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BRE Test Report

Weathertightness test according to BS 6375-1:2015+A1:2016 on a Roofglaze Ltd Flatglass rooflight

Prepared for: Daniel Pugh, Flatglass Technical Manager
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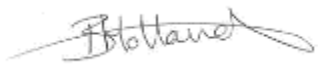
Signature 

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Name Dr. Paul Blackmore

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Table of Contents

1 Introduction

At the request of Daniel Pugh, Flatglass Technical Manager of Roofglaze Ltd, 11 Howard Road, Eaton Socon, St Neots, PE19 8ET, BRE issued project number P110587 on the 27th October 2017. The proposal was accepted by Richard Cliffe, Managing Director of Roofglaze Ltd, on the 27th October 2017. BRE received and stored the test specimen on the 27th November 2017 in BRE laboratory B21.2. The specimen was tested on the 28th November 2017.

BS EN 14351-1:2006+A2:2016 is the product standard that identifies mandated and non-mandated characteristics for windows and external pedestrian doors for the European market, and it enables products to be CE marked. Designers, specifiers, manufacturers and end users need to identify those characteristics and performance levels appropriate for the selected end use. These will vary from site to site and from country to country.

To avoid uneconomical and inappropriate specifications for the UK market recommended levels of performance have been identified. These performance levels (in this case for weathertightness) are in the National Application Document (NAD) BS 6375-1:2015+A1:2016.

The tests to methods specified in BS 6375-1:2015+A1:2016 are BS EN 1026:2016, BS EN 1027:2016 and BS EN 12211:2016, measure the weathertightness of the specimens in terms of air permeability, watertightness and resistance to wind load respectively. Classifications of the results is based on BS 6375-1:2015+A1:2016 and BS EN 12207:2016, BS EN 12208:2000 and BS EN 12210:2016.

The tests on the specimen were carried out by Mr Ben J Holland under the BRE Standard Terms and Conditions of Business for testing and to the UKAS BRE Specific Procedures Series F, as BRE Project number P110587-1000.

Testing was witnessed by:

Paul Butler	Roofglaze Ltd
Daniel Pugh	Roofglaze Ltd
Ian Osborne	Roofglaze Ltd
Phil Wood	Roofglaze Ltd

2 Test programme

BS 6375-1:2015+A1:2016 specifies that the air permeability test is performed under both positive and negative test pressures and that the average of the measurements defines the results. It also specifies that watertightness method 1A or 1B is used (dependant on installation location) and that deflections measured during the resistance to wind load test do not exceed 1/150 of the span. In this case, watertightness method 1A was used. The specimen was tested with the ventilation slots sealed off with tape.

The weathertightness test comprised of three parts in the sequence:

1. Air permeability to BS EN 1026:2016; by application of a series of test air pressure differentials across the specimen with measurement of the air permeability of it at each pressure step. The maximum positive and negative pressure differential was 300 Pa reached in pressure steps of 50, 100, 150, 200, 250 and 300 Pa.

2. Watertightness to BS EN 1027:2016; by applying specified amounts of water spray to the outside face of the specimen while incrementally increasing the air pressure differential across it. The test pressure, time and position of any water penetration are recorded. The maximum positive air pressure differential was 300 Pa. Pressure (Pa)/time (min) steps were 0/15, 50/5, 100/5,150/5, 200/5, 250/5 and 300/5.

3. Resistance to wind load to BS EN 12211:2016; by application of a series of positive and negative test air pressures. Measurements and inspections are made to assess relative frontal deflection and resistance to damage from wind loads.

   The resistance to wind load test includes a deflection test, a repeated pressure test and operational test, an air permeability test and finally a safety test. For the purpose of the resistance to wind load test three test pressures are defined:

   P1 applied to measure the deflections of parts of the test specimen.

   P2 50 cycles of pulsating pressure to assess performance under repeated wind loads.

   P3 applied to assess the safety of the test specimen under extreme conditions.

   The values of P1, P2 and P3 are related as follows: P2 = 0.5P1, P3 = 1.5P1.

