Technical Report

Title	WEATHERTIGHTNESS TESTING A SAMPLE OF AVON DRYWALL BEAM CLADDING
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Abstract

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CONTENTS

1. INTRODUCTION

This report describes tests carried out at our premises in Leighton Buzzard at the request of Alumet Systems (UK) Ltd, Senator House, Bourne End, Kineton Road Industrial Estate, Southam, Warwickshire CV47 0NA.

The test sample consisted of a sample of Avon Drywall Beam Cladding manufactured by Alumet Systems.

Taylor Woodrow is accredited by the United Kingdom Accreditation Service as UKAS Testing Laboratory No.0057 and is also approved with Lloyds Register of Quality Assurance for ad-hoc in-service inspections and tests to ISO 9001 2000.

The tests were carried out between March and April 2004 and were to determine the weathertightness of the test sample. The test methods were in accordance with the CWCT Standard Test Methods for curtain walling for:

Air permeability.

Watertightness using static pressure.

Watertightness using dynamic pressure.

Watertightness using hose.

Wind resistance - serviceability & safety.

The testing was carried out in accordance with Taylor Woodrow Method Statement C861/MS rev1.

This test report relates only to the actual sample as tested and described herein.

The results are valid only for the conditions under which the tests were conducted.

The tests were witnessed wholly or in part by A. J. Lynch and D. Brady of Alumet Systems.

2. DESCRIPTION OF TEST SAMPLE

2.1 GENERAL ARRANGEMENT

The sample was as shown in the photo below and the drawings included as an appendix to this report. For details of any remedial work carried out refer to Section 7.

PHOTO 04070001

TEST SAMPLE ELEVATION

2.2 CONTROLLED DISMANTLING

During the dismantling of the sample no water penetration or discrepancies from the drawings were found.

The following photographs were taken during the controlled dismantle.

PHOTO 04130011

TERRACOTTA TILES REMOVED

PHOTO 04130033

MENBRANE ABOVE CURTAIN WALLING

PHOTO 04130043

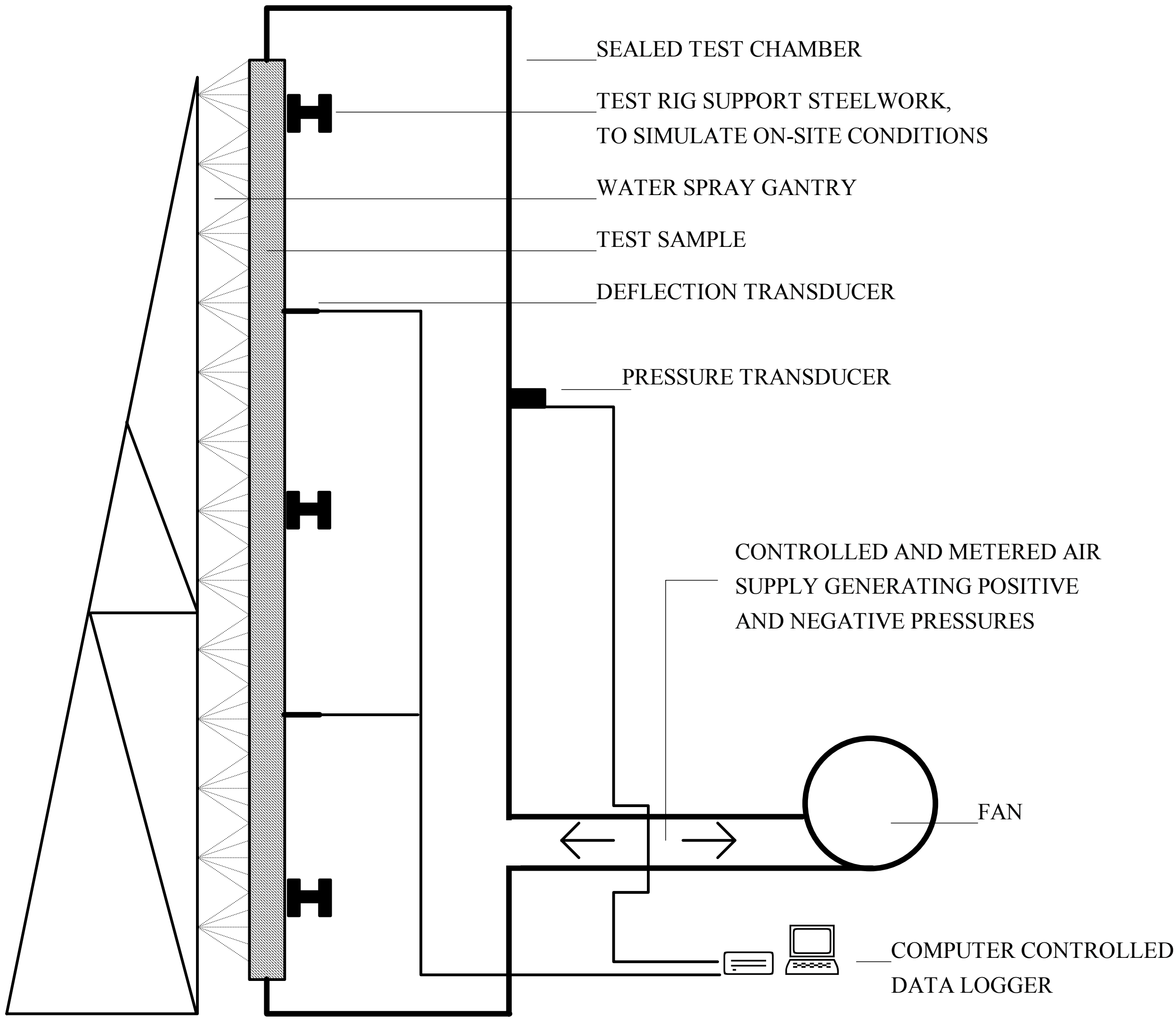
RAINSCREEN PANELS/TILES AND CURTAIN WALLING REMOVED.

