

Durability summary of Saflex® Structural interlayer France regulatory compliance

Durability of laminated safety glass is defined and standardized in ISO 12543-4 which has been adopted as French standard FR EN ISO 12543-4. Saflex Structural DG interlayer meets the requirements as set forth in this standard and independent test reports are available and included in this report. In addition, interlayers can be registered in France in a voluntary arrangement through registration body Ceval. Part of the evaluation protocol is a durability program that exceeds the requirements of the standard of France, which has been executed by an independent test institute in France. Saflex DG passes these requirements and is registered with Ceval for use in the market governed by France. The durability criteria of ISO 12543 apply regardless of final use of laminated glass in exposed or captured edge, interior or exterior applications. Common uses of laminated glass complying with ISO 12543 range from facades to balustrades, including open edge applications, as well as museum encasements, partitions and furniture.

EN ISO 12543-4

Introduction & requirements

International Organization for Standardization (ISO) has published ISO 12543-2:2011 *Glass in building - Laminated glass and laminated safety glass - Part 2: Laminated safety glass*. This standard specifies performance requirements for laminated safety glass, as defined in ISO 12543-1. These performance requirements comprise a classification for breakage characteristics related to safety, and durability requirements. The text of ISO 12543-2:2011 has been approved by CEN as EN ISO 12543-2:2011 without any modification.

The durability requirements according to EN ISO 12543-2 for laminated safety glass that does not include plastic glazing materials are:

- 1) A high temperature test as described in ISO 12543-4:2011, paragraph 5, and evaluated in accordance with ISO 12543-4:2011, 5.4.
- 2) A high humidity test according as described in 12543-4:2011, paragraph 6, and evaluated in accordance with ISO 12543-4:2011, 6.4.
- 3) A UV radiation test as described in ISO 12543-4:2011, paragraph 7, and evaluated in accordance with ISO 12543-4:2011, 7.5.1

Saflex Structural (DG) can meet the durability requirements as set forth in EN ISO 12543-2.

Test methods used & evaluation criteria

High temperature humidity tests (ISO 12543-4:2011 – paragraph 5)

For the high temperature test, samples of laminated glass of 30 * 30 cm in size were prepared from 3 mm clear float glass using a Saflex Structural interlayer of 0.76 mm thickness. The three test specimens were heated to a temperature of 100 °C in an oven. The test temperature was maintained for 16h, excluding the time required for heating of the samples. The test specimens were taken out and allowed to cool to room temperature by storing them vertically under natural convection. The assessment of the test samples was carried out when the glass surface temperature was lower than 30 °C.

Humidity tests (ISO 12543-4:2011 – paragraph 6)

For the humidity test, samples of laminated glass of 30 * 30 cm in size were prepared from 3 mm clear float glass using a Saflex Structural interlayer of 0.76 mm thickness. The three test specimens were kept vertically over water in a closed container for two weeks. The temperature of the air in the container was

maintained between 50 and 55°C. Adequate spacing between the test specimens was provided. The samples were removed from the container and inspected at a distance between 300 mm and 500 mm in front of a white diffuse background.

Criteria for the high temperature and humidity test

A laminated glass passes these tests, if the following criteria apply:
 No fault (i.e. bubbles, delamination, haze or cloudiness) was found in three test specimens after the test. If faults were found in only one test specimen, three new test specimens would have to be tested. No fault shall be found in any of these three test specimens.

UV radiation test (ISO 12543-4:2011 – paragraph 7)

Samples of laminated glass of 30 * 30 cm in size were prepared from 3 mm clear float glass using a Saflex Structural interlayer of 0.76 or 0.38 mm thickness. The samples were submitted to an independent laboratory where a radiation test was performed according to the specifications of EN 12543-4 using 16 OSRAM ULTRAVITALUX 300 W lamps, for 2000 hours, at a temperature of 45+/-5 °C. The transmittance values of the samples were measured and calculated as specified by EN 410 *Glass in building - Determination of luminous and solar characteristics of glazing*.

