BRITISH STANDARD

BS EN
1279-4:2002

Glass in building — Insulating glass units —

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

The European Standard EN 1279-4:2002 has the status of a British Standard

ICS 81.040.20

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National foreword

This British Standard is the official English language version of EN 1279-4:2002.

The UK participation in its preparation was entrusted by Technical Committee B/520, Glass and glazing in building, to Subcommittee B/520/2, Insulating glass products, which has the responsibility to:

— aid enquirers to understand the text;

— present to the responsible international/European committee any enquiries on the interpretation, or proposals for change, and keep the UK interests informed;

— monitor related international and European developments and promulgate them in the UK.

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

Cross-references

The British Standards which implement international or European publications referred to in this document may be found in the *BSI Catalogue* under the section entitled "International Standards Correspondence Index", or by using the "Search" facility of the *BSI Electronic Catalogue* or of British Standards Online.

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This British Standard, having been prepared under the direction of the Building and Civil Engineering Sector Policy and Strategy Committee, was published under the authority of the Standards Policy and Strategy Committee on 12 July 2002

Summary of pages

This document comprises a front cover, an inside front cover, the EN title page, pages 2 to 29 and a back cover.

The BSI copyright date displayed in this document indicates when the document was last issued.

Amendments issued since publication

Amd. No.	Date	Comments

© BSI 12 July 2002

ISBN 0 580 40110 3

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EUROPEAN STANDARD

NORME EUROPÉENNE

EUROPÄISCHE NORM

EN 1279-4

July 2002

ICS 81.040.20

English version

Glass in building - Insulating glass units - Part 4: Methods of test for the physical attributes of edge seals

Verre dans la construction - Vitrage isolant préfabriqué scellé - Partie 4: Méthodes d'essai des propriétés physiques des produits de scellement

Glas im Bauwesen - Mehrscheiben-Isolierglas - Teil 4: Prüfmethoden der physikalischen Eigenschaften des Randverbundes

This European Standard was approved by CEN on 5 March 2002.

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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 Management Centre has the same status as the official versions.

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Ref. No. EN 1279-4:2002 E

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Foreword

This document EN 1279-4:2002 has been prepared by Technical Committee CEN/TC 129 "Glass in building", the secretariat of which is held by IBN.

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 January 2003, and conflicting national standards shall be withdrawn at the latest by January 2003.

The described testing is part of type evaluation of insulating glass units.

This Part of the standard does not stand alone, it is part of one standard:

- prEN 1279-1, Glass in building - Insulating glass units - Part 1: Generalities, dimensional tolerances and rules for the system description.
- prEN 1279-2, Glass in building - Insulating glass units - Part 2: Long term test method and requirements on moisture vapour penetration.
- prEN 1279-3, Glass in building - Insulating glass units - Part 3: Long term test method and requirements for gas leakage rate and for gas concentration tolerances.
- EN 1279-4, Glass in building - Insulating glass units - Part 4: Methods of test for the physical attributes of edge seals.
- prEN 1279-5, Glass in building - Insulating glass units - Part 5: Evaluation of conformity.
- EN 1279-6, Glass in building - Insulating glass units - Part 6: Factory production control and periodic tests.

The annexes A, B, C and D are normative. The annexes E and F are informative.

This standard includes a Bibliography.

According to the CEN/CENELEC Internal Regulations, the national standards organizations of the following countries are bound to implement this European Standard: Austria, Belgium, Czech Republic, Denmark, Finland, France, Germany, Greece, Iceland, Ireland, Italy, Luxembourg, Malta, Netherlands, Norway, Portugal, Spain, Sweden, Switzerland and the United Kingdom.

1 Scope

This European Standard is the product standard for insulating glass units, which defines insulating glass units, and ensures by means of an adequate evaluation of conformity to this standard that over time:

- energy savings are made because the U-value and solar factor 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.

It covers additional characteristics that are of importance for trade. Marking conditions are included.

For glass products with electrical wiring or connections for e.g. alarm or heating purposes, this standard covers only wiring subject for electrical potential difference to earth less than 50 V a.c. or less than 75 V d.c.

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

NOTE 1 In cases where there is no protection against direct ultraviolet radiation at the edges, such as structural sealant glazing systems, additional European technical specifications should be followed. See Bibliography [4] and [5].

NOTE 2 Units where the nature is only artistic are not part of this standard.

This European Standard, which is inextricably bound up with the other Parts of the standard, covers evaluation of the edge seal strength, and partial evaluation of moisture and gas permeation through sealants, by testing and/or report examination as means of verifying whether a product made in accordance with its system description, and its variations in accordance with prEN 1279-1, conforms with the relevant aspects of the definition of insulating glass units.