3. TEST RIG GENERAL ARRANGEMENT

The test sample was mounted on a rigid test rig with support steelwork designed to simulate the on-site/project conditions. The test rig comprised a well sealed chamber, fabricated from steel and plywood. A door was provided to allow access to the chamber. Representatives of Alumet Systems installed the sample on the test rig. See Figure 1.

FIGURE 1

TYPICAL TEST RIG GENERAL ARRANGEMENT



SECTION THROUGH TEST RIG

4. TEST SEQUENCE

The test sequence was as follows:

(1) Air permeability

(2) Watertightness - static

(3) Wind resistance - serviceability

(4) Air permeability

(5) Watertightness - static

(6) Watertightness - dynamic

(7) Watertightness - hose

(8) Wind resistance - safety

Prior to starting the formal test sequence a watertightness pre-test (2) was carried out.

5. SUMMARY OF TEST RESULTS

The following summarises the results of the tests carried out. For full details refer to Sections 6, 7 and 8.

TABLE 1

Date	Test number	Test description	Result
16 March 2004	2	Watertightness – static (pre-test)	Fail
18 March 2004	2	Watertightness – static (pre-test)	Fail
24 March 2004	2	Watertightness – static (pre-test)	Fail
29 March 2004	2	Watertightness – static (pre-test)	Fail
30 March 2004	2	Watertightness – static (pre-test)	Fail
1 April 2004	2	Watertightness – static (pre-test)	Pass
7 April 2004	1	Air permeability	Pass
8 April 2004	2	Watertightness – static	Pass
8 April 2004	3	Wind resistance – serviceability	Pass
8 April 2004	4	Air permeability	Pass
8 April 2004	5	Watertightness - static	Pass
8 April 2004	6	Watertightness - dynamic	Pass
8 April 2004	7	Watertightness - hose	Pass
8 April 2004	8	Wind resistance - safety	Pass

6. AIR PERMEABILITY TESTING

6.1 INSTRUMENTATION

6.1.1 Pressure

One static pressure tapping was provided to measure the chamber pressure and was located so that the readings were unaffected by the velocity of the air supply into or out of the chamber.

A pressure transducer, capable of measuring rapid changes in pressure to within 2% was used to measure the differential pressure across the sample.

6.1.2 Air Flow

A laminar flow element mounted in the air system ductwork was used with a pressure transducer to measure the air flow into the chamber. This device was capable of measuring airflow through the sample to within 2%.

6.1.3 Temperature

Platinum resistance thermometers (PRT) were used to measure air temperatures to within 1°C.

6.1.4 General

Electronic instrument measurements were scanned by a computer controlled data logger, which also processed and stored the results.

All measuring instruments and relevant test equipment were calibrated and traceable to national standards.

6.2 FAN

The air supply system comprised a variable speed centrifugal fan and associated ducting and control valves to create positive and negative static pressure differentials. The fan provided essentially constant air flow at the fixed pressure for the period required by the tests and was capable of pressurising at a rate of approximately 600 pascals in one second.

6.3 PROCEDURE

Three positive pressure pulses of 660 pascals were applied to prepare the test sample.

The average air permeability was determined by measuring the rate of air flow through the chamber whilst subjecting the sample to positive pressure differentials of 50, 100, 150, 200, 300, 450, 600, 450, 300, 200, 150, 100 and 50 pascals. Each pressure increment was held for at least 10 seconds.

Extraneous leakage through the test chamber and the joints between the chamber and the test sample was determined by sealing the sample with polythene sheeting and adhesive tape and measuring the air flow at the pressures given above.

The test was then repeated with the sample unsealed; the difference between the readings being the rate of air flow through the sample.

6.4 PASS/FAIL CRITERIA

The permissible air flow rate, Q_o, at peak test pressure, p_o, could not exceed:

1.5 m^3 per hour per m^2.

At intermediate pressures, p_n, flow rates, Q_n, were calculated using $Q_n = Q_o(p_n/p_o)^{2/3}$

The area of the sample = 51.5 m^2.