   For these tests the values are: P1 = 2400 Pa, P2 = 1200 Pa and P3 = 3600 Pa.

Note: The repeat air permeability test is an integral part of the resistance to wind load test and its significance is as an indicator of damage that may occur during that test.

3 Classification of results

BS 6375-1:2015+A1:2016 classifies the results for products in the UK. For a window or door to be included in an exposure category the appropriate test pressures for air permeability, watertightness and resistance to wind shall be attained or exceeded. The relevant product standard BS EN 14351-1:2006+A2:2016 also states that classification of air permeability is based on the averages of the positive and negative air leakage values at each pressure step.

The specimen was tested to a UK exposure category of '2000+' (2400 Pa). The classifications set in BS 6375-1:2015+A1:2016 for a UK exposure category of 2000+ for windows and doors are:

- Air permeability at Class 2 (300 Pa)
- Watertightness at Class 7A up to and at 300 Pa
- Resistance to wind load at Class E 2400 (P1 2400 Pa, P2 1200 Pa and P3 3600 Pa).

When averages of the measurements of air permeability per square metre and length of the opening joints on the specimen give rise to adjacent air permeability classes then the specimen shall be classified in the most favourable of the two adjacent classes (according to BS EN 12207:2016 Clause 4.6).

BS EN classifications are explained below:

Air permeability: BS EN 12207:2016. The classification is based on a comparison of the air permeability of the test specimen related to both overall area and length of opening joint. There are four classes; Class 4 is applicable to the most airtight specimens while Class 1 describes those with most air leakage. To meet any class the measured air permeability of the specimen must not exceed the upper limit at any test pressure step in that class.

Watertightness: BS EN 12208:2000. The classification is based on a comparison of the watertightness of the test specimen related to test pressures and duration of the test. There are nine classes; 1A/1B up to 9A for test pressures from 0 Pa to 600 Pa. For specimens that remain watertight over 600 Pa for 5 minutes a class E 'xxx' is used. The 'xxx' is the maximum test pressure e.g. 750 Pa. To meet any class the specimen must remain watertight for 5 minutes up to and at the test pressure set for that class.

Resistance to wind load: BS EN 12210:2016. The classification is based on a comparison of the resistance to wind loads of the test specimen when subjected to test pressures P1, P2 and P3. There are five classes; 1 up to 5 for P1 test pressures from 400 Pa to 2000 Pa. For specimens that are tested to P1 pressures exceeding 2000 Pa a class E 'xxxx' is used. The 'xxxx' is the actual test pressure P1 used e.g. 2400 Pa. To achieve any class the resistance of the specimen to wind load must meet all the requirements for that class.

Note: This report has results for air permeability under positive and negative test pressures and a graph showing the average air permeability for them at each pressure step.

4 Test Specimen

Identity:	Roofglaze Ltd Flatglass Rooflight
Condition:	The Roofglaze Ltd Flatglass Rooflight was delivered and installed on the 27th November 2017 on a bespoke test rig.
Frame:	The specimen was installed on to a timber kerb
Glazing:	The glazing consisted of the follow: - 6 mm clear heat soak toughened and heat soak tested - 16 mm argon filled cavity and warm edge spacers - 6.8 mm clear laminated and low E
Seals:	Dow Corning 791 silicone seal around perimeter of glazing Weather seals: Butyl weather sealing tape and Illbruck TN163 security glazing tape
Hardware:	N/A
Fixings:	Specimen had two fixings each side with 740 mm centres
Dimensions:	1045 mm x 1045 mm. Area: 1.09 m^2 Overall length of opening joint = 0 m

Disclaimer: Please note BRE have not carried out a full forensic examination of the described test specimens. The full details were provided by Daniel Pugh of Roofglaze Ltd

5 Test rig and preparatory procedures

The test specimen was conditioned for at least 4 hours within temperature and humidity ranges specified in the test standards of 10ºC to 30ºC and 25% to 75% RH respectively.

The water temperature in the watertightness test was within the specified range of 4ºC to 30ºC.

