

Name and signature

Figure 5 — Test report for the physical attributes of edge seals

Annex A
(normative)

Test specimens for adhesion test

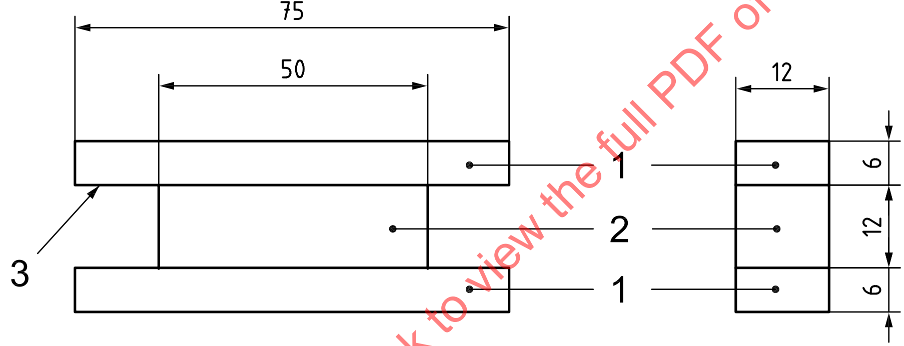
A.1 Polymer based edge sealants

The test specimens consist of preparing a number of glass-sealant-glass joints (see Figure A.1) as follows:

— glass size: 75 mm × 12 mm × 6 mm;

— sealant size: 50 mm × 12 mm × 12 mm.

Dimensions in millimetres
Tolerances on the dimensions of the sealant ±1 mm



Key

1 glass

2 sealant

3 face that may be coated

Figure A.1 — A polymer-based edge sealant test specimen

After the glass is cut to the desired dimensions, it should be thoroughly cleaned and dried before being used in the test specimen. The cleaning process can be similar to that used by the insulating glass manufacturer and, when necessary precautions are taken, the bonds may be prepared in the factory of the insulating glass unit manufacturer.

Other cleaning processes are allowed providing that the process does not interfere with the adhesive qualities of the sealant either positively or negatively, by chemically modifying the glass surface.

After cleaning the glass, the test specimen shall be prepared from freshly mixed (in case of two part sealant) or freshly opened sealant. The sealant shall be prepared according to the manufacturer's instructions. For two-part systems, the mix ratio shall be within the limit ±5 % of the absolute value specified.

The pieces of glass 75 mm × 12 mm × 6 mm shall be so arranged as to form a cavity 50 mm × 12 mm × 12 mm between two parallel surfaces. Larger pieces of glass may be used if this aids the production of the test samples, but the cavity shall still be the size 50 mm × 12 mm × 12 mm. Gunnable seal shall be extruded into the cavity and struck off smoothly to form a bond of desired dimensions. See Figure A.1. Polyethylene or other non-adhesive mould pieces may be used to ensure the correct joint dimensions, but at least one 50 mm × 12 mm sealant surface shall be exposed to the atmosphere during initial curing.

For pre-extruded sealants, a length of 50 mm is applied on one piece of glass. The second piece of glass is compressed onto the sealant according to the sealant manufacturer's instructions. Sealant height should be preferably 12 mm.

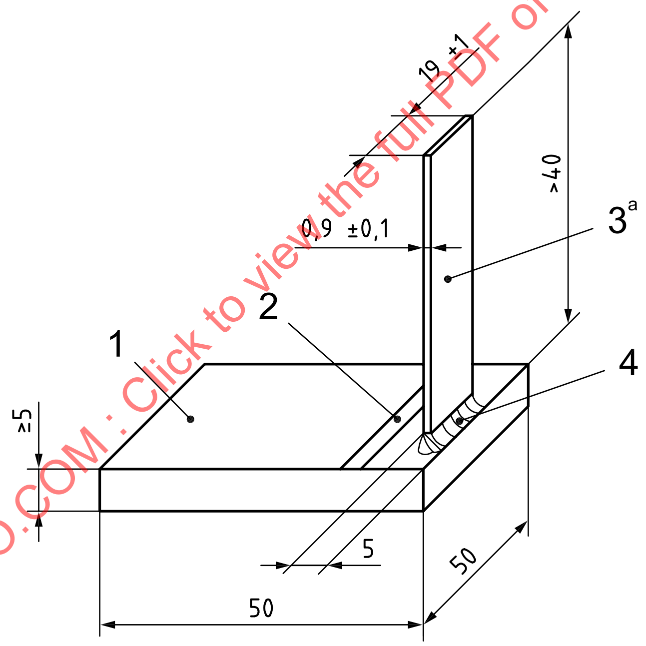
In the case of polymer-based edge sealants, condition all prepared glass-sealant-glass joints at standard room conditions for not less than 21 days (initial cure).