6.5 RESULTS

TABLE 2

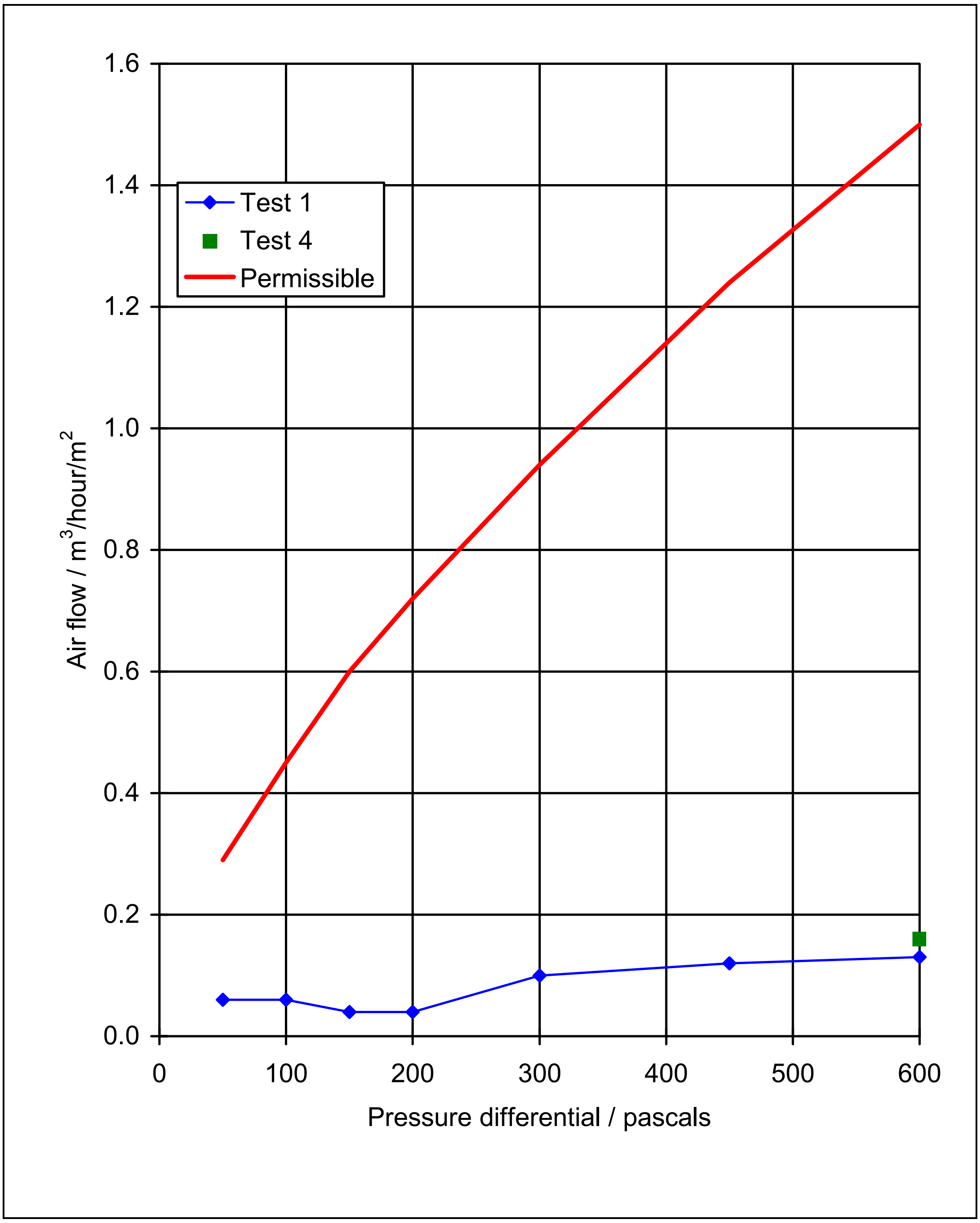
Pressure differential (pascals)	Maximum air flow through sample (m^3/hour/m^2)	
	Test 1 Date: 7 April 2004	Test 4 Date: 8 April 2004
50	0.06	--
100	0.06	--
150	0.04	--
200	0.04	--
300	0.10	--
450	0.12	--
600	0.13	0.16
Temperatures	Ambient = 7°C Chamber = 18°C	Ambient = 8°C Chamber = 19°C

The results are shown graphically in Figure 2.

Note: For test 4 an overall chamber/sample air reading was taken at a pressure differential of 600 pascals.

FIGURE 2

Air permeability test results



7. WATERTIGHTNESS TESTING

7.1 INSTRUMENTATION

7.1.1 Pressure

One static pressure tapping was provided to measure the chamber pressure and was located so that the readings were unaffected by the velocity of the air supply into or out of the chamber.

A pressure transducer, capable of measuring rapid changes in pressure to within 2% was used to measure the differential pressure across the sample.