A bespoke timber test rig was built on BRE's ACR Test Rig in which the specimen was mounted horizontally.

A spray bar with four full circular cone nozzles was mounted 200 mm above the specimen to apply water to the outside face of the specimen. The water flow rate per nozzle was 2 L/min in accordance with BS EN 1027:2016 spraying method 1A.

Transducers were mounted on independent supports to measure deflections of a frame member. Deflections were measured on the span at the positions indicated in the Appendix of this report.

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6 Summary of test results

The test results are summarised in Table 1 below for tests at a UK exposure category of '2000+'. Figures show detail of the test specimen and detailed results are given in the Appendix of this report.

Air permeability		**Watertightness**		**Resistance to wind loads**	
Requirements	**Results**	**Requirements**	**Results**	**Requirements**	**Results**
Class 2 at 300 Pa	Met requirements to achieve Class 2	Class 7A at 300 Pa	Met requirement to achieve Class 7A	Class E 2400 P1 = 2400 Pa P2 = 1200 Pa P3 = 3600 Pa	Met all of the requirements for Class E 2400

Table 1. Summary of results for Roofglaze Ltd Flatglass Rooflight

7 Conclusions

When the test specimen was tested to the standards described herein to a UK exposure category of '2000+' it was found to be:

- Sufficiently airtight to attain Class 2 based on the averages of results under positive and negative test pressures thus meeting the BS 6375-1:2015+A1:2016 requirements and those of BS EN 12207:2016 for Class 2 at 300 Pa.
- Successful in meeting the BS 6375-1:2015+A1:2016 requirements for Class 7A at 300 Pa at a UK exposure category of 2000+ using test method 1A up to and at 300 Pa.
- Resistant to wind loads of ±2400 Pa causing deflections less than 1/150 of the span of the frame member. Resistant to repeated pressure cycles of ±1200 Pa and able to sustain the corresponding safety test pressure of ±3600 Pa. The overall classification for resistance to wind load is Class E 2400 thus meeting the requirements of BS 6375-1:2015+A1:2016 and BS EN 12210:2016.
- Overall weathertightness performance measured on this specimen means it is suitable, in the condition tested, for a UK exposure category of '2000+', as tested and defined in BS 6375-1:2015+A1:2016.

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8 References

1. BS EN 14351-1:2006 +A2:2016 Windows and doors – Product standard. British Standards Institution, London.
2. BS 6375-1:2015+A1:2016. Performance of windows and doors – Classification for weathertightness and guidance on selection and specification
3. BS EN 1026:2016. Windows and doors – Air permeability – Test method. British Standards Institution, London.
4. BS EN 1027:2016. Windows and doors – Watertightness – Test method. British Standards Institution, London.
5. BS EN 12211:2016. Windows and doors – Resistance to wind load – Test method. British Standards Institution, London.
6. BS EN 12207:2016. Windows and doors – Air permeability - Classification. British Standards Institution, London.
7. BS EN 12208:2000. Windows and doors – Watertightness - Classification. British Standards Institution, London.
8. BS EN 12210:2016. Windows and doors – Resistance to wind load - Classification. British Standards Institution, London.

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Appendix A Weathertightness Test Results

Roofglaze Ltd Flatglass Rooflight

Air Permeability Results

Conditions in the test laboratory and test rig at the start of tests:

Barometric Pressure (mb) 1000 Temperature (°C) 19.1 Relative Humidity (%) 65.3
Water Temperature (°C) 18.4 Temperature in Test Rig (°C) 18.5

Pressure Differential Pa	Air flow through the Specimen m³/h	Air flow per unit area of the specimen m³/h.m²
50	0.00	0.00
100	0.03	0.03
150	0.18	0.16
200	0.43	0.39
250	0.56	0.51
300	0.59	0.54

Table A1. Air permeability under positive pressure

Pressure Differential Pa	Air flow through the Specimen m³/h	Air flow per unit area of the specimen m³/h.m²
50	0.01	0.01
100	0.03	0.02
150	0.25	0.23
200	0.64	0.58
250	1.27	1.16
300	1.34	1.23