Criteria for the UV radiation test

A laminated glass passes this test, if the following criteria apply:
 The luminous transmittance (or (visible) light transmittance) of three irradiated test specimens has not changed by more than
 a) ±3 % of their value before exposure for initial light transmittances of greater than 65 %, or
 b) ±2 % of their absolute value for initial light transmittances of less than or equal to 65 %.
 When visually inspected, no fault (i.e. bubbles, delamination, haze or cloudiness) was found in the three irradiated test specimens. If faults were found in only one test specimen, three new test specimens would have to be prepared to be tested in accordance with ISO 12543-4:2011, Clause 7, and evaluated in accordance with ISO 12543-4:2011, 7.5.1. No fault shall be found in any of these three test specimens.

Test results

The evaluation of Saflex Structural for the durability requirements of EN12543-4 is summarized in Table 1. Actual test reports are provided in the Annexes.

Table 1. Test results of EN12543-4 UV high temperature, humidity and UV radiation testing

Product	Types	EN12543-4 High temperature	EN12543-4 Humidity	EN12543-4 UV radiation exposure testing
Saflex Structural	DG41	Pass	Pass	Pass
	DG41 XC			Pass

It is recommended that compliance with the high temperature and humidity requirements is verified by the laminated glass manufacturer on different product types as offered.

CEKAL registration requirements (durability)

Requirements

French voluntary registration body Cekal registers interlayers for use in Cekal certified laminated safety glass. The requirements for durability aspects of interlayers to be registered comprise the tests of EN12543-2, and in addition the evaluation of adhesion and color change and yellowness change upon accelerated aging. These evaluations were executed by independent French test laboratory LRCCP (Laboratoire de recherches et de contrôle duc caoutchouc et des plastiques, Vitry, France).

Test methods and evaluation criteria

Samples of laminated glass in a 44.2 configuration are evaluated before and after accelerated aging in Atlas Weather-O-Meter Ci3000 for 4000 hours, with a black panel temperature of 50 °C, under a Xenon arc lamp with 0.51 W/m² capacity at a humidity of 65 % without spray.

Adhesion is measured using an adhesion torque test. Samples of 20 mm diameter are drilled using a precision drill at 1500 rpm. Samples are clamped using a 5.5 Nm couple and are torqued until failure at a temperature of 20 °C. At least 5 different valid measurements should be obtained as basis for calculating the average. The requirement is an adhesion force of at least 9 MPa for rigid interlayers before and after ageing.

Optical properties are measured between 300 and 2500 nm according to NF EN 14500. Light transmission is determined according to EN410. Yellowness index is calculated according to NF EN 16153 §5.4.4. Details are provided in Annex 4 along with a summary of the measured data for Saflex DG41. The requirements are:

- 1) Light transmission should change by no more than 1 %
- 2) YI should change by no more than 1 unit
- 3) Delta E (color change) should change by no more than 2 units

Test results

The evaluation of Saflex Structural against the durability requirements Cekal is summarized in Table 2.

Table 2. Test results of Cekal required accelerated aging program (WOM, 4000 h UV exposure, 50 °C) for Saflex DG41

Product	Types	Adhesion	Light transmission change	Yellowness index change	Delta E color change
Saflex Structural	DG41	Pass	Pass	Pass	Pass

Saflex DG41 is currently registered with Cekal for use in laminated glass in France.

Other data

Apart from and above the requirements derived from standards and/or registration, Eastman has executed additional natural or accelerated exposure testing on Saflex DG41, including Florida and Arizona natural exposures. Details can be provided in a separate statement.

Annexes

Annex 1: test report high temperature and durability Saflex DG41 (SSV, Venice, Italy)

Annex 2: test report UV radiation Saflex DG41 (SSV, Venice, Italy)

Annex 3: test report UV radiation Saflex DG41 XC (SSV, Venice, Italy)

Annex 4: extract test report durability UV exposure and test method details (Cekal procedure). Results from other and/or non-Eastman interlayers are blocked out.

Annex 1: test report high temperature and durability Saflex DG41 (SSV, Venice, Italy)

Stazione Sperimentale del Vetro S.c.p.A.