2 Normative references

This European Standard incorporates, by dated or undated reference, provisions from other publications. These normative references are cited at the appropriate places in the text and the publications are listed hereafter. For dated references, subsequent amendments to or revisions of any of these publications apply to this European Standard only when incorporated in it by amendment or revision. For undated references, the latest edition of the publication referred to applies (including amendments).

EN 410, *Glass in building - Determination of luminous and solar characteristics of glazing*.
EN 1096, *Glass in building - Coated glass*.
prEN 1279-1, *Glass in building - Insulating glass units - Part 1: Generalities, dimensional tolerances and rules for the system description*.
prEN 1279-2, *Glass in building - Insulating glass units - Part 2: Long term test method and requirements on moisture vapour penetration*.
prEN 1279-3, *Glass in building - Insulating glass units - Part 3: Long term test method and requirements for gas leakage rate and for gas concentration tolerances*.
EN 1279-6, *Glass in building - Insulating glass units - Part 6: Factory production control and periodic tests*.

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3 Terms, definitions and symbols

3.1 Terms and definitions

For the purposes of this European Standard, the terms and definitions of prEN 1279-1, prEN 1279-2, prEN 1279-3 and EN 1279-6 apply as well as the following terms and definitions.

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) % r.h

3.2 Symbols

ε	Extension of bond expressed as a percent
σ	Stress applied to the bond during extension
ΔP_{H2O}	Difference in water vapour pressure across a membrane

4 Requirements

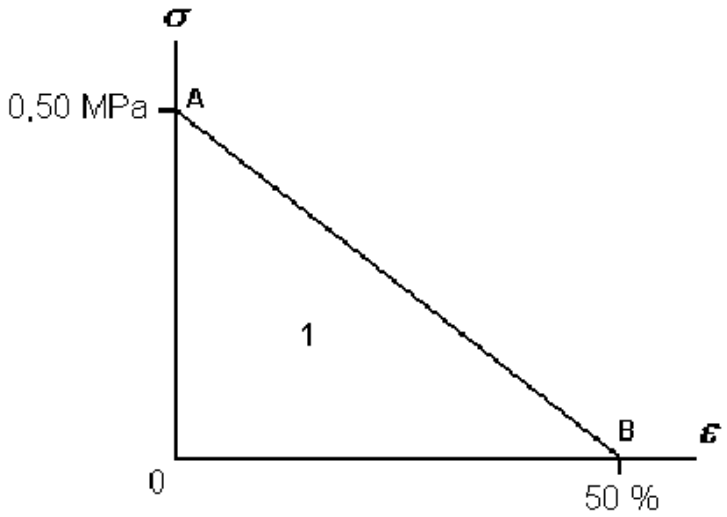
4.1 Edge seal strength

All edge seals shall have sufficient adhesive and cohesive strength to allow the joints as specified to be extended such that any failure occurs outside the area OAB of Figure 1.

If during the strength test of the glass-sealant-glass joint, seen from the side view, loss of adhesion or cohesion extends through the whole depth of the sealant within the area OAB 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.

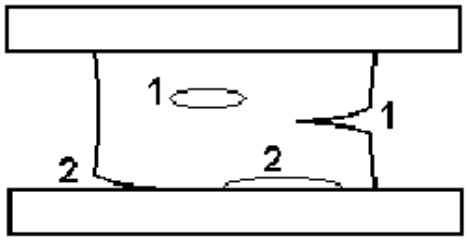
Breakage of the glass during testing does not constitute failure, providing that sufficient successful joints are tested in order that the average result can be obtained.

For comparisons of seal strength, needed for substituting sealants, refer to annex B.



Key 1 Area OAB. In that area, no breakage allowed before and after ageing
σ Stress in the sealant
ε Strain in the sealant

Figure 1 - Stress/strain triangle



Key 1 Loss of cohesion
2 Loss of adhesion

Figure 2 - Illustration of loss of adhesion or cohesion extends through the whole depth

4.2 Conformity with the definition of insulating glass units

4.2.1 General

There shall be available a test report of the concerned insulating glass outer sealant according to clause 6 of this EN 1279-4:2002 (which summarizes the test report in which the edge seal strength is recorded) with a moisture penetration test report according to prEN 1279-2 and in case of gas-filled units also with a gas leakage rate report according to prEN 1279-3, and fulfills the requirement to demonstrate the conformity with the definition of insulating glass units. Refer to prEN 1279-1.

In case of sealing the insulating glass unit also on a coating (in accordance with EN 1096) not intended to be stripped, a test report according to annex D of this EN 1279-4:2002 shall be made available for inclusion in the assembling of the other test reports. Refer toprEN 1279-1.