Table A2. Air permeability under negative pressure

Pressure Differential Pa	Average air flow per m of opening joint on the specimen m³/h.m
50	0.00
100	0.03
150	0.06
200	0.07
250	0.08
300	0.09

Table A3. Average of air permeability under positive and negative pressure differential

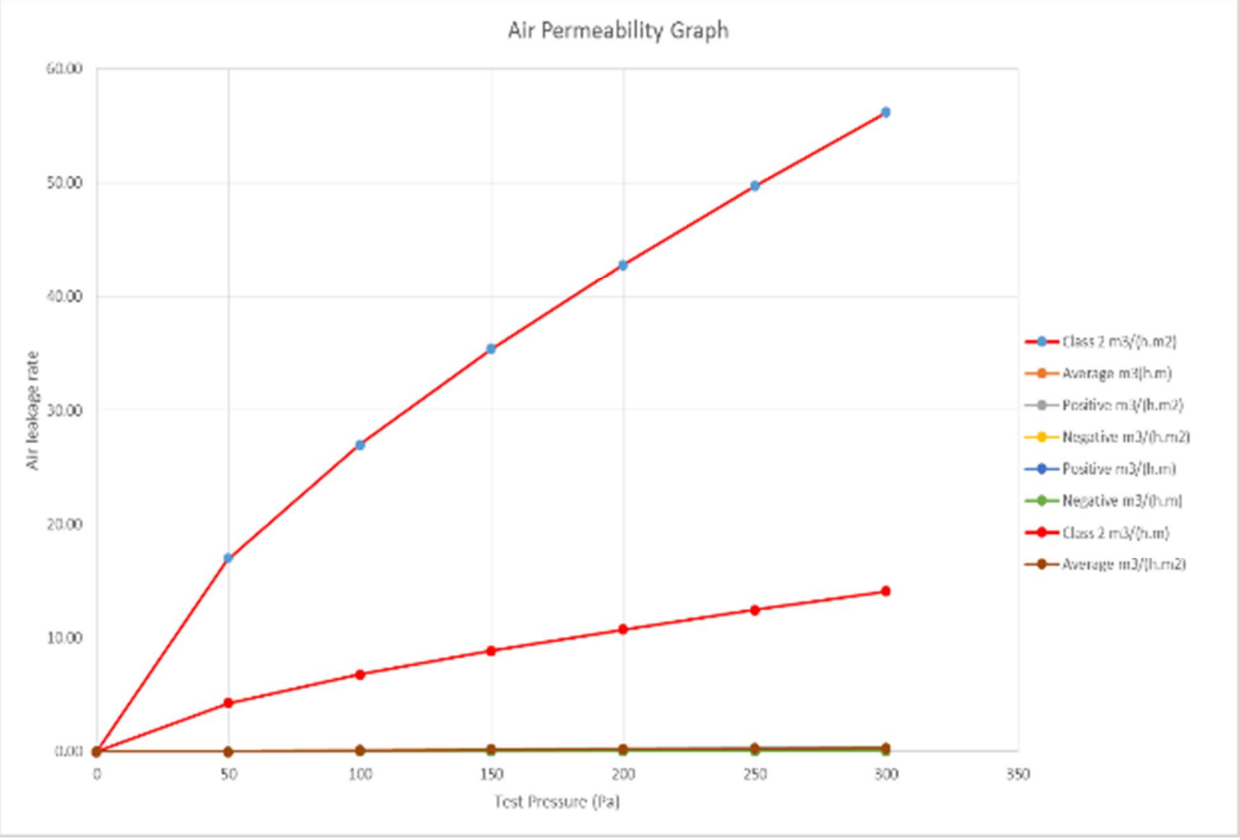

Figure A1. Test results. Air permeability under positive and negative pressures; showing air leakage limits and averages of air permeability across positive and negative differentials