A.2 Metallic edge seals

A piece of glass 5 mm thick containing one or more edges with a metallic deposit in accordance with the specified type of insulating glass unit, is cut into pieces of 50 mm × 50 mm, with each piece containing an edge with metallic deposit.

A lead tape long enough to allow clamping in the tensiometer, (19 ± 1) mm wide and (0,9 ± 0,1) mm thick, is soldered on the metal deposit as indicated in Figure A.2. The soldering is as applied in manufacturing the insulating glass unit type. The lead tape strength shall be equal to or greater than 3 MPa.

Dimensions in millimetres



Key

1 clear float glass

2 metallic deposit as applied during manufacturing

3 lead tape

4 solder as applied in manufacturing

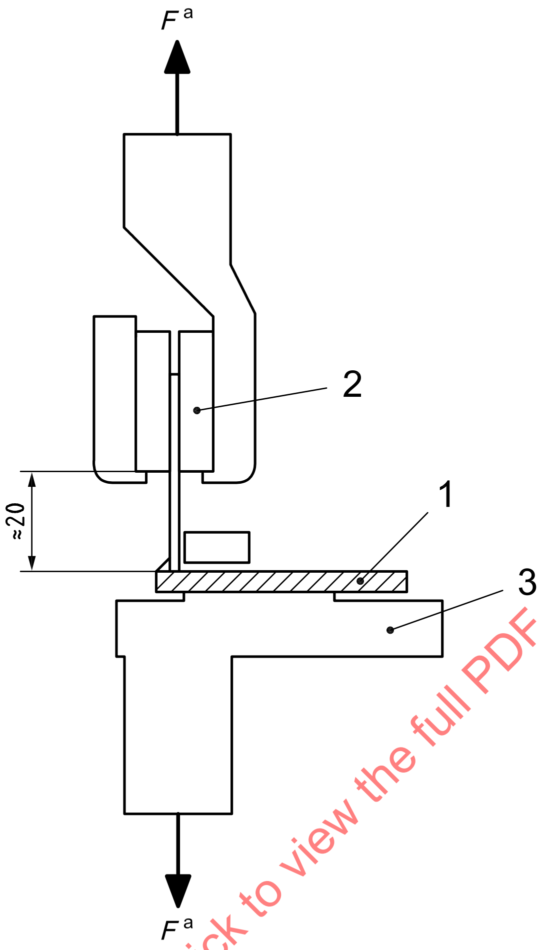
a Breaking stress greater than 3 MPa.

Figure A.2 — A metallic edge seal test specimen

During soldering, attention shall be given to ensure that the solder goes between tape and metallic deposit. Solder flux as used in manufacturing insulating glass units shall be applied.

A possible method of clamping the test specimen in the tensiometer is illustrated in Figure A.3. The separation speed is (12,5 ± 0,5) mm/min.

Dimensions in millimetres



Key

1 test specimen

2 clamp for lead tape

3 clamp for glass

[a] F is the tensile force at a separation speed of (12,5 ± 0,5) mm/min.

Figure A.3 — Clamping test specimen metallic edge seal for tensile strength measurement

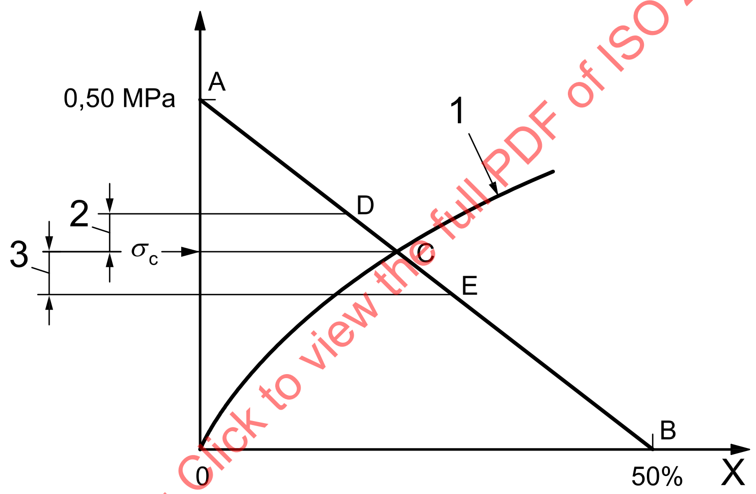
Annex B
(normative)

Requirement for edge seal strength comparisons in case of substituting sealant

The average stress-strain profile of the joints in the area A0B for each corresponding conditioning of testing shall be substantially the same as the profile obtained for the original tested as a type test.