7.1.2 Water Flow

An in-line water flow meter was used to measure water supplied to the spray gantry to within 5%.

7.1.3 Temperature

Platinum resistance thermometers (PRT) were used to measure air and water temperatures to within 1°C.

7.1.4 General

Electronic instrument measurements were scanned by a computer controlled data logger, which also processed and stored the results.

All measuring instruments and relevant test equipment were calibrated and traceable to national standards.

7.2 FAN

7.2.1 Static Pressure Testing

The air supply system comprised a variable speed centrifugal fan and associated ducting and control valves to create positive and negative static pressure differentials. The fan provided essentially constant air flow at the fixed pressure for the period required by the tests and was capable of pressurising at a rate of approximately 600 pascals in one second.

7.2.2 Dynamic Pressure Testing

A wind generator was mounted adjacent to the external face of the sample and used to create positive pressure differentials during dynamic testing. The wind generator comprised a piston type aero-engine fitted with 4 m diameter contra-rotating propellers.

7.3 WATER SPRAY

7.3.1 Spray Gantry

The water spray system comprised nozzles spaced on a uniform grid not more than 700 mm apart and mounted approximately 400 mm from the face of the sample. The nozzles provided a full-cone square pattern with not less than 80° spread. The spray system delivered water uniformly against the exterior surface of the sample.

7.3.2 Hose test

The water was applied using a brass nozzle that produced a solid cone of water droplets with a nominal spread of 30°. The nozzle was used with a ¾" hose and provided with a control valve and a pressure gauge between the valve and nozzle.

7.4 PROCEDURE

7.4.1 Watertightness – static

Three positive pressure pulses of 660 pascals were applied to prepare the test sample.

Water was sprayed onto the sample using the method described above at a rate of at least 3.4 litres/m^2/minute for 15 minutes at zero pressure differential. With the water spray continuing the pressure differential across the sample was then increased in increments of: 50, 100, 150, 200, 300, 450 and 600 pascals, each held for 5 minutes.

Throughout the test the interior face of the sample was examined for water penetration.

7.4.2 Watertightness – dynamic

Water was sprayed onto the sample using the method described above at a flow rate of at least 3.4 litres/m^2/minute.

The aero-engine was used to subject the sample to wind of sufficient velocity to produce average deflections in the principle framing members equal to those produced by a static pressure differential of 600 pascals. Suction was applied to the inside of the specimen to achieve the required test deflections but was limited to 25% of the peak static pressure. These conditions were maintained for 15 minutes. Throughout the test the inside of the sample was examined for water penetration.

7.4.3 Watertightness – hose

Working from the exterior, the selected area was wetted progressing from the lowest horizontal joint, then the intersecting vertical joints, then the next horizontal joint above, etc. The water was directed at the joint and perpendicular to the face of the sample. The nozzle was moved slowly back and forth above the joint at a distance of 0.3 metres from it for a period of 5 minutes for each 1.5 metres of joint. Shorter or slightly longer joints were tested pro rata. The water flow to the nozzle was adjusted to produce 22, ±2 litres per minute when the water pressure at the nozzle inlet was 220, ±20 kPa.

Throughout the test the interior face of the sample was examined for water penetration. The joints tested are shown in Figure 3.

