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## General construction technique permit

**Number:**

**Z-70.3-253**

**Applicant:**

**Kuraray Europe GmbH**  
Philipp-Reis-Straße 4  
65795 Hattersheim, Germany

**Validity**

from: **15 April 2025**

to: **15 April 2030**

**Subject of decision:**

**Glazing made of laminated safety glass using the 'SentryGlas® SG5000' interlayer**

The subject named above is herewith granted a general construction technique permit (*allgemeine Bauartgenehmigung*).

This decision contains five pages and five annexes.

**Translation authorised by DIBt**

DIBt

## I GENERAL PROVISIONS

- 1 The general construction technique permit confirms the fitness for application of the subject concerned within the meaning of the Building Codes of the federal states (*Landesbauordnungen*).
- 2 This decision does not replace the permits, approvals and certificates required by law for carrying out construction projects.
- 3 This decision is granted without prejudice to the rights of third parties, in particular private property rights.
- 4 Notwithstanding further provisions in the 'Special Provisions', copies of this decision shall be made available to the installer of the subject concerned. Furthermore, the installer of the subject concerned shall be made aware of the fact that this decision must be made available at the place of application. Upon request, copies of the decision shall be provided to the authorities involved.
- 5 This decision shall be reproduced in full only. Partial publication requires the consent of DIBt. Texts and drawings in promotional material shall not contradict this decision. In the event of a discrepancy between the German original and this authorised translation, the German version shall prevail.
- 6 This decision may be revoked. The provisions contained herein may subsequently be supplemented and amended, in particular if this is required by new technical findings.
- 7 This decision is based on the information and documents provided by the applicant on the subject concerned during the permit procedure. Alterations to the information on which this general construction technique permit was based are not covered by this decision and shall be notified to DIBt without delay.

## II SPECIAL PROVISIONS

### 1 Subject concerned and field of application

The subject of the permit is the planning, design and execution of glazing made of laminated safety glass (VSG) using the SentryGlas® SG5000 interlayer made by Kuraray Europe GmbH.

The field of application includes glazing made of laminated safety glass using the SentryGlas® SG5000 interlayer in accordance with the DIN 18008 series of standards<sup>1</sup> with and without the shear interaction of the interlayer being applied.

### 2 Provisions for planning, design and execution

#### 2.1 Planning

The Technical Building Rules (*Technische Baubestimmungen*), particularly the DIN 18008<sup>1</sup> series of standards as well as the following provisions, shall be observed for planning the glazing.

The laminated safety glass shall consist of at least two flat panes and the SentryGlas® SG5000 interlayer.

Contrary to the provisions of the DIN 18008 series of standards<sup>1</sup>, the maximum dimensions of overhead glazing shall be 3.21 m x 6.00 m.

For glazing using laminated safety glass without a static shear interaction being applied, the composition and manufacture as well as the impact and bond behaviour of the laminated safety glass shall comply with Annex 1.1.

For glazing using laminated safety glass with a static shear interaction being applied, the composition and manufacture as well as the impact, bond and adhesion behaviour of the laminated safety glass shall comply with Annex 1.2.

The impact behaviour<sup>2</sup> shall be indicated in a declaration of performance. The accuracy of the information on the bond strength<sup>2</sup> as well as the adhesion<sup>3</sup> of the laminated safety glass taking into account regular factory production controls, including initial type-testing by a testing laboratory, inspection body or certification body (*PÜZ-Stelle*) in accordance with no. 9/3<sup>4</sup> (see Annex 2), shall be demonstrated in a technical document<sup>5</sup>.

It shall be ensured that the glass and interlayer edges are only in contact with adjacent materials that are permanently compatible with the SentryGlas® SG5000 interlayer. The relevant instructions provided by Kuraray Europe GmbH shall be observed.

#### 2.2 Design

The Technical Building Rules, particularly the DIN 18008 series of standards<sup>1</sup>, as well as the following provisions, shall be observed for designing the glazing.

The laminated safety glass using the SentryGlas® SG5000 interlayer may be used as the laminated safety glass within the meaning of DIN 18008<sup>1</sup> if the composition and manufacture as well as the impact behaviour and bond behaviour of the laminated safety glass are in compliance with Annex 1.1.

The typical fragmentation pattern for panes of component size required in DIN 18008-1<sup>6</sup>, Clause 4.1.3, is guaranteed for the glass panes used in the laminated safety glass, see Annexes 1.1 and 1.2.