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Watertightness Results

Test Pressure (Pa)	Duration in minutes	Test Results
0	15	Nil
50	5	Nil
100	5	Nil
150	5	Nil
200	5	Nil
250	5	Nil
300	5	Nil

Table A4. Watertightness test results

Resistance to Wind Load Results

Deflection Test

Position deflection measured	Positive pressure P1 to +2400 Pa		Negative pressure P1 to -2400 Pa	
	Deflection		Deflection	
	mm	defl./span	mm	defl./span
Edge of rooflight (see Figure A3)	0.85	1/1146 ≤1/150	0.67	1/1463 ≤1/150

Table A5. Deflections measured on edge of rooflight in resistance to wind load test

Repeated Pressure test including the second air permeability test

Repeated pressure	Damage or functional defects
50 cycles to P2 at ±1200 Pa	None

Table A6. Table of damages or defects after repeated pressure test

Second air permeability test* under positive air pressures (part of resistance to wind load test)

Pressure differential Pa	Air flow through the specimen m³/h	Air flow through specimen measured at first air permeability test m³/h	Comparison to the air permeability measured previously (see Table A1)
50 100 150 200 250 300	0.01 0.01 0.03 0.06 0.09 0.12	0.00 0.03 0.18 0.43 0.56 0.59	After the test pressures P1 and P2 were applied the amount of air flowing through the test specimen was reduced.

Table A7. Second air permeability test results under positive air pressures

Second air permeability test* under negative air pressures (part of resistance to wind load test)

Pressure differential Pa	Air flow through the specimen m³/h	Air flow through specimen measured at first air permeability test m³/h	Comparison to the air permeability measured previously (see Table A2)
50	0.02	0.01	After the test pressures P1 and P2 were applied the amounts of air flowing through the test specimen was reduced.
100	0.04	0.03	
150	0.08	0.25	
200	0.18	0.64	
250	0.30	1.27	
300	0.34	1.34	