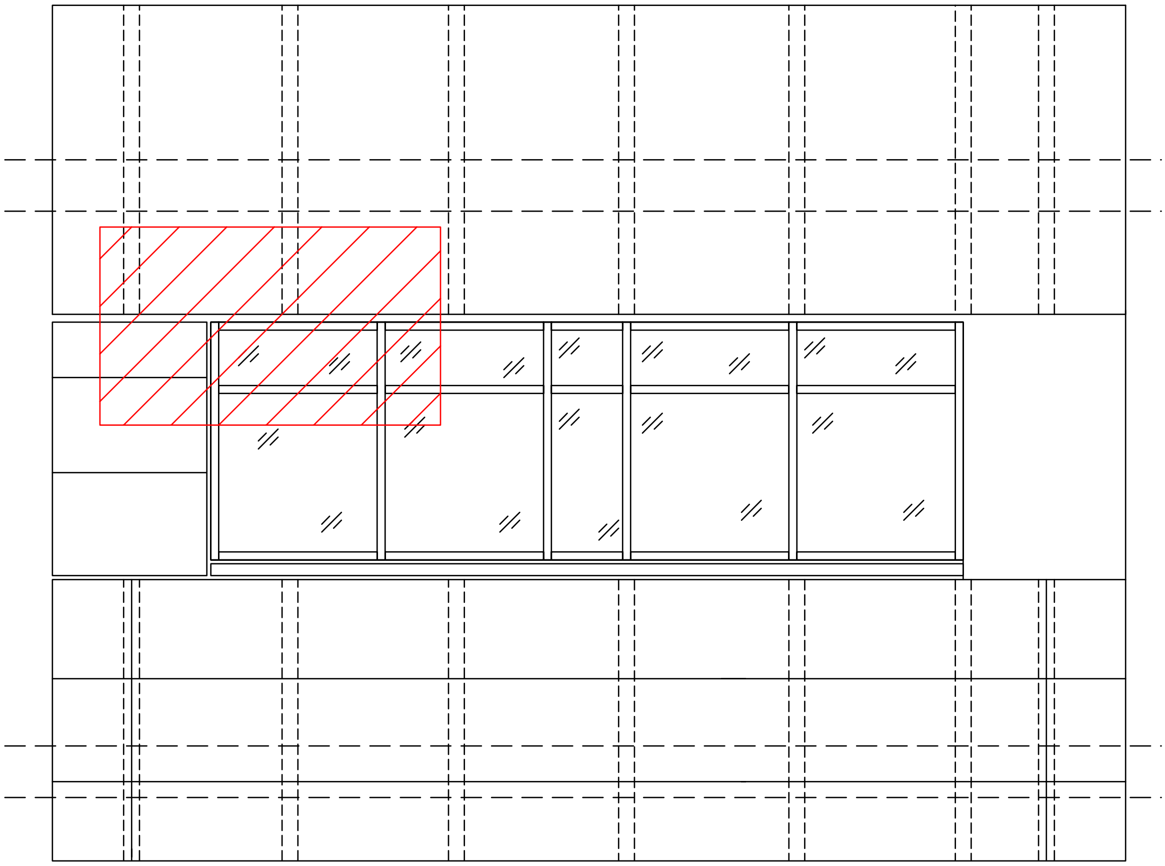
7.5 PASS/FAIL CRITERIA

There shall be no water penetration to the internal face of the sample throughout testing. At the completion of the test there shall be no standing water in locations intended to remain dry.

FIGURE 3

HOSE TEST AREA

External View



7.6 RESULTS

Test 2 (Static pressure pre-test) Date: 16 March 2004

Water leakage was observed during the test as described below and shown in Figure 4.

At zero pressure water was observed from transom/mullion joints at locations 1 & 2.

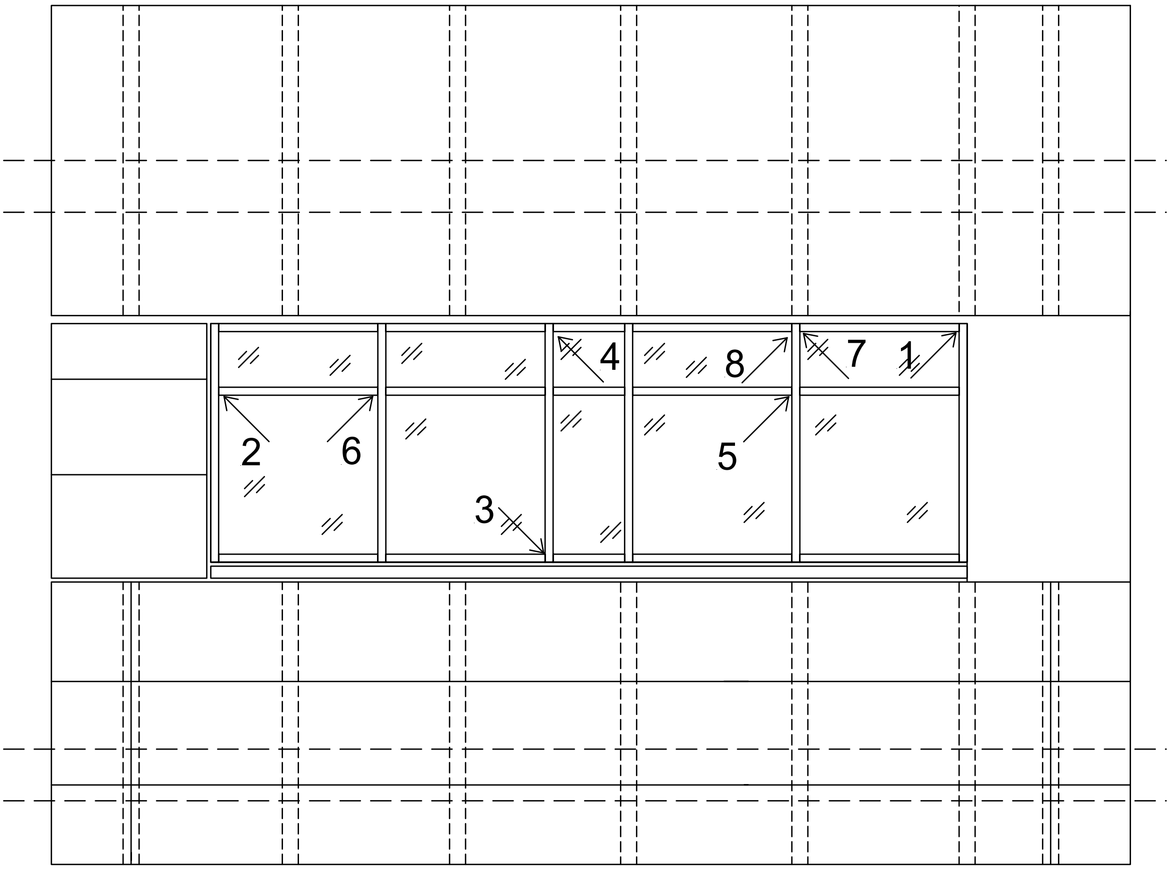
At a pressure differential of 50 pascals, water was observed from transom/mullion joints at locations 3 & 4.