<sup>1</sup> DIN 18008 Glass in building – Design and construction rules

<sup>2</sup> see Annex 1.1, Section A 1.1.2 and Annex 1.2, Section A 1.2.2

<sup>3</sup> see Annex 1.2, Section A 1.2.2

<sup>4</sup> see List of Testing Laboratories, Inspection Bodies and Certification Bodies (*PÜZ-Stellen*) in Accordance with the Building Codes of the Federal States (*Landesbauordnungen*), published on [www.dibt.de](http://www.dibt.de)

<sup>5</sup> see Model Administrative Provisions (*MVV TB*), Issue 2024/1, D3, published on [www.dibt.de](http://www.dibt.de) as implemented in the federal states

<sup>6</sup> DIN 18008-1:2020-05 Glass in building – Design and construction rules – Part 1: Terms and general bases

When designing the glazing, the bonding effect of the SentryGlas®SG5000 interlayer may be taken into account if the composition and manufacture as well as the impact, adhesion and bond behaviour of the laminated safety glass are in compliance with Annex 1.2.

By derogation from the provisions of DIN 18008<sup>1</sup>, a linear elastic behaviour of the SentryGlas® SG5000 interlayer may be assumed when verifying the load-bearing capacity of vertical glazing under wind and horizontal line loads or of horizontal glazing under snow and wind loads in order to take into account the shear interaction between the individual panes provided that the conditions listed below are met.

For single-pane glazing, the shear modulus values given in Table 1 for the respective load cases and a Poisson's ratio of  $\mu = 0.49$  may be used as linear elastic characteristics of the SentryGlas® SG5000 interlayer. The characteristics for verification of the 'horizontal line loads' in interiors apply to a film temperature of up to 30 °C and a maximum load duration of one hour.

Table 1: Characteristics applicable to single-pane glazing

Load case		Shear modulus G [N/mm <sup>2</sup> ]	k <sub>VSG</sub> <sup>7</sup>	k <sub>mod</sub>
Facades	<b>Glazing without fall protection function</b>			
	Load case: wind	100	1	0.7
	<b>Glazing with fall protection function</b>			
	Load case: horizontal imposed load caused by people <sup>8</sup>	4	1	0.7
	Load case: wind and horizontal line loads	65	1	0.7
Interiors	<b>Glazing without fall protection function</b>			
	Load case: wind	100	1	0.7
	<b>Glazing with fall protection function</b>			
	Load case: horizontal line loads	65	1	0.7
	Load case: wind and horizontal line loads	65	1	0.7
Overhead area	Load case: snow	60	1	0.4
	Load case: wind and snow	60	1	0.7
	Load case: self-weight	0	1.1	0.25

The calculations may be geometrically linear or non-linear. The following sequence shall be observed for verification purposes:

- 1) Load case combinations in accordance with DIN EN 1990<sup>9</sup> including the associated partial safety factors and combination coefficients shall be formed.

<sup>7</sup> k<sub>VSG</sub> Factor for laminated glass and laminated safety glass, see DIN 18008-1, Clause 8.3.9

<sup>8</sup> Applicable for a maximum temperature of 50 °C, a load duration of one hour and under the following additional definitions:

SentryGlas® laminates consisting of two panes of clear float glass or float glass with low iron oxide content, with or without a neutral thermal insulation coating, can be used without limitations as a single pane or room-facing pane in insulating glass units.

<sup>9</sup> Clear SentryGlas® laminates without coating or printing can also be used as an exterior pane in insulating glass.  
DIN EN 1990:2010-12 Eurocode: Basis of structural design

- 2) The main tensile stresses in the laminated safety glass shall be calculated separately for each load component ( $\gamma$ -,  $\psi$ -fold load) of the relevant load case combination. The following system assumptions shall be observed:
  - For wind, horizontal line and snow loads, a partial shear interaction in accordance with Table 1 may be used for the calculation.
  - For climate loads (temperature, atmospheric pressure, difference in altitude), the method specified in Clause 7.2 of DIN 18008-1<sup>6</sup> shall be used. The extreme cases 'without shear interaction' and 'full shear interaction' shall be considered. The more unfavourable case shall be taken.
  - No shear interaction shall be considered for the calculation of the other loads (e.g. self-weight).
- 3) The main tensile stresses shall then be added up for each load component for the load case combination considered.
- 4) The load-bearing capacity shall be verified in accordance with DIN 18008-1<sup>6</sup> for the relevant load case combination in consideration of the  $k_{\text{mod}}$  and  $k_{\text{VSG}}$  coefficients in accordance with Table 1.