Venezia - Murano, Via Briati 10
 Venezia - Marghera, Via delle Industrie 13 - c/o VEGA Edificio Pegaso
 ORGANISMO NOTIFICATO CE CPR 305/2011 n°1694



	RAPPORTO DI PROVA / TEST REPORT N.	118744	page 1 of 2
Marghera	12/07/2014	rif. Your order n.JS2836ZM of 23.04.2014	
richiedente proposer	EASTMAN COMPANY UK LIMITED ACORNFIELD ROAD-KNOWSLEY IND.PARK - 00000 LIVERPOOL, L33 7UF		
campione sample	Laminated glass	prova eseguita dal / from test date al / to	12/06/2014 26/06/2014
contrassegnato reference	Saflex DG - 0.76 mm structural PVB interlayer		
ricevuto il received	13/05/2014 by carrier		CEEN12543BUE 15 4/10/2013

**EN 14449:2005 – Glass in building – Laminated glass and laminated safety glass
 Evaluation of conformity/Product standard**

Type of test:	High temperature test and High humidity test according EN ISO 12543-4:2011	
Producer:	Solutia Inc. (a subsidiary of Eastman Chemical Company) - Springfield, MA 01151 USA;	
Site of production:	not declared;	
Type of product:	Laminated safety glass / Laminated glass (ISO EN 12543-2:2011 or ISO EN 12543-3:2011);	
Family of interlayer:	polyvinyl butyral - pvb (EN 14449:2005);	
Sampling:	under responsibility of the Producer;	
Marking of the sample:	date of sampling: 2014, April 23 rd ; line of production: not declared;	
Personnel involved:	Comiati F., Schiavonato M.;	Test carried out at: Marghera laboratories.

For the details of the Product description and of the laminated process see Producer Technical File.
 Tests have been carried out according to points 5 (point 5.3.2 - Procedure A) and 6.3.1 of EN ISO 12543-4:2011 on 06 specimens of laminated safety glass with a nominal thickness of 6.76 mm.

Declared structure of laminated glass (mm)	clear float glass 3 mm / pvb 0.76 mm / clear float glass 3 mm
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Type of specimen:	specimens cut from a larger pane;
Edge work:	no edge working;
Protection at the edge:	no edge protection;
Dimension of the specimens:	300 mm x 300 mm;
Method of supporting:	one edge supported by test frame.

Visual Examination before test

According to EN ISO 12543-4:2011 each specimen has been inspected prior to the test at a distance between 300 mm to 500 mm in front of a white diffuse background. Only samples free of faults (bubbles, delamination, cloudiness) have been used for the test:

Specimens undergone to:	Bubbles	Delamination	Cloudiness
High Temperature Test	None	None	None
Humidity Test	None	None	None

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Mod.: PGS-06 REV. 7 01.5.2013

Annex 2: test report UV radiation Saflex DG41 (SSV, Venice, Italy)

Stazione Sperimentale del Vetro S.c.p.A.

Venezia - Murano, Via Briati 10
 Venezia - Marghera, Via delle Industrie 13 - c/o YEGA Edificio Pegaso
 ORGANISMO NOTIFICATO CE CPR 305/2011 n°1694



RAPPORTO DI PROVA / TEST REPORT N. 120326 page 1 of 1

Murano 16/09/2014 rif. Your order n.JS2836ZM of 23.04.2014

richiedente EASTMAN COMPANY UK LIMITED
 proposer ACORNFIELD ROAD-KNOWSLEY IND.PARK - 00000 LIVERPOOL, L33 7UF

campione Laminated glass
 sample prova eseguita dal / from 26/05/2014
 test date al / to 12/09/2014

contrassegnato Saflex DG - 0.76 mm structural PVB interlayer
 reference

ricevuto il 13/05/2014 by carrier
 received CE EN12543UVB r6 4/10/2013

**EN 14449:2005 Glass in building - Laminated glass and laminated safety glass
 Evaluation of conformity/Product standard**

Type of test: Solar radiation durability test according to EN ISO 12543-4: 2011
 Producer: Solutia Inc. (a subsidiary of Eastman Chemical Company) - Springfield, MA 01151 USA
 Site of production: not declared
 Type of product: Laminated safetyglass /laminated glass (ISO EN 12543-2:2011)
 Family of interlayer: PolyVinyl Butyral (EN 14449:2005)
 Sampling: under responsibility of the Producer
 Marking of the sample: date of sampling: 23/4/2014
 line of production: not declared
 Personnel involved: Fabrizio Comiati e Antonio Giulio Daneo