At a pressure differential of 100 pascals, water was observed from transom/mullion joints at locations 5 & 6.

At a pressure differential of 450 pascals, water was observed from transom/mullion joints at locations 7 & 8.

Chamber temperature= 22°C
Ambient temperature = 15°C
Water temperature = 8°C

FIGURE 4



Remedial work

The following remedial work was carried out by Alumet Systems.

The missing EPDM was fitted to the head of the curtain walling.

The drain channel obscured by the head trim was cleared.

The pressure plate screws were torqued up to 6-7 Nm.

Test 2 (Static pressure pre-test) Date: 18 March 2004

Water leakage was observed during the test as described below and shown in Figure 5.

At a pressure differential of 150 pascals, water was observed from transom/mullion joints at locations 1, 2 & 3.

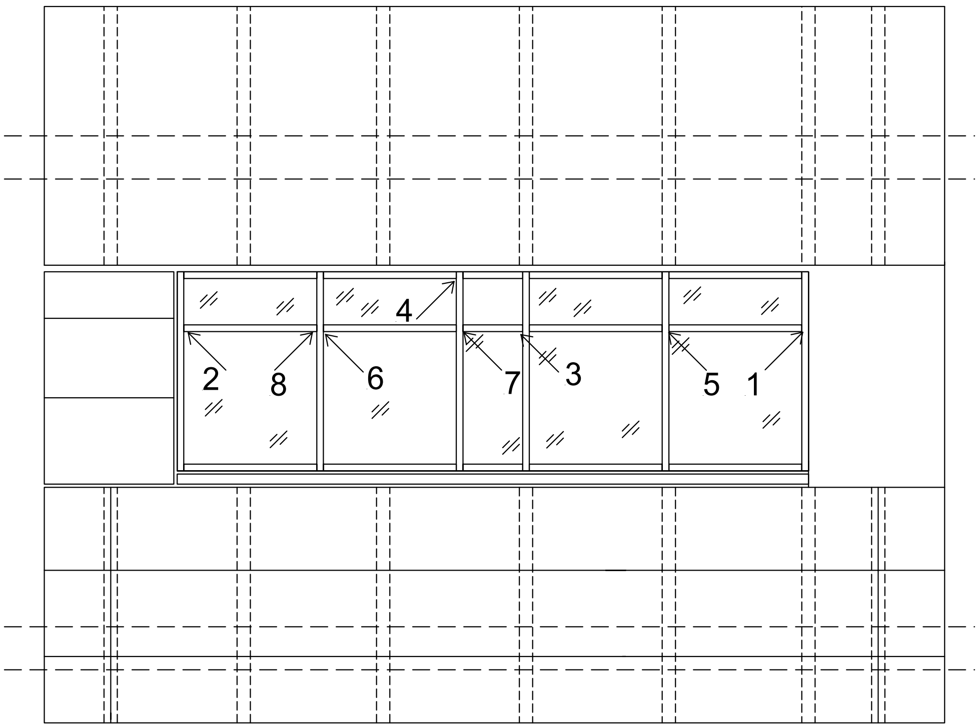
At a pressure differential of 200 pascals, water was observed from transom/mullion joints at locations 4 & 5.

At a pressure differential of 450 pascals, water was observed from transom/mullion joint at location 6.

At a pressure differential of 600 pascals, water was observed from transom/mullion joints at locations 7 & 8.

Chamber temperature= 20°C
Ambient temperature = 14°C
Water temperature = 9°C

FIGURE 5



Remedial work

The following remedial work was carried out by Alumet Systems.

The SARA curtain walling was replaced with Schuco curtain walling.

Test 2 (Static pressure pre-test) Date: 24 March 2004

Water leakage was observed during the test as described below and shown in Figure 6.