By derogation from the specifications in Table 1, for verification of the load case 'horizontal line loads' for facades, a temperature calculation shall be allowed for the determination of the film temperature in accordance with the specifications given in DIN EN 13363-2<sup>10</sup> for the respective glass design and the expected use conditions (location, orientation, inclination). In the absence of available data, the following conditions may be assumed for steady-state calculations for vertical installation:

Outside: temperature 30 °C, heat transfer coefficient 12 W/m<sup>2</sup>K, solar radiation exposure 850 W/m<sup>2</sup>

Inside: temperature 26 °C, heat transfer coefficient 8 W/m<sup>2</sup>K.

The shear modulus values for load duration of one hour shall be taken from Table 2 for the respective interlayer temperatures. Intermediate values may be interpolated.

Table 2: Shear modulus values for different interlayer temperatures

Interlayer temperature T [°C]	30	35	40	45	50	55	60
Shear modulus G [N/mm <sup>2</sup> ]	65	30	9	7	4	3	2

Interlayer temperatures higher than those given in Table 2 are not covered by this general construction technique permit.

## 2.3 Execution

The Technical Building Rules, particularly the DIN 18008 series of standards<sup>1</sup>, shall be observed for executing the glazing.

The executing company shall provide a declaration of conformity in accordance with Section 16a(5) in conjunction with Section 21(2) of the Model Building Code<sup>11</sup> to confirm the conformity of the construction technique with this general construction technique permit.

## 3 Provisions for use, maintenance and repair

Damaged panes shall be replaced immediately. Hazardous areas shall be sealed off immediately. When replacing the panes, it shall be ensured that solely construction products to which this general construction technique permit applies are used.

Andreas Schult  
Head of Section

Drawn up by  
Stöhr

<sup>10</sup> DIN EN 13363-2:2005-06 Solar protection devices combined with glazing – Calculation of total solar energy transmittance and light transmittance - Part 2: Detailed calculation method

<sup>11</sup> or its implementation in the Building Codes of the federal states

## A 1.1 Composition, manufacture and performance values of the laminated safety glass

### A 1.1.1 Composition and manufacture

DIN EN 14449<sup>1</sup> and the following provisions shall apply to the laminated safety glass:

- The glass panes consist of the following glass products:
  - float glass (soda lime silicate glass) in accordance with DIN EN 572-2<sup>2</sup>,
  - safety glass in accordance with DIN EN 12150-1<sup>3</sup> with a fragmentation pattern in accordance with A 1.1.3,
  - heat-soaked thermally toughened soda lime silicate safety glass in accordance with DIN EN 14179-1<sup>4</sup> with a fragmentation pattern in accordance with A 1.1.3,
  - heat strengthened glass in accordance with DIN EN 1863-1<sup>5</sup> with a fragmentation pattern in accordance with A 1.1.3,
  - coated glass in accordance with DIN EN 1096-1<sup>6</sup>.
- The minimum thickness of the SentryGlas® SG5000 interlayer shall be 0.76 mm, the maximum thickness 3.04 mm.
- When manufacturing laminated safety glass using coated glass products (excluding enamelled glass products), the glass panes are laminated with the SentryGlas® SG5000 interlayer only on the uncoated glass surface.
- The moisture content of the film during manufacture is  $\leq 0.15\%$ , measured in accordance with **Annex 5**.
- For laminated safety glass with an interlayer nominal thickness of 0.76 mm, the nominal thickness of thermally toughened glass shall not exceed 8 mm.
- The laminated safety glass is manufactured in accordance with the Kuraray Manual (Lamination Guidelines) for SentryGlas® SG5000.

### A 1.1.2 Performance values

- Impact behaviour tested in accordance with DIN EN 12600<sup>7</sup> (4 mm float/0.76 mm SentryGlas® SG5000/4 mm float): 1(B)1
- Impact behaviour tested in accordance with DIN EN 356<sup>8</sup> (4 mm float/0.76 mm SentryGlas® SG5000/4 mm float): P1A
- Laminate bond strength (pummel test) tested in accordance with **Annex 3**: pummel value  $\geq 4$

### A 1.1.3 Fragmentation pattern

Glass products in accordance with DIN EN 12150-1<sup>3</sup> and DIN EN 14179-1<sup>4</sup> shall have the fragmentation pattern defined in DIN EN 12150-1<sup>3</sup> for test panes for each manufactured component size.

Glass products in accordance with DIN EN 1863-1<sup>5</sup> with a component size of 1000 mm x 1500 mm and more shall have a fragmentation pattern in which the proportion of the area made up of fragments of a non-critical size is more than four-fifths of the total area. The method for assessing the fragmentation pattern is based on DIN EN 1863-1<sup>5</sup>, Section 8. All fragments in which a circle of diameter 120 mm can be drawn may be deemed non-critical in terms of size.