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NOTE Although only clear float glass is referred to in the standard, it is the responsibility of the insulating glass manufacturer to ensure that the edge sealant is capable of bonding to all used glasses listed in prEN 1279-1. The requirements for the use of coated glasses in accordance with EN 1096, are detailed in annex D.

4.2.2 Possibility to substitute the sealant

4.2.2.1 Limits of application

This possibility is applicable only in the case of insulating glass units with hollow metal spacer. For other systems, no experience is available for the setting up of substitution rules. Refer also to prEN 1279-1.

4.2.2.2 Air filled insulating glass units

Available test reports according to clause 6 of this EN 1279-4:2002 allows for the substitution of the sealant without repeated moisture penetration testing according to prEN 1279-2, when the substituting sealant:

(a) for units with an I value below 0,1:

– shall be applicable with the same production equipment;
– has been previously applied in insulating glass units which have been demonstrated to comply with prEN 1279-2. The demonstrated compliance may have been obtained separately using units of different construction and therefore the test report numbers may vary;
– and the moisture vapour transmission rate of the sealant is not more than 20 % higher than that of the initial sealant;
– and the stress/strain curve comparison satisfies the requirement in annex B;
– and the relevant Parts of EN 1279-6 (periodic test, mixing ratio, hardness test, etcetera) shall be carried out.

(b) for units with an I value between 0,1 and 0,2: the list under a) applies however with the following deviation:

– 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 according to clause 6 of this EN 1279-4:2002 allows to substitute the sealant without repeated gas loss rate testing according to prEN 1279-3, when the substituting sealant:

(a) for units with a gas loss rate L_i below 0,8 %·a^{-1}:

– is allowed for limiting the moisture vapour penetration in accordance with 4.2.2.2;
– has been previously applied in insulating glass units which have been demonstrated to comply with prEN 1279-3. The demonstrated compliance may have been obtained

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separately using units of different construction and therefore the test report numbers may vary;
– and the gas permeation of the sealant is not more than 20 % higher than that of the initial sealant.

(b) 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 following deviation:

– and 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 according to annex D of this EN 1279-4:2002 allow for the substitution of the coated glasses (coated glass in accordance with EN 1096), coating not intended to be stripped from the area where the insulating glass will be sealed without repeated moisture penetration testing according to prEN 1279-2, and in case of gas-filled units without repeated gas loss rate testing according to prEN 1279-3, when the provisions set out in the annex D are followed. Refer also to prEN 1279-1.

5 Test methods

5.1 Adhesion

5.1.1 Principle

The test consists of preparing a number of glass-sealant-glass joints and subjecting them to ageing regimes as outlined in 5.1.2 of this EN 1279-4:2002:

– heat exposure,
– water immersion,
– UV exposure,

as well as to no ageing (initial test) before testing under tensile load.

The test specimen shapes and bond preparations shall be as given in normative annex A. For insulating glass units with systems which 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 are seven per exposure condition.

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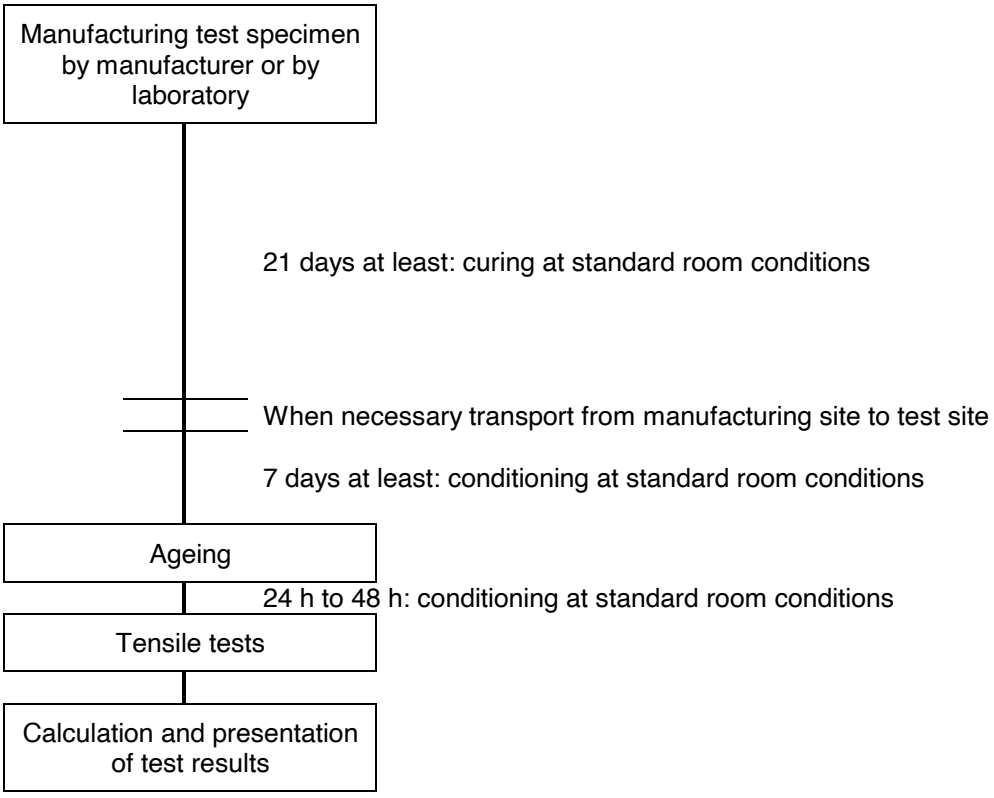