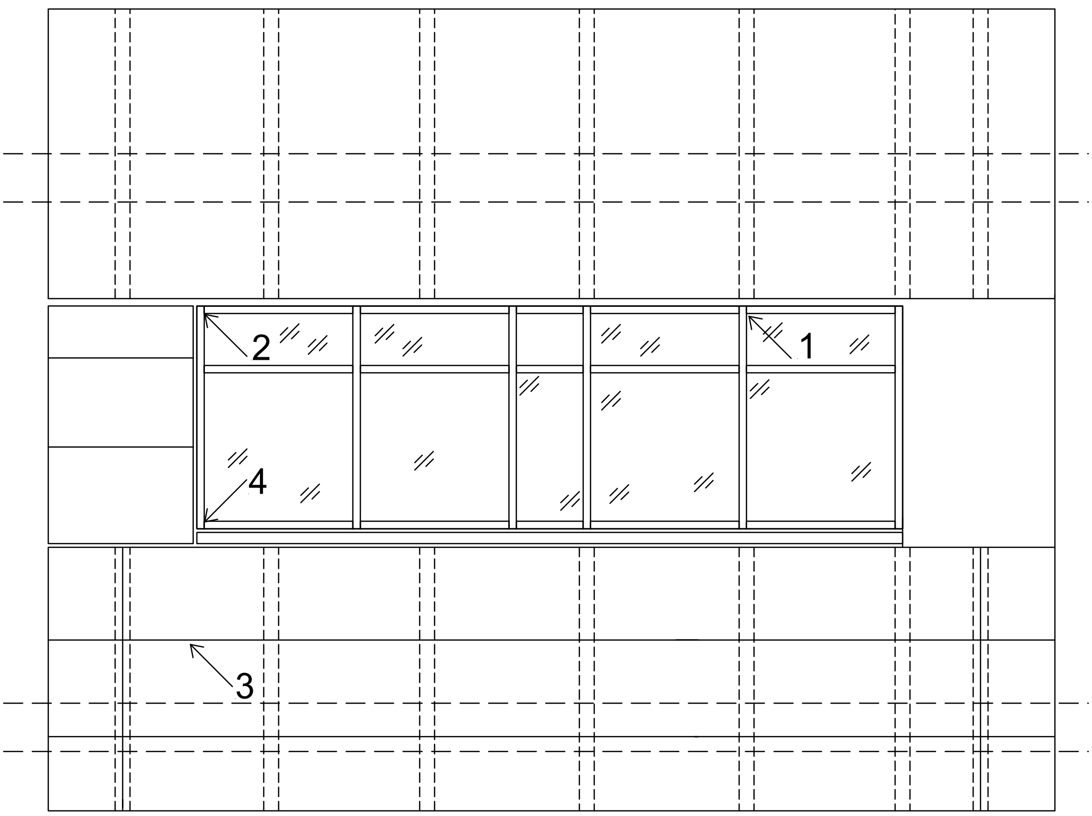
At a pressure differential of 300 pascals, water was observed from transom/mullion joint at location 1.

At a pressure differential of 450 pascals, water was observed from transom/mullion joint at location 2.

At a pressure differential of 600 pascals, water was observed from the EPDM seal at location 3. Water was also observed from the glazing gasket at location 4.

Chamber temperature= 17°C
Ambient temperature = 13°C
Water temperature = 9°C

FIGURE 6



Remedial work

The following remedial work was carried out by Alumet Systems.

The membranes were amended as shown in the drawings included at the back of this report.

Test 2 (Static pressure pre-test) Date: 29 March 2004

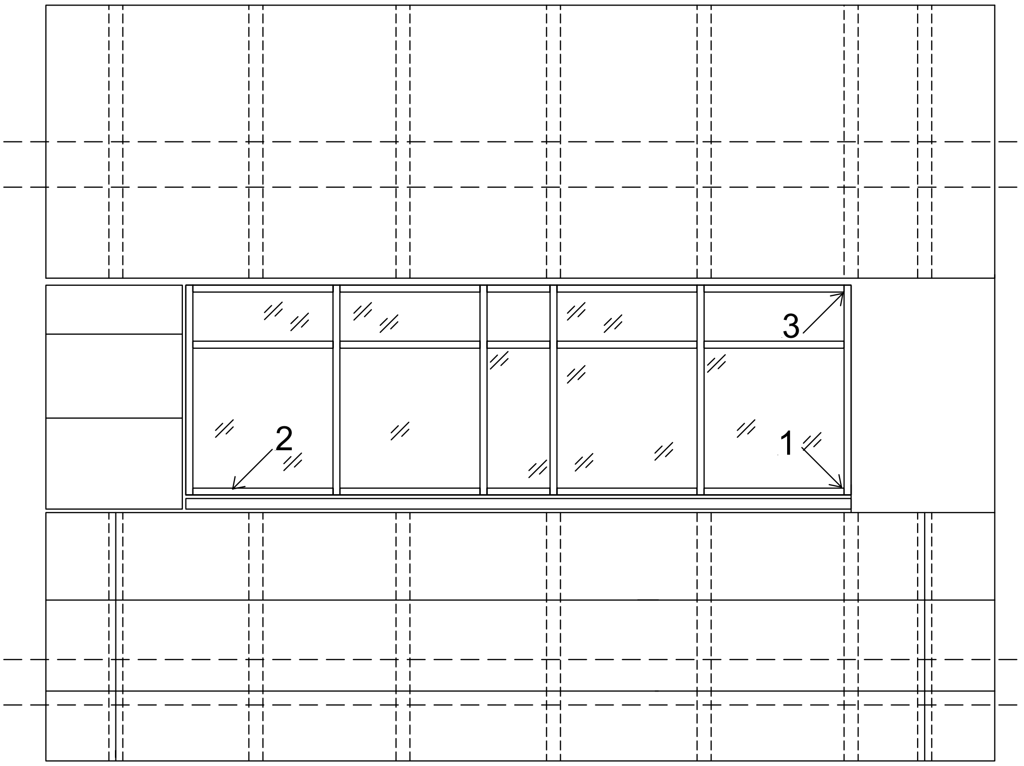
Water leakage was observed during the test as described below and shown in Figure 7.