Table A8. Second air permeability test results under negative air pressures

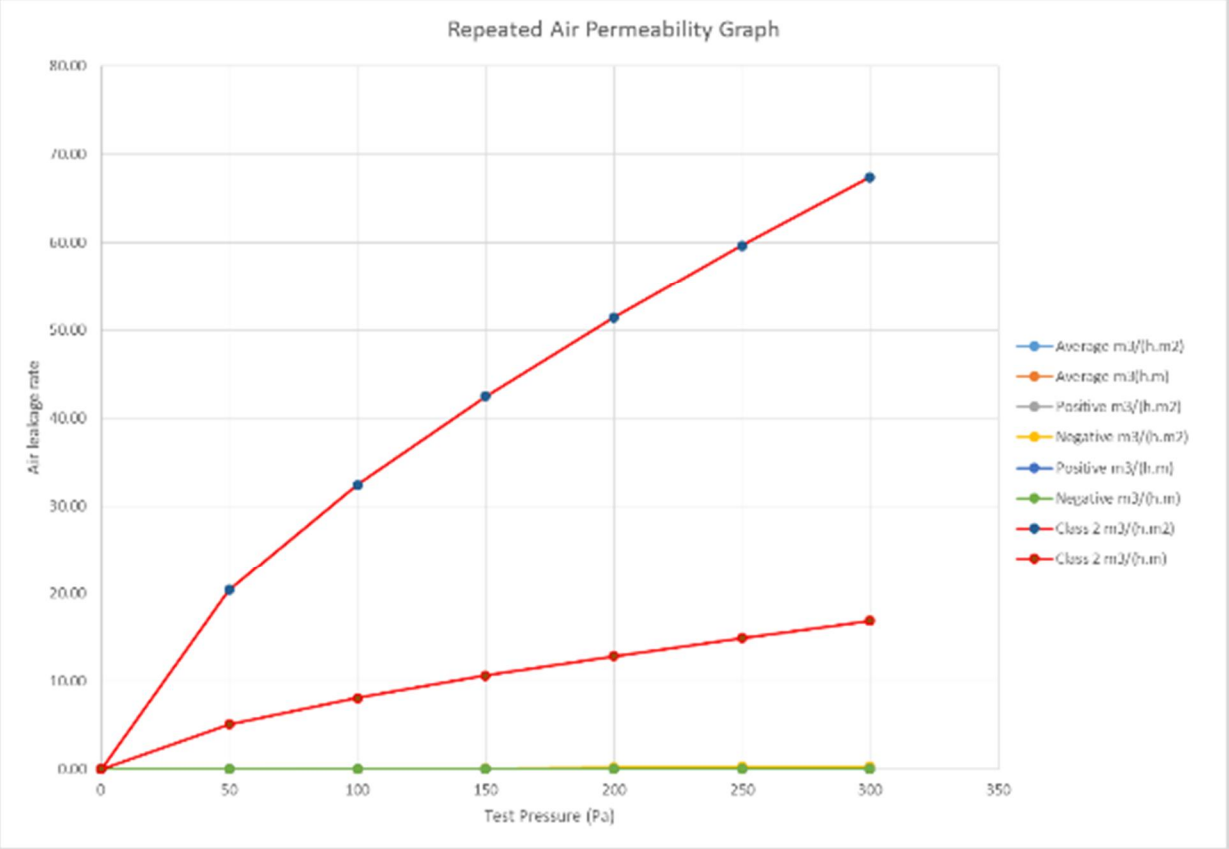

Figure A2. Test results. Air permeability under positive and negative pressures; showing air leakage limits and averages of air permeability across positive and negative differentials including 20% increase allowance

Resistance to wind load - Safety test

Safety test	Condition after test
One pressure pulse to pressure: P3 at – then + 3600 Pa	No parts became detached and the test specimen remained closed