Figure 3 - Schematic presentation of test order for adhesion - Flow from top to bottom

After manufacturing, ageing where relevant, and conditioning during 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 lower than 2 %.

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 addition of a second piece of glass or other material bonded e.g. with a cyano acrylate 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 in 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.

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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 one litre to two litres distilled or deionised 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 EN 410 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 subject 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.

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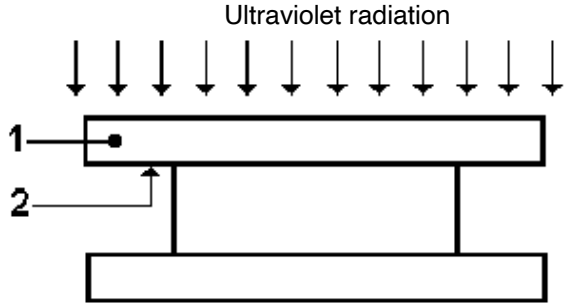

Key 1 Clear float glass
2 Tested surface which can be coated

Figure 4 - Orientation of the surface to be tested to the ultraviolet radiation

5.2 Moisture vapour transmission rate

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

5.2.1 Principle

The moisture vapour transmission rate (*MVTR*), when undertaken shall be determined on a 2 mm thick film as outlined in 5.2.2 of this EN 1279-4:2002.

5.2.2 Procedure

5.2.2.1 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, may give erratic results.

5.2.2.2 Applicable tests

There is a wide variety of tests covering Moisture vapour transmission rate. They vary by film thickness, ΔP_{H2O} across the film and temperature of test.

For comparison the method defined in the normative 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_{H2O} shall be from equal or less than 5 % (desiccant) to equal or more than 90 % r.h. (test chamber) across the membrane

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5.3 Gas permeation test on film

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

5.3.1 Principle

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

The gas permeation rate when undertaken shall be determined as a 2 mm thick film as outlined in section 5.3.2 of this Part of the standard.

5.3.2 Procedures

The gas permeation test shall be carried out using similar apparatus and the same test conditions to that defined in prEN 1279-3. In place of the test unit a gas cell shall be introduced 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 will be recorded. The value of gas permeating through the film when a steady state condition is achieved, shall be determined as $g.m^{-2} \cdot h^{-1}$.

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6 Test report

The test report shall evaluate the test in detail and shall include the following summary:

Name of the test house, its address and logo

Summary of report n° …….. Date: …….
Insulating glass units - Seal properties results according to EN 1279-4
For details, see the test report

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

Plant: Name: …….
Address: …….
…….
…….
…….

Sealant specification: …….
Sealant in IGU positively tested according to prEN 1279-2, report n°: ……..
Glass specification when not float glass is used: ……..

Seal strength test Adhesion:	At intersection with line A-B (*EN 1279-4, Figure 1*):		Type of failure observed (*if any*) C= cohesive A = adhesive				
	Average stress σ_{av} in MPa	Average extension ε_{av} in %	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*

Moisture vapour transmission rate (*when applicable for substituting sealant*):
Film thickness ……. mm
ΔP_{H2O} ……. % relative humidity difference across the membrane
Temperature ……. °C
MVTR ……. grams $H_2O \cdot m^{-2} \cdot (24h)^{-1} \cdot (2\ mm)^{-1}$

Gas permeation rate (*when applicable for substituting sealant and when sealant serves for gas-filled insulating glass units*):
Film thickness ……. mm
Surface: ……. m² - Shape: circular/square (*delete whichever is not applicable*)
Permeation rate: ……. $g \cdot m \cdot \cdot h^{-1}$

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

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Annex A
(normative)