NOTE Conditioning of testing is covered in 5.1.1.

The cross-over at line AB in Figure B.1 shall be within ±20 % with a minimum of ±0,02 MPa from the original cross-over stress for each corresponding conditioning of test.



Key

1 stress strain curve of the original sealant; breaking shall be somewhere outside of the triangle 0AB

2 allowable plus deviation

3 allowable minus deviation

σ_c cross-over stress

Figure B.1 — Illustration of the allowable deviation (±20 % with a minimum of ±0,02 MPa) from the cross-over stress of the original sealant when comparing seal strength for substituting sealant

Annex C
(normative)

Method of measuring the moisture vapour transmission rate

C.1 General

This test method covers the determination of moisture vapour transmission (MVT) of organic sealing material through which the passage of moisture vapour is of importance.

NOTE This measurement is based on ASTM E96[6].

C.2 Summary of the test method

The test specimen is sealed to the open mouth of a test dish, and the assembly placed in a controlled atmosphere. Periodic weightings determine the rate of moisture vapour movement through the specimen into the desiccant.

C.3 Reagents and/or materials

For the desiccant method, molecular sieve 4 Å or 3 Å can be used as long as the initial water content, measured in accordance with the 950 °C drying method relevant to the type test, is not over 5 %.

In order for the sealant used for attaching the specimen to the dish to be suitable for this purpose, it shall be highly resistant to the passage of moisture vapour and water. It shall not lose mass to, or gain mass from, the atmosphere in an amount, over the required period of time, that can affect the test result by more than 2 %.

C.4 Apparatus

C.4.1 Test dish

The test dish shall be of any non-corroding material, impermeable to water or moisture vapour. Light weight is desirable. The mouth of the dish shall be suitable for membranes of approximately 100 cm^2 as defined by a disc of approximately 113 mm diameter. The desiccant area shall be not less than the mouth area. An external flange or ledge around the mouth, to which the specimen may be attached, is useful when shrinking or warping occurs.

C.4.2 Test chamber

The room of the cabinet where the assembled test dishes are placed shall have a controlled temperature and relative humidity. Both the temperature and relative humidity shall be measured frequently, or preferably recorded continuously. Air shall be continuously circulated throughout the chamber, with a velocity sufficient to maintain uniform conditions at all test locations. Its velocity over the specimen shall be not less than 2,5 m/sec.

C.4.3 Balance

The balance shall be sensitive to a change smaller than 1 % of the mass change during the period when a steady state is considered to exist.

C.5 Test specimen

The test specimen shall be representative of the material tested. The overall thickness of each specimen shall be measured at the centre of each quadrant and the results averaged. Measurements of the 2 mm thickness of the membranes shall be made to the nearest 0,1 mm.

When testing any material that can be expected to lose or gain mass throughout the test (because of evaporation or oxidation), it is strongly recommended that an additional specimen, or “dummy”, be tested exactly like the others, except that no desiccant is put in the dish. Failure to use this dummy specimen to establish modified dish masses can significantly increase the time required to complete the test.

C.6 Attachment of specimen to test dish

Attach the specimen to the dish by sealing (and clamping if desired) in such a manner that the dish mouth defines the area of the specimen exposed to the vapour pressure in the dish.

C.7 Procedure

Fill the test dish with desiccant within 6 mm of the specimen. Leave enough space so that shaking the dish, which shall be done at each weighing, mixes the desiccant.

With the specimen attached to the dish, place it in the controlled chamber, specimen up, weighing it at once.

NOTE This mass can be helpful to an understanding of the initial moisture in the specimen.

Weigh the dish assembly periodically, often enough to provide eight or ten data points during the test. A data point is the mass at a particular time. The time that the dish is weighed shall be recorded to a precision of approximately 1 % of the time span between successive weighing. At first, the mass can change rapidly; but later a steady state is reached when the rate of change is substantially zero. Weighing should be accomplished without removal of the test dishes from the controlled atmosphere, but if removal is necessary, the time the specimens are kept at different conditions, temperature or relative humidity, or both, should be kept to a minimum.

Terminate the test or change the desiccant before moisture added to the desiccant exceeds 10 % of its starting mass.

C.8 Calculation and analysis of results

C.8.1 General

The results of the rate of moisture vapour transmission may be determined either graphically or numerically.

C.8.2 Dummy specimen

If a dummy specimen has been used to compensate for variability in test conditions due to temperature or barometric pressure, or both, the daily recorded masses should be adjusted by calculating the mass change from initial time to the weighing time. The adjustment is made by reversing the direction of the dummy's mass change, relative to its initial mass, and modifying all the appropriate mass(es) recorded at the time.