<sup>1</sup> DIN EN 14449:2005-07	Glass in building – Laminated glass and laminated safety glass – Evaluation of conformity/Product standard
<sup>2</sup> DIN EN 572-2:2012-11	Glass in building – Basic soda lime silicate glass products – Part 2 – Float glass
<sup>3</sup> DIN EN 12150-1:2020-07	Glass in building – Thermally toughened soda lime silicate safety glass – Part 1: Definition and description
<sup>4</sup> DIN EN 14179-1:2016-12	Glass in building – Heat soaked thermally toughened soda lime silicate safety glass – Part 1: Definition and description
<sup>5</sup> DIN EN 1863-1:2012-02	Glass in building – Heat strengthened soda lime silicate glass – Part 1: Definition and description
<sup>6</sup> DIN EN 1096-1:2012-04	Glass in building – Coated glass – Part 1: Definitions and classification
<sup>7</sup> DIN EN 12600:2003-04	Glass in building – Pendulum tests – Impact test method and classification for flat glass
<sup>8</sup> DIN EN 356:2000-02	Glass in building – Security glazing – Testing and classification of resistance against manual attack

Glazing made of laminated safety glass using the SentryGlas® SG5000 interlayer

Composition, manufacture and performance values of the laminated safety glass

Annex 1.1

## A 1.2 Composition, manufacture and performance values of the laminated safety glass with shear interaction

### A 1.2.1 Composition and manufacture

DIN EN 14449<sup>1</sup> and the following provisions shall apply to the laminated safety glass:

- The glass panes consist of the following glass products:
  - float glass (soda lime silicate glass) in accordance with DIN EN 572-2<sup>2</sup>,
  - safety glass in accordance with DIN EN 12150-1<sup>3</sup> with a fragmentation pattern in accordance with A 1.2.3,
  - heat-soaked thermally toughened soda lime silicate safety glass in accordance with DIN EN 14179-1<sup>4</sup> with a fragmentation pattern in accordance with A 1.2.3,
  - heat strengthened glass in accordance with DIN EN 1863-1<sup>5</sup> with a fragmentation pattern in accordance with A 1.2.3,
  - coated glass in accordance with DIN EN 1096-1<sup>6</sup> - with coatings with properties at least equivalent to black enamelled glass in terms of absorption performance and the resultant interlayer temperature.
- The minimum thickness of the SentryGlas® SG5000 interlayer shall be 0.76 mm, the maximum thickness 3.04 mm.
- When manufacturing laminated safety glass using coated glass products (excluding enamelled glass products), the glass panes are laminated with the SentryGlas® SG5000 interlayer only on the uncoated glass surface.
- The moisture content of the film during manufacture is  $\leq 0.15\%$ , measured in accordance with **Annex 5**.
- For laminated safety glass with an interlayer nominal thickness of 0.76 mm, the nominal thickness of thermally toughened glass shall not exceed 8 mm.
- The laminated safety glass is manufactured in accordance with the Kuraray Manual (Lamination Guidelines) for SentryGlas® SG5000.

### A 1.2.2 Performance values

- Impact behaviour tested in accordance with DIN EN 12600<sup>7</sup> (4 mm float/0.76 mm SentryGlas® SG5000/4 mm float): 1(B)1
- Impact behaviour tested in accordance with DIN EN 356<sup>8</sup> (4 mm float/0.76 mm SentryGlas® SG5000/4 mm float): P1A
- Laminate bond strength (pummel test) tested in accordance with **Annex 3**: pummel value  $\geq 4$
- Adhesion tested in accordance with **Annex 4**: tensile stress  $\sigma \geq 8.5 \text{ N/mm}^2$

### A 1.2.3 Fragmentation pattern

Glass products in accordance with DIN EN 12150-1<sup>3</sup> and DIN EN 14179-1<sup>4</sup> shall have the fragmentation pattern defined in DIN EN 12150-1<sup>3</sup> for test panes for each manufactured component size.

Glass products in accordance with DIN EN 1863-1<sup>5</sup> with a component size of 1000 mm x 1500 mm and more shall have a fragmentation pattern in which the proportion of the area made up of fragments of a non-critical size is more than four-fifths of the total area. The method for assessing the fragmentation pattern is based on DIN EN 1863-1<sup>5</sup>, Section 8. All fragments in which a circle of diameter 120 mm can be drawn may be deemed non-critical in terms of size.