For the details of the product description and of the laminated process see Producer Technical File.
 The radiation tests has been carried out according to EN ISO 12543-4: 2011 on your 3 samples of laminated glass labelled SAFLEX DG - 0.76 nominal thickness structural PVB interlayer consisting of:

clear float glass 3 mm / pvb 0.76 mm / clear float glass 3 mm

The samples, 30 x 30 cm in size, 6.65 mm average thickness, showed no particular edge treatment or protection.
 The samples were submitted, at Marghera laboratories, to the radiation test with 16 OSRAM ULTRAVITALUX 300 W lamps for 2000 h, at a temperature of 45±5 °C, according to the prescriptions of the standard EN ISO 12543-4: 2011.
 The following light transmittance values were measured, at Murano laboratories, according to method LPO/MI/10-01 r.4 and calculated according to EN 410: 2011 before and after radiation:

Sample	Light transmittance (%) before exposure ($\tau_{v, bc}$)	Light transmittance (%) after exposure ($\tau_{v, ac}$)	% Relative difference $\left(\frac{\tau_{v, ac} - \tau_{v, bc}}{\tau_{v, bc}} \right)$
1	89.1	89.1	0
2	89.1	89.1	0
3	89.1	89.1	0

No delamination was observed in the samples after exposure to radiation.
 The above test results indicate that the samples are in compliance with the requirements described in point 4.3 of the standard EN ISO 12543-2: 2011.

THE ANALYST
 Antonio Giulio Daneo

THE LABORATORIES DIRECTOR
 Dr. Nicola Favaro

THE TECHNICAL DIRECTOR
 Eng. Roberto Dall'igna

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Annex 3: test report UV radiation Saflex DG41 XC (SSV, Venice, Italy)
Stazione Sperimentale del Vetro S.c.p.A.

Venezia - Murano, Via Briati 10
 Venezia - Marghera, Via delle Industrie 13 - c/o VEGA Edificio Pegaso
 ORGANISMO NOTIFICATO CE CPR 305/2011 n°1694



	RAPPORTO DI PROVA / TEST REPORT N.	135257	page 1 of 1
Murano	14/04/2016	rif. Your Order n.42686216 of 16.12.2015	
richiedente proposer	SOLUTIA EUROPE SPRL/BVBA OTTERGEMSESTEENWEG ZUID 707 - 01348 9000 GHENT		
campione sample	Laminated glass	prova eseguita dal / from	29/12/2015
		test date	al / to 14/04/2016
contrassegnato reference	DG41 XC		
ricevuto il received	22/12/2015 by carrier		CE EN12543UVE v.6 4/10/2013

**EN 14449:2005 Glass in building - Laminated glass and laminated safety glass
 Evaluation of conformity/Product standard**

Type of test: Solar radiation durability test according to EN ISO 12543-4: 2011
 Producer: EASTMAN CHEMICAL COMPANY
 Site of production: Ottergemsesteenweg-Zuid 707 - 9000 Ghent - Belgium
 Type of product: Laminated safety glass (ISO EN 12543-2:2011)
 Family of interlayer: PolyVinyl Butyral (EN 14449:2005)
 Sampling: under responsibility of the Producer
 Marking of the sample: date of sampling: 21/12/2015
 line of production: GT2
 Personnel involved: Fabrizio Comiati e Antonio Giulio Daneo

For the details of the product description and of the laminated process see Producer Technical File.
 The radiation tests has been carried out according to EN ISO 12543-4: 2011 on your 3 samples of laminated glass labelled DG41 XC consisting of:

3 mm clear float glass / 0.76 mm DG41 XC PVB / 3 mm clear float glass

The samples, 30 x 30 cm in size, 6.4 mm average thickness, showed no particular edge treatment or protection.
 The samples were submitted, at Marghera laboratories, to the radiation test with 16 OSRAM ULTRAVITALUX 300 W lamps for 2000 h, at a temperature of 45±5 °C, according to the prescriptions of the standard EN ISO 12543-4: 2011.
 The following light transmittance values were measured, at Murano laboratories, according to method LPO/MI/10-01 r.4 and calculated according to EN 410: 2011 before and after radiation:

