

TNO report

TQS-RAP-08-

**AGC Westland B.V.
EN ISO 12543 - 4 Glass in building –
Laminated safety glass - Durability tests
SentryGlassPlus ST5000 + Dia**

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1 Introduction

AGC Westland B.V. has commissioned TNO Quality Services BV, BU Glass with the assessment of the performance of the ITT testing as specified in the product standard EN – ISO 12543.

The ITT is part of the standard of a series of interrelated parts:

- EN ISO 12543-1: Glass in building - Laminated glass and laminated safety glass - Part 1: Definitions and description of component parts
- EN ISO 12543-2: Glass in building - Laminated glass and laminated safety glass - Part 2: Laminated safety glass
- EN ISO 12543-3: Glass in building - Laminated glass and laminated safety glass - Part 3: Laminated glass
- EN ISO 12543-4: Glass in building - Laminated glass and laminated safety glass - Part 4: Test methods for durability
- EN ISO 12543-5: Glass in building - Laminated glass and laminated safety glass - Part 5: Dimensions and edge finishing
- EN ISO 12543-6: Glass in building - Laminated glass and laminated safety glass - Part 6: Appearance
- EN 14449 Glass in building - Laminated glass and laminated safety glass - FPC and Evaluation of Conformity

The responsibility to comply to the above standards lies at the manufacturer. The task of the Notified Test Body is limited to the assessment of the ITT.

The product description shall be added to this initial type test report by the manufacturer. It was to the manufacturer's responsibility that the samples delivered for initial type test are representative to the production and normal production deviations were included in the delivered test samples.

If any deviation of applied materials/process/machines is encountered (and a so-called major change), re-type testing or additional tests may be required. This decision and responsibility belongs to the manufacturer. The product description is the lead for determining the window of these rules.

The following paragraphs describe the tests, the results and the conclusions.

2 Product Testing

2.1 Producer of the samples

AGC Westland B.V.
Aartsdijkweg 23
2676 LE Maasdijk

2.2 Product description

6 samples of the following description were delivered for testing in March 2008:

- SentryGlass 33.44 with 2 x 1.52 mm SGP interlayer and Dia type GVT
Dimensions of the sample: 6 samples of 100 x 100 mm, thickness average 9.2 mm for high temperature test

Configuration of the test sample:

Flat glass	3 mm annealed float glass
Interlayer	1.52 mm SGP
Dia	GVT
Interlayer	1.52 mm SGP
Flat glass	3 mm annealed float glass

The samples of 100 x 300 mm were directly used for the durability tests at high temperature and high humidity.

Test specimens should be representative of standard production. Test specimens should either be specially manufactured to the test size or be cut from larger panes. Test specimen with cut edges should contain at least one edge from the original pane from which it was cut. If the final product has all its edges sealed/protected then the test specimen should also have all its edges sealed/protected.

The method of supporting the test specimen shall not cover two edges of the test specimen. If the test specimen is cut from a larger pane at least one original edge was covered. The samples were identified and visually inspected prior to the test at a distance between 30 cm and 50 cm in front of a white diffuse background. Only samples free of faults (bubbles, delamination, cloudiness) were used for the test.

2.3 Normative references

The EN ISO 12543-4 Standard specifies test methods in respect of resistance to high temperature, humidity and radiation for laminated glass and laminated safety glass for use in building. This European Standard EN ISO 12543-4 incorporates by dated or undated references, 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;

EN 410	Glass in building - Determination of luminous and solar characteristics of glazing
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2.4 Testing procedures

2.4.1 General

Testing the durability of laminated glass can be divided into two main groups with each two subgroups.

Laminated safety glass (EN – ISO 12543-2):

- Durability of laminated safety glass and laminated safety glass with fire resistant properties
 - High temperature test
 - Humidity test 5.3.1 (exposed direct to solar radiation)
 - Radiation test
- Durability of fire resistant laminated safety glass
 - Subgroup A:
 - Humidity test 5.3.2 (not exposed to direct solar radiation)
 - Subgroup B:
 - Humidity test 5.3.1 (exposed direct to solar radiation)
 - Radiation test

Laminated glass (EN – ISO 12543-3):

- Durability of laminated glass and laminated glass with fire resistant properties
 - High temperature test
 - Humidity test 5.3.1 (exposed direct to solar radiation)
 - Radiation test
- Durability of fire resistant laminated glass
 - Subgroup A:
 - Humidity test 5.3.2 (not exposed to direct solar radiation)
 - Subgroup B:
 - Humidity test 5.3.1 (exposed direct to solar radiation)
 - Radiation test

2.4.2 High temperature test

2.4.2.1 Principle

The purpose of this test is to determine whether the laminated glass and laminated safety glass will withstand exposure to high temperatures over an extended period of time without its properties becoming substantially altered. The change in properties is judged by the occurrence of bubbles, delamination and cloudiness (not discolouration).

2.4.2.2 Size and number of test specimens

The test specimens were not smaller than 300 mm x 100 mm.

2.4.2.3 Procedure

The three test specimens were heated to a temperature of 100_{-3}°C and maintained this

Temperature for a period of 2 h, then the test specimens were allowed to cool to room temperature. To avoid extreme thermal stresses leading to crack formation the specimens were heated up in two steps by first heating up at 50°C for 1 hour.