<sup>1</sup> DIN EN 14449:2005-07	Glass in building – Laminated glass and laminated safety glass – Evaluation of conformity/Product standard
<sup>2</sup> DIN EN 572-2:2012-11	Glass in building – Basic soda lime silicate glass products – Part 2 – Float glass
<sup>3</sup> DIN EN 12150-1:2020-07	Glass in building – Thermally toughened soda lime silicate safety glass – Part 1: Definition and description
<sup>4</sup> DIN EN 14179-1:2016-12	Glass in building – Heat soaked thermally toughened soda lime silicate safety glass – Part 1: Definition and description
<sup>5</sup> DIN EN 1863-1:2012-02	Glass in building – Heat strengthened soda lime silicate glass – Part 1: Definition and description
<sup>6</sup> DIN EN 1096-1:2012-04	Glass in building – Coated glass – Part 1: Definitions and classification
<sup>7</sup> DIN EN 12600:2003-04	Glass in building – Pendulum tests – Impact test method and classification for flat glass
<sup>8</sup> DIN EN 356:2000-02	Glass in building – Security glazing – Testing and classification of resistance against manual attack

Glazing made of laminated safety glass using the SentryGlas® SG5000 interlayer

Composition, manufacture and performance values of the laminated safety glass with shear interaction

Annex 1.2

## A 2 Factory production control, initial type-testing

### A 2.1 Factory production control

The factory production control shall include at least the measures listed in Table A 2.1, in addition to those specified in DIN EN 14449<sup>1</sup>.

No.	Characteristic	Requirements	Frequency
1	Material control	In accordance with DIN EN 14449 <sup>1</sup>	
2	Production control	In accordance with DIN EN 14449 <sup>1</sup>	
3	Product control	In accordance with DIN EN 14449 <sup>1</sup>	
4	Moisture content of the film in the laminate	Moisture content of the film in accordance with <b>Annex 5</b> : $\leq 0.15\%$	Every production batch
5	Laminate bond strength	Pummel test in accordance with <b>Annexes 3.1 and 3.2</b> on at least 5 test specimens. Pummel value: $\geq 4$	Every production batch
6	Adhesion <sup>2</sup>	Tensile test (pull test) on at least 5 specimens in accordance with <b>Annex 4</b> . Minimum value $\sigma \geq 8.5 \text{ N/mm}^2$	Once per month

Table A 2.1 Factory production control

### A 2.2 Initial type-testing

Initial type-testing of the construction product is carried out at every manufacturing plant by a testing laboratory, inspection body or certification body (*PÜZ-Stelle*) in accordance with no. 9/3<sup>3</sup>. This shall include testing the characteristics listed under no. 4 to 6 in Table A 2.1 as well as the impact behaviour<sup>4</sup>.

<sup>1</sup> DIN EN 14449:2005-07 Glass in building – Laminated glass and laminated safety glass – Evaluation of conformity/Product standard

<sup>2</sup> laminated safety glass for glazing with shear interaction

<sup>3</sup> see List of Testing Laboratories, Inspection Bodies and Certification Bodies (*PÜZ-Stellen*) in accordance with the Building Codes of the Federal States (*Landesbauordnungen*) - published on [www.dibt.de](http://www.dibt.de)

<sup>4</sup> see Annex 1.1, A 1.1.2 and Annex 1.2, A 1.2.2

Glazing made of laminated safety glass using the SentryGlas® SG5000 interlayer

Factory production control, initial type-testing

Annex 2

A 3 Test description for laminate bond strength (pummel test)

A 3.1 General

- The test specimens are manufactured in compliance with the Kuraray Manual (Lamination Guidelines) for SentryGlas® SG5000.
- The standard dimensions of the test specimens are 80 mm x 300 mm (min. 80 mm x 150 mm).
- The test specimens have the following composition: 3 mm float / 1.52 mm SentryGlas® SG5000 / 3 mm float.
- Number of test specimens: at least 5

A 3.2 Conducting the test

- Before testing, the test specimens are equilibrated at room temperature for at least 30 minutes ( $25\text{ °C} \pm 5\text{ °C}$ ).
- The test specimen is held at an angle of approx.  $5^\circ$  to the plane of the pummel plate or placed on the striking tool so that only the edge of the unbroken glass is in contact with the plate (Fig. A 3.1).
- The test specimen is repeatedly struck with a hammer (500 g flat-head hammer) in an overlapping pattern (uniform strikes, starting at the bottom edge, overlapping half of the previous strike area, spacing approx. 20 mm) to break the glass into powdered particles. At least 6 to 10 cm of the laminate is struck (Fig. A 3.1).
- The laminate is then turned over (short end over short end) and the process is repeated. Both ends (the inside of one end and the outside of the other) are struck and read. On completion, the centre section, which contains the specimen ID, should be the only glass that has not been crushed.