C.8.3 Graphic analysis

Plot the mass, modified by the adjustment based on the dummy specimen when used, against elapsed time, and plot a curve that tends to become straight. Judgment here is required and numerous points are helpful. When a straight line adequately fits the plot of at least six properly spaced points, a nominal steady state is assumed, and the slope of the straight line is the rate of the moisture vapour transmission.

C.8.4 Numerical analysis

A mathematical least-squares regression analysis of the mass, modified by the adjustment based on the dummy specimen when used, as a function of time gives the rate of moisture vapour transmission.

An uncertainty, or standard deviation of this rate, can also be calculated to define the confidence band.

C.8.5 Calculation

Calculate the moisture vapour transmission rate, θ, expressed in grams of H_2O per square metre per 24 h as given in Equation (C.1):

$$\theta = \frac{G}{tA} = \frac{G/t}{A} \qquad \text{(C.1)}$$

where

G is mass change (from the straight line), expressed as grams of H_2O;

t is time, expressed in days (24 h);

NOTE 1 G/t is the slope of the straight line, expressed in grams H_2O per 24 h, is the result of the division.

A is the test area (cup mouth area), expressed in square metres.

NOTE 2 The variability in results (standard deviation over mean value for the reproducibility together with the repeatability) is in the order of 25 %; see Reference [6].

Annex D
(normative)

Adhesion on coatings and interlayer adhesion of coatings

D.1 General

Insulating glass units with a coating in the cavity shall not be sealed on the coating, unless the coated glass is accompanied by information from the coated-glass supplier that sealing on the concerned coating is allowed. That information for coated glasses as defined in D.2 shall be collected as described D.3 to D.6.

When no sealing is allowed on the coating, the coated glass shall be accompanied by information from the coated-glass supplier on how the coating can be stripped. These types of coatings are not considered further in this annex.

D.2 Concerned coatings

The concerned coatings, which have been declared as “not necessary to be stripped”, shall be in accordance with EN 1096 (all parts).

D.3 Composition of coatings

The coating manufacturer shall establish a list of combinations of coatings with a given sealant (public part of the list) and their composition in layers (confidential part of the list).

The layers may be listed by the full-name composition or by a manufacturer's code. Additional coatings may be added to this list when evaluated according to this part of ISO 20492.

D.4 Evaluation

D.4.1 General

For each of those coatings, it shall be demonstrated that the adhesion between glass and coating, between sealant and coating, and between the different layers of the coating is sufficiently strong. Demonstration shall be performed by testing, or by available previous test reports, or by a combination of testing and available previous test reports.

D.4.2 Evaluation by testing

The flow chart in Figure D.1 shall be followed; however step 3 may be omitted. The test report shall include a section made in accordance with this annex.

The test specimens in step 3 shall be made with a reference sealant. That reference sealant shall be a neutral one and strong enough to test cohesion and adhesion strength. It can be a neutral silicone sealant.

In step 5, it shall be taken into account that the internal strength of the coating is already satisfactorily investigated so that testing can be limited to only the top layer/sealant adhesion.

The test report shall include a section in accordance with Clause 6.