Sample	Light transmittance (%) before exposure ($\tau_{v, bc}$)	Light transmittance (%) after exposure ($\tau_{v, ac}$)	% Relative difference $\left(\frac{\tau_{v, ac} - \tau_{v, bc}}{\tau_{v, bc}} \right)$
1	87.9	87.7	-0.2
2	87.9	87.6	-0.3
3	87.9	87.7	-0.2

No delamination was observed in the samples after exposure to radiation.
 The above test results indicate that the samples are in compliance with the requirements described in point 4.3 of the standard EN ISO 12543-2: 2011.

THE ANALYST
 Antonio Giulio Daneo

THE TECHNICAL DIRECTOR
 Eng. Roberto Dall'igna

THE LABORATORIES DIRECTOR
 Dr. Nicola Favaro

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Annex 4: extract test report durability UV exposure and test method details (Cekal procedure).

Note: Results from other and/or non-Eastman interlayers are redacted.



Solutia Europe SPRL/BVBA
Rapport n° V430033ZZ
19 mai 2017

CONFIDENTIEL

23/25

ANNEXE I - : DETAILS DES RESULTATS DES MESURES DE FACTEURS OPTIQUES

Référence échantillon	τ_v^{nh} (%)	Espace chromatique L*a*b* CIE 1976 Observateur 2° Illuminant D65						
		L*	a*	b*	ΔE	Yi	ΔY_i	
DG41	témoin	89	95.73	- 1.15	0.83	-	0.7	-
	vieilli	88	95.19	- 0.96	0.84	0.6	0.9	0.2

Tableau 1 (suite) : Facteurs de transmission et caractéristiques colorimétriques

Details test method:

DETERMINATION DE FACTEURS OPTIQUES (ESSAIS SOUS TRAITES)

IV.1 PREPARATION DES ECHANTILLONS

Les mesures sont réalisées dans les conditions ambiantes de laboratoire avec un spectrophotomètre de marque CARY et de type 5000, équipé d'une sphère d'intégration de 150 mm de diamètre. Les sources lumineuses de cet appareil permettent de couvrir le domaine spectral compris entre 300 et 2500 nm.

La courbe de transmission spectrale normale hémisphérique est enregistrée en utilisant la méthode d'essais décrite dans le chapitre 7.3 de la norme NF EN 14500 (méthode d'essai B – Spectrophotomètre double faisceau).

IV.2 RESULTATS DES ESSAIS

Les facteurs de transmission normale hémisphérique lumineuse sont déduits de la courbe spectrale conformément à la norme EN 410 et exprimés en pourcentage. L'incertitude absolue estimée sur ces facteurs est de 1%. Les coordonnées trichromatiques L*, a*, b* et l'écart colorimétrique ΔE^*_{ab} dans l'espace chromatique CIE 1976 sont calculés à partir de la courbe de transmission spectrale hémisphérique, spéculaire inclus, en utilisant l'illuminant D65 et un observateur standard 2° conformément aux normes NF ISO 11664-1, 2 et 4.

L'indice de jaune YI (Yellowness Index) est calculé à partir de la courbe de transmission spectrale hémisphérique, spéculaire inclus, en utilisant l'illuminant D65 et un observateur standard 2° conformément à la norme NF EN 16153 §5.4.4. L'amplitude et le sens de variation de l'indice de jaune sont calculés à l'aide de la formule : où YI et YI0 sont respectivement les indices de jaune d'une éprouvette vieillie et d'une éprouvette à l'état initial.

Le facteur de transmission lumineuse est le pourcentage qui caractérise la quantité de lumière transmise à travers un vitrage. Plus il est élevé, meilleur est le passage de la lumière.

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The data presented is derived from samples tested. Results are not guaranteed for all samples or for conditions other than those tested. Data and its respective measured, calculated or estimated single number ratings is for glass panels only – glazing installed in frames may differ significantly in performance.

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