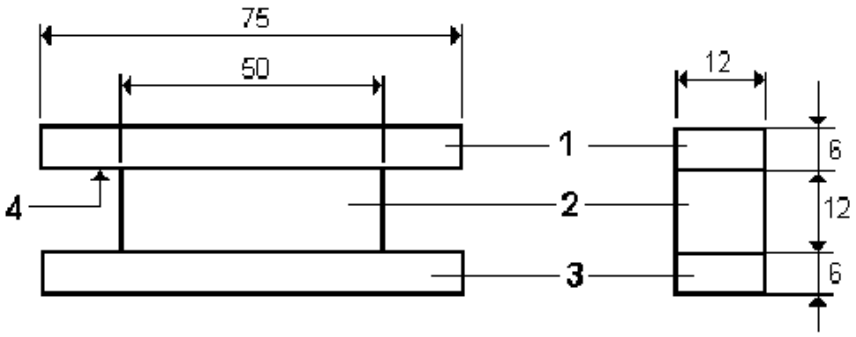
Test specimens for adhesion test

A.1 Polymer based edge sealants

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

– glass size 75 mm × 12 mm × 6 mm
– sealant size: 50 mm × 12 mm × 12 mm

Dimensions in millimetres



Key
1 Glass
2 Sealant
3 Glass
4 Face which may be coated

Tolerances on the dimensions of the sealant ± 1 mm.

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

After cutting the glass to the desired dimensions they 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 manufacturers instructions. For two part systems the mix ratio shall be within the limit ± 5 % of the absolute value specified.

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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. Gunnable seal shall be extruded into the cavity and struck off smoothly to form a bond of desired dimensions. See Figure A.1. The use of 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.

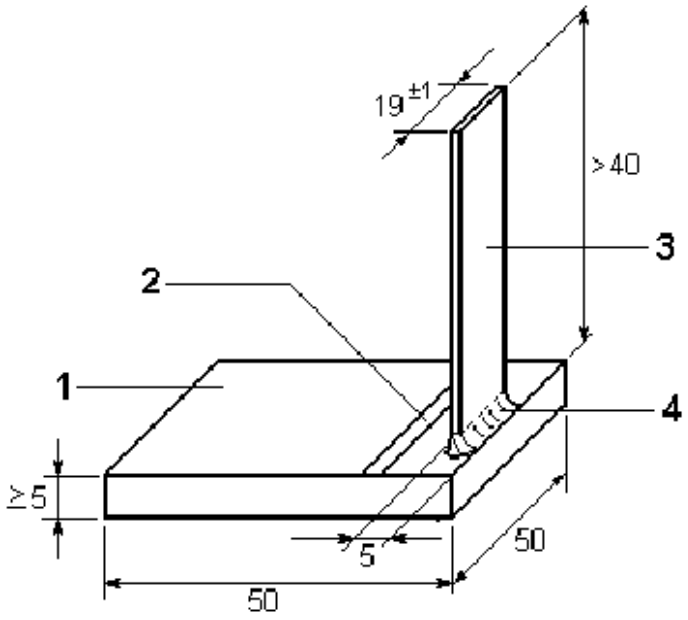
In the case of polymer based edge sealants, condition all prepared glass-sealant-glass joints at standard room conditions for not less than 21 days (initial cure).

A.2 Metallic edge seals

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

A lead tape long enough to allow clamping in the tensiometer, width (19 ± 1) mm, thickness (0,9 ± 0,1) mm, will be 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 greater than or equal to 3 MPa.

Dimensions in millimetres



Key
1 Clear float glass
2 Metallic deposit as applied during manufacturing
3 Lead tape: thickness (0,9 ± 0,1) mm, breaking stress greater than 3 Mpa
4 Solder as applied in manufacturing

Figure A.2 - A metallic edge seal test specimen

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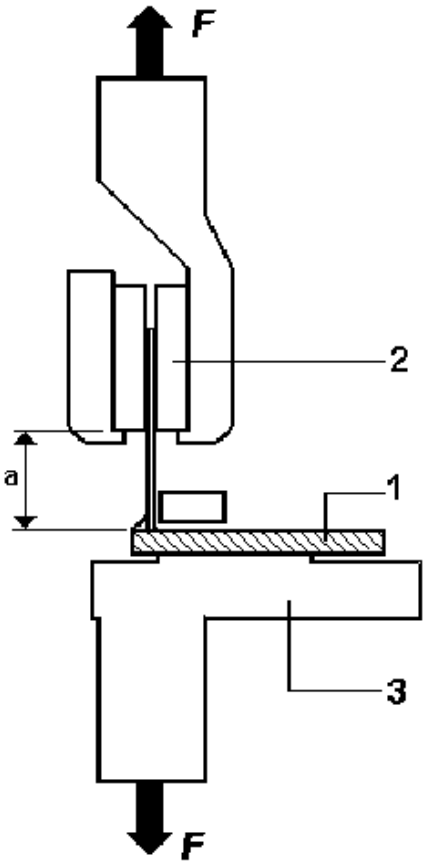
During soldering, attention shall be given to ensure that the solder will go between tape and metallic deposit. Solder flux as used in manufacturing insulating glass units shall be applied.