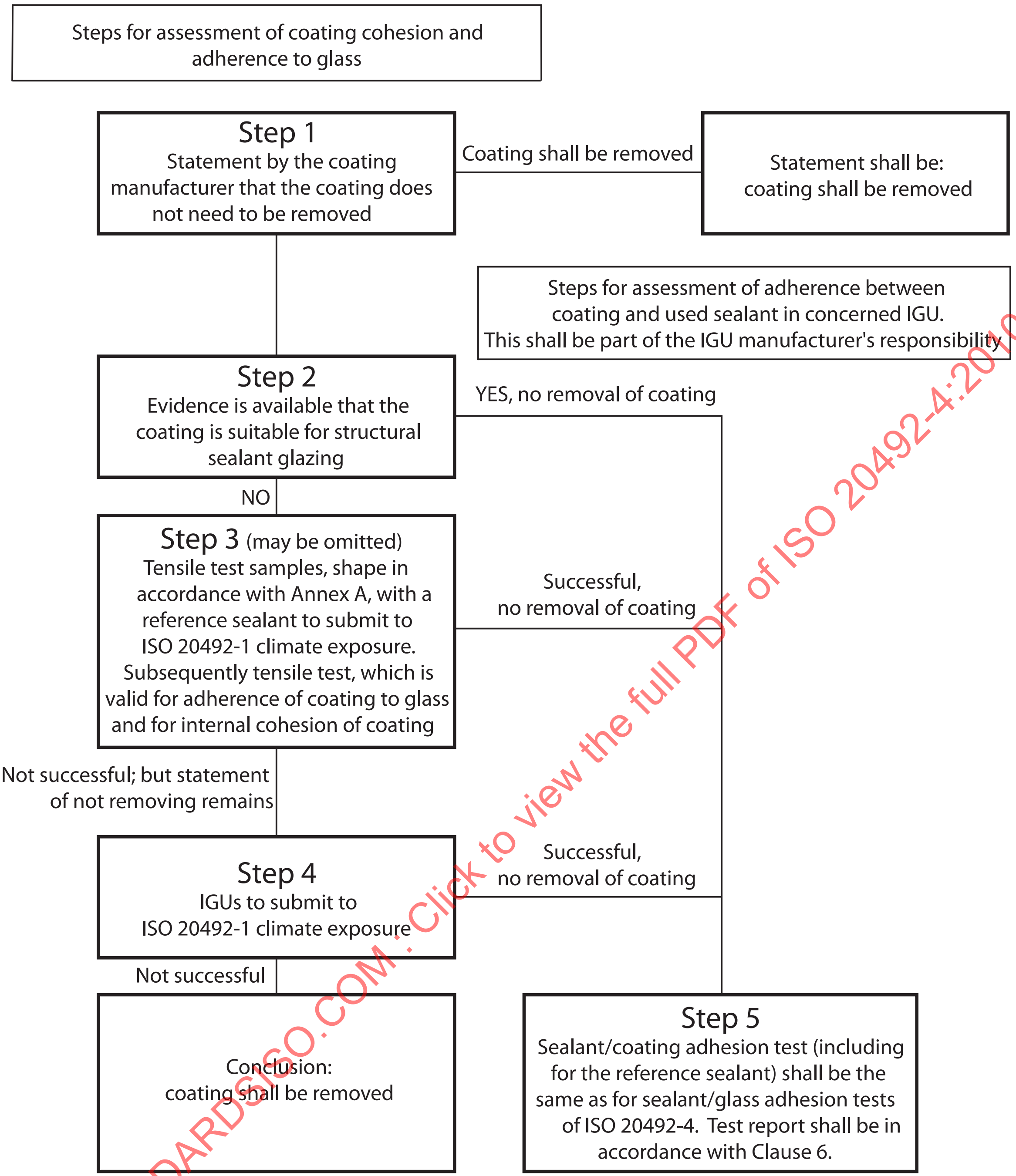


Figure D.1 — Flow chart of evaluation of adhesion on coatings and interlayer adhesion of coatings
(flow from top to bottom and from left to right)

D.4.3 Evaluation by previous test reports

When a coating is submitted for an evaluation of suitability, previous test reports in accordance with this annex may be presented, when the test results concern

— test specimens with a same sealant/top layer bonding as for the sealant/coating combination being evaluated; and/or

— test specimens with a same glass/base layer bonding as for the glass/coating combination being evaluated; and/or

— test specimens with any same adjacent layer combination in the coating as for the coating being evaluated.

D.4.4 Evaluation by a combination of testing and previous test reports

Where the previous test reports do not cover specified layer combinations or the specified top layer of the coating to be evaluated,

— the test specimens shall be sealed on coated glass containing the specified layer combination, or specified top layer/sealant combination; or

— the test specimens shall be sealed with the concerned coating/sealant combination, for submitting to the test procedures of Clause 5 and for reporting in accordance with this annex.

D.5 Example

D.5.1 Requested for coated glasses from one manufacturer:

— coating I submitted for evaluation of suitability: [glass] - [layer 1-layer 2] - [sealant A];

— coating II submitted for evaluation of suitability: [glass] - [layer 2-layer 1] - [sealant A].

D.5.2 Available test reports in accordance with ISO 20492-1 or in accordance with this annex on coated glasses from the same coated glass supplier:

— adhesion report 1: [glass] - [layer 1-layer 2-layer 3] - [sealant B]; accepted;

— adhesion report 2: [glass] - [layer 2] - [sealant A]; accepted.

D.5.3 It may be concluded that

— coating I is accepted because

1) glass - layer 1 is accepted (report 1),

2) layer 1 - layer 2 is accepted (report 1),

3) layer 2 - sealant A is accepted (report 2),

— coating II is acceptable after testing of a coating in which appears the combination “layer 1 - sealant A”, because

1) glass - layer 2 is accepted (report 2),

2) layer 2 - layer 1 is accepted (report 1),

3) layer 1 - sealant A was not tested.