Table A9. Condition of the specimen after the safety test to P3 at ±3600 Pa

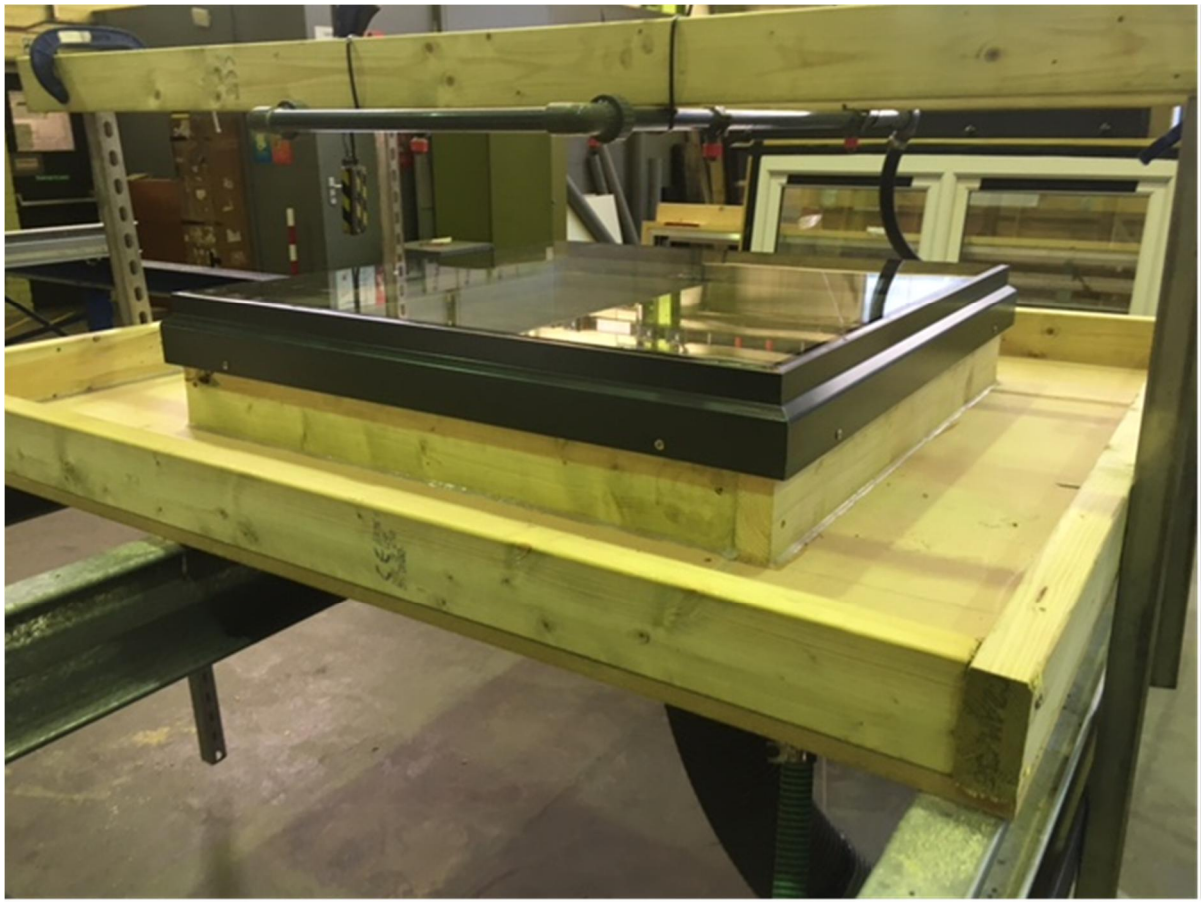

Figure A3. Roofglaze Ltd Flatglass Rooflight installed on BRE Test Rig