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.



Key
1 Test specimen
2 Clamp for lead tape
3 Clamp for glass
a Approximately 20 mm
F Tensile force
separation speed (12,5 ± 0,5) mm/min

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

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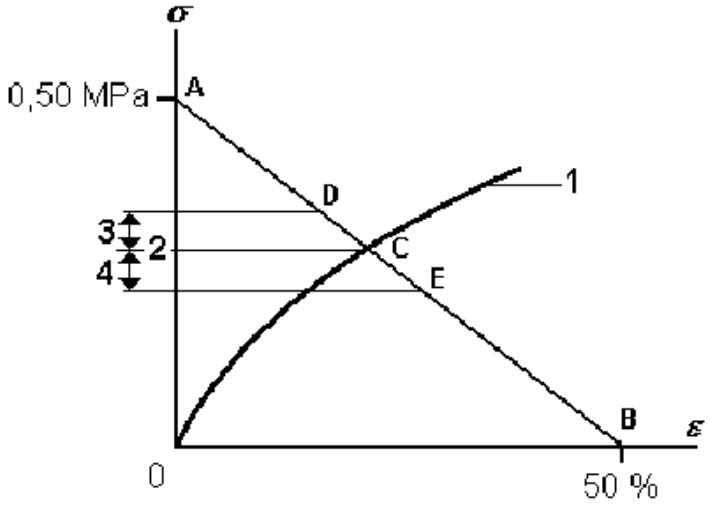
Annex B
(normative)

Requirement for edge seal strength comparisons in case of substituting sealant

The average stress-strain profile of the joints in the area AOB for each corresponding conditioning of testing (see 5.1.1) shall be substantially the same as the profile obtained for the original tested as a type test. 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 out of triangle OAB
2 Cross over stress σ_c
3 Allowable plus deviation
4 Allowable minus deviation

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

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Annex C
(normative)

Method of moisture vapour transmission rate measurement

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 E 96-90 "Standard Test Methods for Water Vapor Transmission of Materials". See Bibliography [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 weighings determine the rate of moisture vapour movement through the specimen into the desiccant.

C.3 Apparatus

C.3.1 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 diametre. 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.3.2 Test chamber

The room of cabinet where the assembled test dishes are to be 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.3.3 Balance

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

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C.4 Materials

For the Desiccant Method, molecular sieve 4 Å or 3 Å can be used as long as the initial water content, measured with the 950 °C drying method according to prEN 1279-2, is not over 5 %.

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

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 may be expected to lose or gain weight 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 weights may 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 of the dish, which shall be done at each weighing, will mix the desiccant.

Attach the specimen to the dish and place it in the controlled chamber, specimen up, weighing it at once.

NOTE This weight may 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 weight at a particular time. The time that the weight is made shall be recorded to a precision of approximately 1 % of the time span between successive weighing. At first the weight may change rapidly; later a steady state will be reached where the rate of change is substantially constant. 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.

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

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 weights should be adjusted by calculating the weight change from initial to time of weighing. The adjustment is made by reversing the direction of the dummy's weight change, relative to its initial weight, and modifying all the appropriate weight(s) recorded at time.

C.8.3 Graphic analysis

Plot the weight, modified by the dummy specimen when used, against elapsed time, and inscribe a curve which 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 weight, modified by the dummy specimen when used, as a function of time will give 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 (*MVTR*) as follows:

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

where G = weight change (from the straight line), grams H_2O

t = time in days (24 h)

G/t = slope of the straight line, grams $H_2O \cdot (24\ h)^{-1}$

A = test area (cup mouth area), m^2,

and because of the membrane is of 2 mm thickness

MVTR = rate of moisture vapour transmission, grams $H_2O \cdot m^{-2} \cdot (24\ h)^{-1} \cdot (2\ mm)^{-1}$

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NOTE The variability in results (standard deviation over mean value for the reproducibility together with the repeatability) is in the order of magnitude of 25 %. See Bibliography [6].

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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 further in this annex D.

When no sealing is allowed on the coating, the coated glass shall be accompanied by information from the coated glass supplier, how the coating shall be stripped. Those coatings are not further subject of this annex D.

D.2 Concerned coatings

The concerned coatings, declared not necessary to be stripped, shall be in accordance with EN 1096.