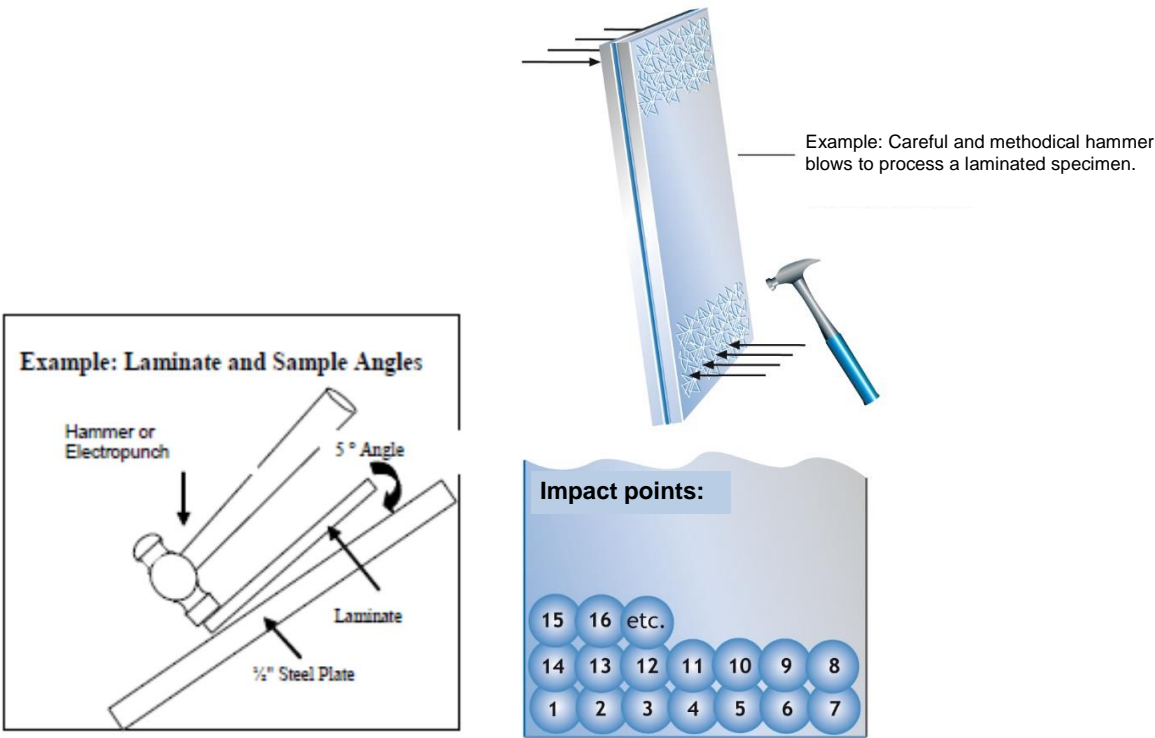


Fig. A 3.1: Conducting the test

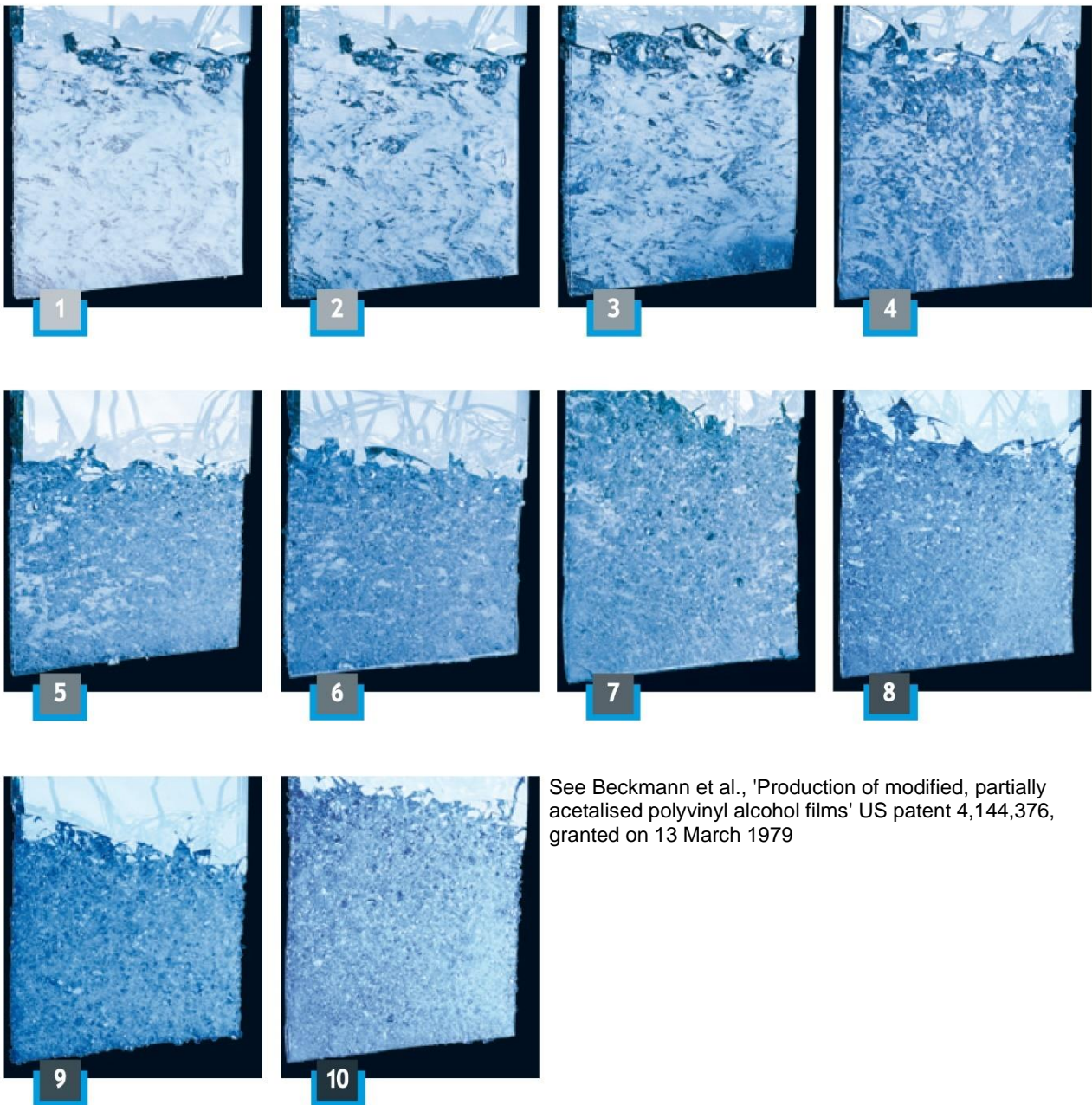
Glazing made of laminated safety glass using the SentryGlas® SG5000 interlayer

Test description for laminate bond strength (pummel test)

Annex 3.1

A 3.3 Evaluation

- The specimens are placed on brown kraft paper, carefully compared with the reference specimens and the degree of bonding (0 to 10) is determined by comparing the specimens with the reference specimens (Fig. A 3.2).
- A pummel value of 0 means no bonding, a pummel value of 10 means very high bonding.



See Beckmann et al., 'Production of modified, partially acetalised polyvinyl alcohol films' US patent 4,144,376, granted on 13 March 1979

Fig. A 3.2: Reference pummel pattern

Glazing made of laminated safety glass using the SentryGlas® SG5000 interlayer

Test description for laminate bond strength (pummel test)

Annex 3.2

A 4 Description of pull test

A 4.1 General

- The laminated safety glass is manufactured in accordance with the Kuraray Manual (Lamination Guidelines) for SentryGlas® SG5000.
- Typical composition of the test specimen: 3 mm float / 1.52 mm SentryGlas® SG5000 / 3 mm float
- Test specimens measuring 40 mm x 10 mm are cut out of the laminated safety glass using a suitable saw or cutting method at a distance of at least 50 mm from the edge of the laminated safety glass.
- The glass surfaces of the test specimens are thoroughly cleaned and degreased with n-pentane.
- The prepared test specimens are glued between two suitable metal test specimen holders at room temperature (23 °C +/- 2 °C) (Fig. A 4.1). F246 Acrylic Adhesive, Bond Master with initiator No. 5 or equivalent adhesives may be used. The adhesive should be allowed to cure for at least 24 hours.
- The test specimens must be stored at room temperature and a relative humidity of less than 60% for one week before the start of the test.
- Number of test specimens: at least 10

A 4.2 Conducting the test

- The test specimens are placed in the specimen holder of a suitable tensile testing machine (e.g., Zwick tensile tester) (Fig. A 4.2).
- The test speed is 0.50 mm/min., vertical movement at room temperature (23°C +/- 2°C).

A 4.3 Evaluation

- The force/displacement curve up to the failure of the bond between SentryGlas® SG5000 and glass is recorded and documented. Test specimens with adhesive bond failure to the specimen holder or cohesive failure of the glass are excluded from the evaluation.
- The recorded data is converted into a stress value  $\sigma$ , taking into account the dimensions of the test specimen.