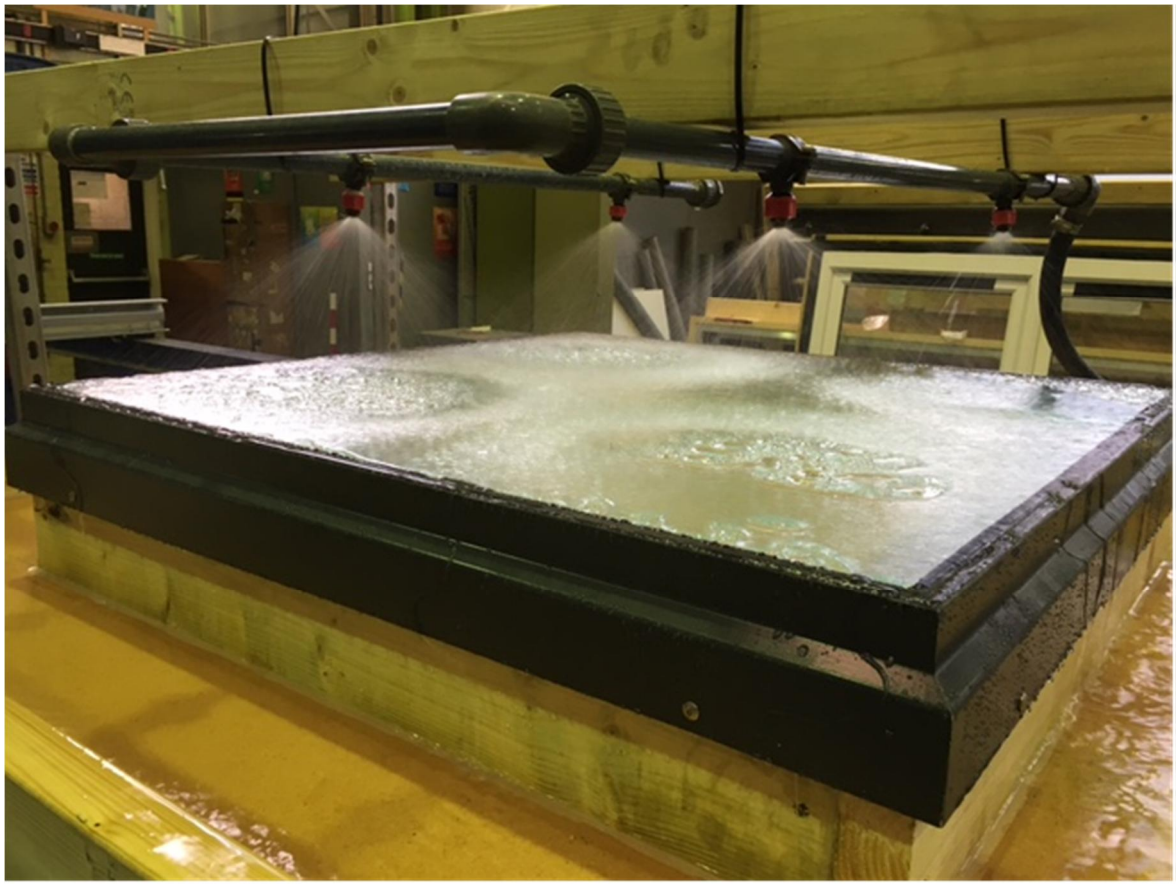

Figure A4. Roofglaze Ltd Flatglass Rooflight under watertightness test

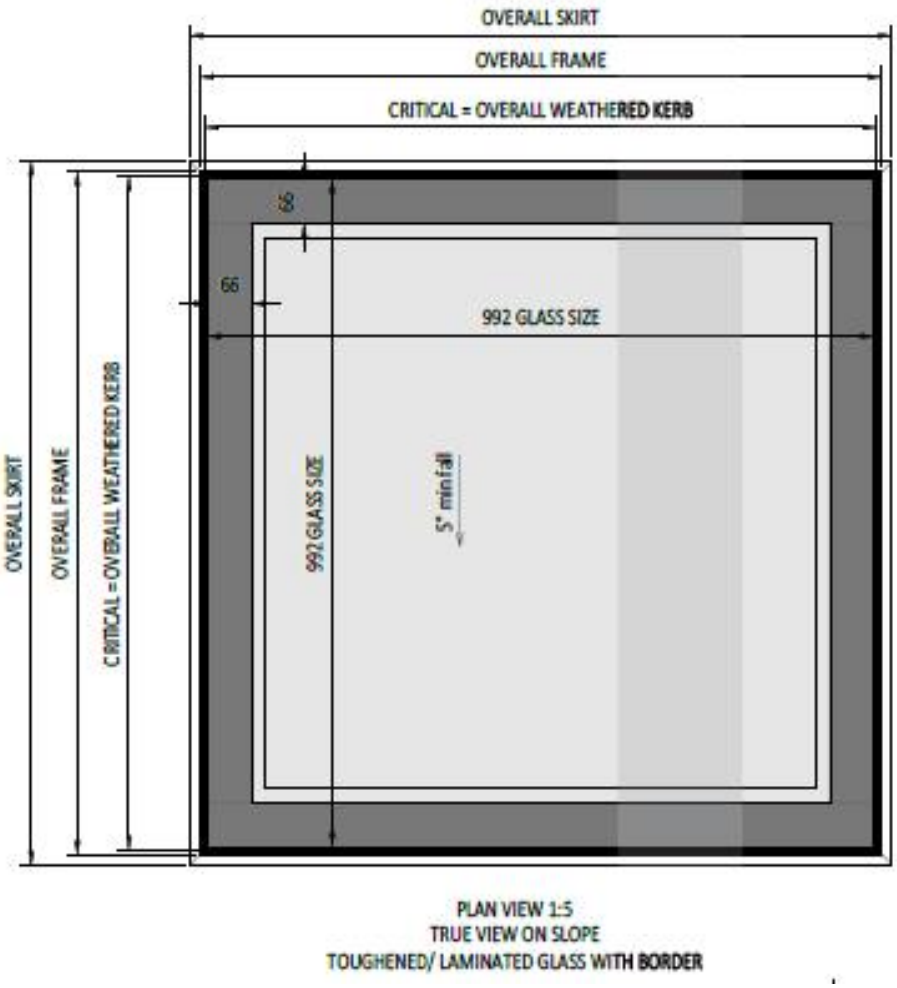

Figure A5. Drawing of Roofglaze Ltd Flatglass Rooflight

Report Ends