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 in full name composition or by a manufacturer's code. Further coatings may be added to this list when evaluated according to this standard.

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 D.

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.

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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.

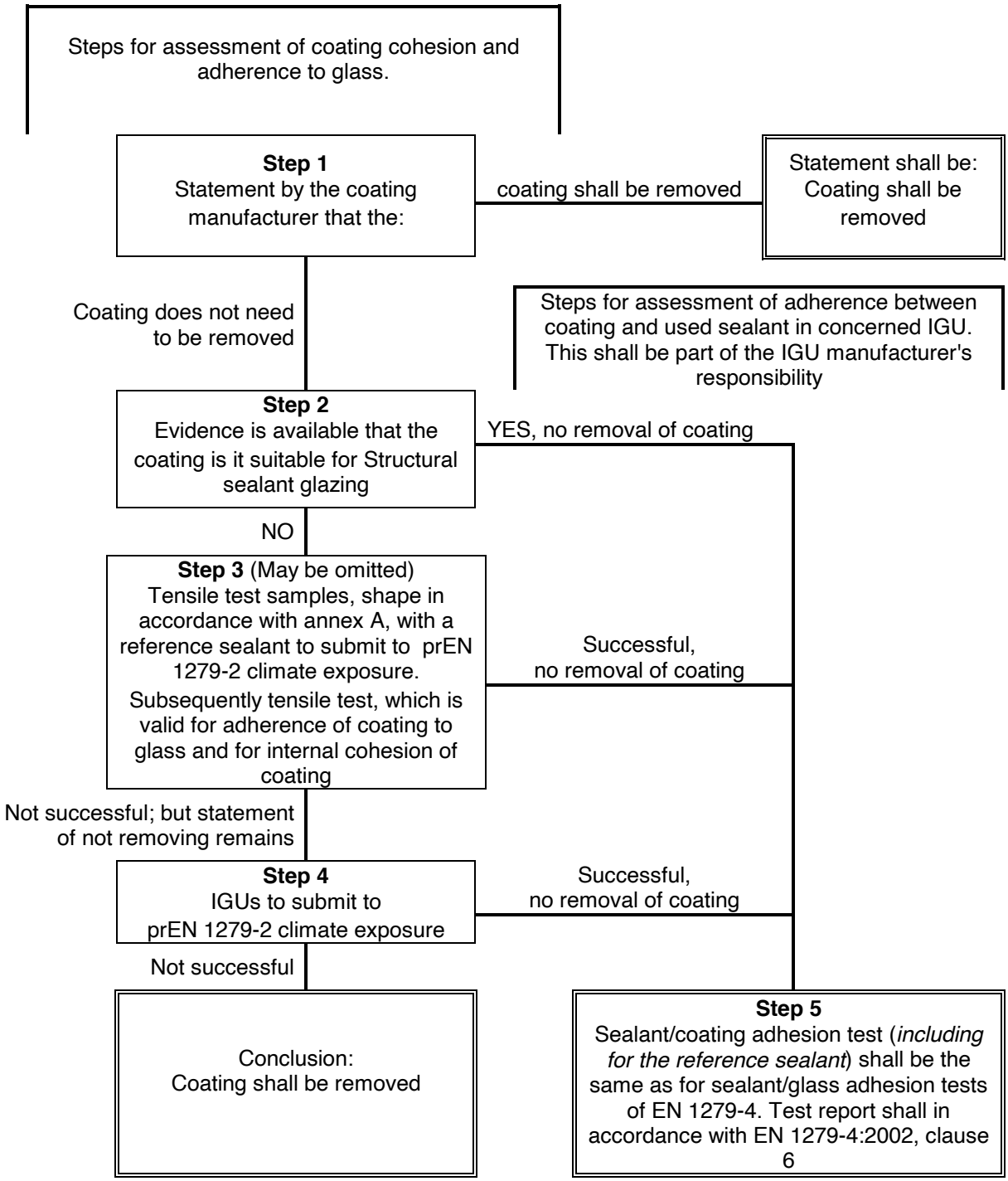

Figure D.1 - Flow chart of evaluation of adhesion on coatings and interlayer adhesion of coatings - Flow from top to bottom and from left to right

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D.4.3 Evaluation by previous test reports

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

- test specimens with a same sealant/top layer bonding as of the sealant/coating combination to be evaluated;
- and/or test specimens with a same glass/base layer bonding as of the glass/coating combination to be evaluated;
- and/or test specimens with any same adjacent layer combination in the coating as of the coating to be evaluated.

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

Where the previous test reports does 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 of this EN 1279-4:2002 and for reporting in accordance with this annex D.