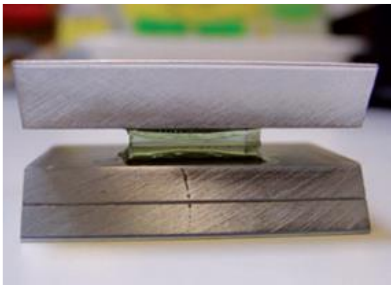


Fig. A 4.1: Test specimen holder

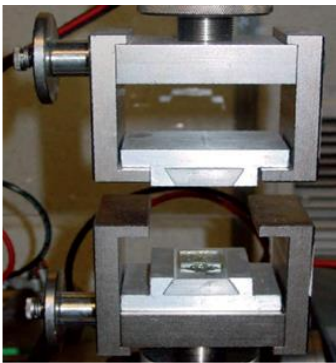
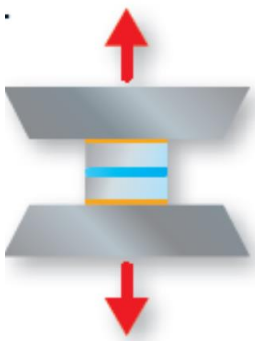


Fig. A 4.2: Tensile testing machine



Glazing made of laminated safety glass using the SentryGlas® SG5000 interlayer	Annex 4
Description of pull test	

A 5 Principle of moisture measurement using NIR spectroscopy

A 5.1 General principle

To determine the moisture content of the laminated film in a laminated glass specimen, a spectral scan is performed in the near infrared range of the spectrum from 1450 to 2200 nm. The absorption caused by moisture in the specimen is in the range 1875-1950 nm and is corrected for specimen thickness by dividing it by the absorption caused by CH<sub>2</sub> groups at 1730 nm.

Correlating Karl Fischer moisture analyses ('MOISTURE Standards') with this NIR ratio allows the percentage moisture content to be calculated. To calibrate and adjust the NIR spectrometer, laminated safety glass specimens with a precisely defined moisture content are prepared and provided in advance. The moisture content of these specimens ('MOISTURE STANDARDS') is determined by Karl Fischer titration (KFT).

The constants are to be determined for the glass substrates used (type of float glass and thickness) and used accordingly (note: laboratories typically work with identical base glass of the same thickness in all cases. Knowledge and experience of conducting and evaluating NIR spectroscopy are required.

A 5.2 Conducting the test

- The NIR spectrophotometer is set up to scan the range from 1450 to 2200 nm.
- The laminated safety glass specimen is cleaned, placed in the spectrophotometer and scanned in the NIR range. A typical scan is shown in Fig. A 5.
- The CH<sub>2</sub> absorption is measured from the horizontal tangent to the 1730 nm peak and from a second horizontal baseline to the minimum close to 1575 nm (the minima are to be defined and specified in the wavelength range).
- The moisture absorption is measured from the maximum in the range of 1875 - 1950 nm to the tangent between the two minima at nominally 1873 and 2087 nm.

A 5.3 Evaluation

- The NIR ratio is the moisture absorption divided by the CH<sub>2</sub> absorption.
- The percentage humidity is calculated using the following equation.

$$\%H_2O = A * (NIR \text{ ratio}) - B$$

- A and B are constants that vary depending on the spectrophotometer, glass colour and glass thickness.

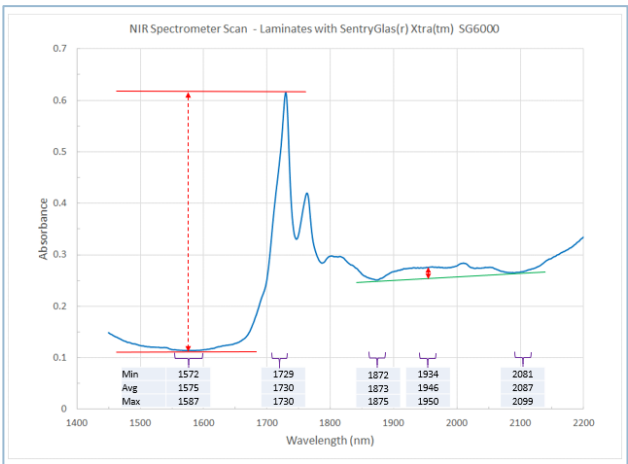


Fig. A 5: Typical scan

Glazing made of laminated safety glass using the SentryGlas® SG5000 interlayer

Principle of moisture measurement using NIR spectroscopy

Annex 5