2.4.2.4 *Expression of results*

The samples were inspected at a distance between 30 cm and 50 cm in front of a white diffuse background. The number and extent of the faults occurring in the interlayer (bubbles, delamination, cloudiness, not discolouration) were recorded for each test specimen. All faults within 15 mm from an original edge and 25 mm from a cut edge were ignored (if any).

Delamination taken as a criterion for evaluation after the high temperature and the humidity test, are defined as essentially two dimensional phenomena, in the interfaces between the glass-interlayer and interlayer-interlayer, in which area no adhesion exists.

Results will be interpreted as the following:

- Laminated safety glass in accordance with clause 4.1 of EN ISO 12543-2
- Laminated glass in accordance with clause 4.1 of EN ISO 12543-3

2.4.3 *Humidity test*

2.4.3.1 *Principle*

The purpose of this test is to determine whether the laminated glass and laminated safety glass will withstand the effects of humidity in the atmosphere over an extended period of time without its properties becoming substantially altered. The effects of the humidity to be judged are bubbles, delamination and cloudiness (not discolouration).

2.4.3.2 *Size and number of test specimens*

The test specimens were not smaller than 300 mm x 100 mm.
There were three test specimens prepared by cutting from the delivered samples.

2.4.3.3 *Procedure*

Option A, Test with condensation (par. 5.3.1 EN ISO 12543-4)

Three test specimens were kept vertically for two weeks over water in a closed container. Maintain the temperature of the air in the container within the limits of 50^{+2}_{0} °C

Adequate spacing between the test specimens was provided.

Results will be interpreted as the following:

- Laminated safety glass in accordance with clause 4.1 of EN ISO 12543-2
- Laminated glass in accordance with clause 4.1 of EN ISO 12543-3

Option B, Test without condensation (par. 5.3.2 EN ISO 12543-4)

Put the three test specimen vertically for two weeks into a climate chamber and keep up the temperature within the limits of 50^{+2}_{0} °C and the relative humidity within the limits

$80 \pm 5\%$. Adequate spacing between the test specimens was provided.

Results will be interpreted as the following:

- Laminated safety glass in accordance with clause 5 of EN ISO 12543-2
- Laminated glass in accordance with clause 5 of EN ISO 12543-3

2.4.3.4 *Expression of results*

The samples were inspected at a distance between 30 cm and 50 cm in front of a white diffuse background. The number and extend of the faults occurring in the interlayer (bubbles, delamination, cloudiness, not discolouration) were recorded (if any) for each test specimen. All faults within 15 mm for an original edge, 25 mm from a cut edge or 10 mm from any crack were not taken into account (if any). Individual bubbles in the immediate vicinity of inlaid wires are permissible. In the case of fire resistant laminated glass and fire resistant laminated safety glass only delamination were considered.

3 Results

3.1 High temperature test

Type of glass: Laminated safety glass

Structure of the glass: 3 mm float / 1.52 mm SGP / Dia GVT / 1.52 mm SGP / 3 mm float

Test Procedure: Dry furnace

Sample Code	Type of test	Indoor / outdoor use?	Dimensions	Nominal thickness
1	High Temperature	outdoor	100 x 300	9.2
2	High Temperature	outdoor	100 x 300	9.2
3	High Temperature	outdoor	100 x 300	9.2

Sample characteristics:

Sample Code	Type of test	Cut or on size production	Edge type	Edge protection	Supported edge marked y/n
1	High Temperature	on size	arrissed	yes	no
2	High Temperature	on size	arrissed	yes	no
3	High Temperature	on size	arrissed	yes	no

For each test specimen the number and size of the bubbles, delamination and cloudiness occurring (not discolouration):

Results

Sample Code	Results	Bubbles y/n	Size of bubbles	Delamination y/n	Cloudiness y/n
1	High Temperature	no	-	no	no
2	High Temperature	no	-	no	no
3	High Temperature	no	-	no	no

3.2 Humidity test

Type of glass: Laminated safety glass

Structure of the glass: 3 mm float / 1.52 mm SGP / Dia GVT / 1.52 mm SGP / 3 mm float

Test Procedure: Test with condensation (5.3.1)

Sample Code	Type of test	Indoor / outdoor use?	Dimensions	Nominal thickness
4	5.3.1	outdoor	100 x 300	9.2
5	5.3.1	outdoor	100 x 300	9.2
6	5.3.1	outdoor	100 x 300	9.2

Sample characteristics:

Sample Code	Cut or on size production	Edge type	Edge protection	Supported edge marked y/n
4	on size	arrissed	yes	no
5	on size	arrissed	yes	no
6	on size	arrissed	yes	no

For each test specimen the number and size of the bubbles, delamination and cloudiness occurring (not discolouration): Note: In the case of fire resistant laminated safety glass and fire resistant laminated glass only (if any) delamination was given.

Results

Sample Code	Bubbles y/n	Size of bubbles	Delamination y/n	Cloudiness y/n
4	no	-	no	no
5	no	-	no	no
6	no	-	no	no

4 Conclusion

Some aspects are checked to establish if the laminated glass product of AGC Westland B.V. conforms to the definition of laminated glass and laminated safety glass.

The high temperature and high humidity test *fulfil* the requirements mentioned in EN ISO 12543 for laminated glass and laminated safety glass products.

When and if changes are made in production method and/or equipment, assessment according the EN ISO 12543 shall be reconsidered and re-test shall be done when the changes can lead to different properties the glass. The decision and responsibility lies at the producer.

5 Signature

Eindhoven, March 2008

TNO Quality Services BV

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