D.5 Example

Requested for coated glasses from one manufacturer:

- Coating I to submit to evaluation of suitability: [glass] - [layer 1-layer 2] - [sealant A]
- Coating II to submit to evaluation of suitability: [glass] - [layer 2-layer 1] - [sealant A]

Available test reports (in accordance with prEN 1279-2 or in accordance with this annex D) 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

One may conclude that:

- Coating I is accepted because:
  - i) glass - layer 1 accepted (report 1)
  - ii) layer 1 - layer 2 accepted (report 1)
  - iii) layer 2 - sealant A accepted (report 2)

- Coating II is acceptable after testing of a coating in which appears the combination: layer 1 - sealant A, because of:
  - i) glass - layer 2 accepted (report 2)
  - ii) layer 2 - layer 1 accepted (report 1)
  - iii) layer 1 - sealant A not tested

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D.6 Test reports

D.6.1 Report of adhesion test with coated glass according to EN 1279-4 (public part)

The test report shall evaluate the test in detail and shall include the following summary accessible for the public:

Name of the test house, its address and logo

Public part

Summary of report n° …….. Date: …….
Insulating glass units sealed on coating - Test according to EN 1279-4
For details, see the test report

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

Name of coated glass: ……
Sealant specification: ……
Sealant in IGU positively tested according to prEN 1279-2, report n°: ……..

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

Conclusion of the test (*delete whichever is not applicable*):
The glass/coating/sealant bonding conforms to the test criteria: **YES** | **NO**

……
Name and signature

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D.6.2 Report of adhesion test with coated glass according to EN 1279-4 (confidential part)

The test report shall evaluate the test in detail and shall include the following confidential information concerning the coatings:

Name of the test house, its address and logo

Confidential part

Summary of report n° …….. Date: …….
Insulating glass units sealed on coating - Test according to EN 1279-4
For details, see the test report

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

Name of coated glass: …….

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		
7		
8		
9		
10		
11		
12		

Further information when relevant:

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Annex E
(informative)

Informative tests

E.1 General

These tests are only carried out when agreement between the user and supplier deems it necessary. The informative tests are designed to give a standardised test procedure for comparison of sealants. However the drafting committee felt that a cautionary note be included as comparison of sealants based on different generic types can lead to fallacious interpretations.

Details of the tests can be found in the specifications referred to.

E.2 Adhesion testing

The adhesion testing outlined in the normative section of this EN 1279-4 can be continued to determine the ultimate elongation, the tensile strength at break and peak tensile strength. The method is outlined in ISO 11600 specification. See Bibliography [2].

E.3 Film properties

Tests on cured films, or in the case of thermoplastic sealants pressed films, can be useful indicators to their usefulness.

A suitable test procedure is laid down in ISO 37. See Bibliography [1]. The following criteria should be observed:

– film thickness (2 ± 0,1) mm
– test temperature (23 ± 1) °C

NOTE Insulating glass units made under the scope of this standard are unlikely to experience tensile stress greater than 2 MPa or a strain of 1,5 (150 % elongation). The correct combination of ultimate stress and strain values required of the sealant should be decided between the sealant user and the supplier. However an idealised requirement chart should be included for reference.

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Annex F
(informative)

Example of a sun simulating radiation source

For demonstration of the suitability of a sun simulating radiation source, OSRAM lamps type Ultra-Vitalux 300 W has been used.

The energy distribution is given in Table F.1.

Table F.1 - Spectral characteristics of radiation

Radiation	Range of wavelength in nm	Percentage of total energy in %
ultraviolet range UVB	280 to 315	≥ 1
ultraviolet range UVA	315 to 380	≥ 3
visible and infrared	> 380	balance

When the total irradiance level in plane of the test specimens is maintained on (900 ± 100) W/m², the required UV intensity on the test specimen is ensured.

NOTE For the determination of the total irradiance level, pyranometers according to the specifications laid down in ISO 9060 (Bibliography [3]) and a (limited) sensitivity to the spectral range from 305 nm to 2 800 nm may be used. Using these radiation detectors, the measured irradiance level in the plane of the test specimens should be (730 ± 80) W/m².

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Bibliography

[1] ISO 37, *Rubber, vulcanized or thermoplastic - Determination of tensile stress-strain properties*.

[2] ISO 11600, *Building construction - Sealants - Classification and requirements*.

[3] ISO 9060, *Solar energy - Specification and classification of instruments for measuring hemispherical solar and direct solar radiation*.

[4] prEN 13022, *Glass in Building - Structural sealant glazing*.

[5] ETAG n° 002, *ETAG for Structural sealant glazing systems (SSGS) - Part 1: Supported and unsupported systems*

[6] ASTM E 96 – 90, *Standard Test Methods for Water Vapor Transmission of Materials*

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