At a pressure differential of 450 pascals, water was observed from the membrane at locations 1 & 2.

At a pressure differential of 600 pascals, water was observed from transom/mullion joint at location 3.

Chamber temperature= 18°C
Ambient temperature = 9°C
Water temperature = 10°C

FIGURE 7



Remedial work

The following remedial work was carried out by Alumet Systems.

The EPDM carrier was re-applied at the bottom of the curtain walling.

A hole was repaired in the bottom right hand side of the membrane.

Test 2 (Static pressure pre-test) Date: 30 March 2004

Water leakage was observed during the test as described below and shown in Figure 8.

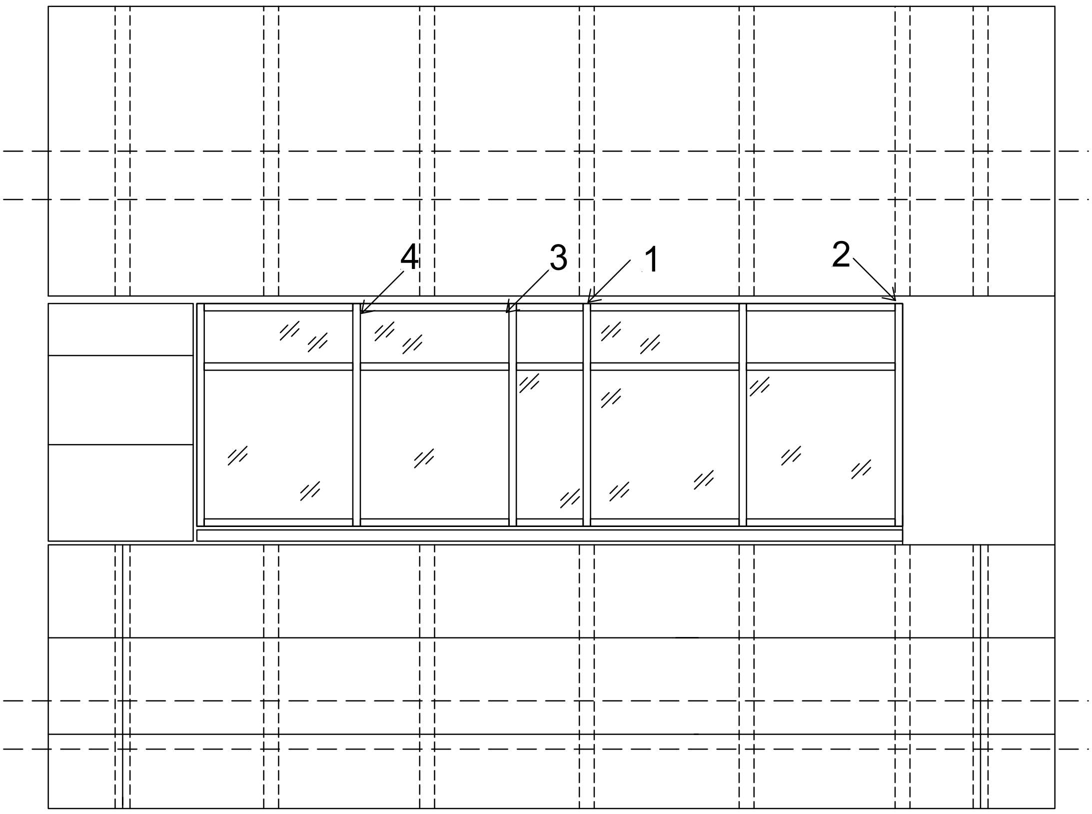
At a pressure differential of 150 pascals, water was observed from the membrane at location 1.

At a pressure differential of 200 pascals, water was observed from the membrane at location 2.

At a pressure differential of 600 pascals, water was observed from transom/mullion joints at locations 3 & 4.

Chamber temperature= 17°C
Ambient temperature = 10°C
Water temperature = 10°C

FIGURE 8



Remedial work

The following remedial work was carried out by Alumet Systems.

The EPDM was re-fitted to the head of the curtain walling and the internal tape re-fitted from the curtain walling to the beam.

The inner seal from between the curtain walling and beam was renewed.

Test 2 (Static pressure pre-test) Date: 1 April 2004

No water penetration was observed throughout the test.

Chamber temperature= 9°C
Ambient temperature = 7°C
Water temperature = 12°C

Remedial work

The following remedial work was carried out by Alumet Systems.

Three cracked glass units were replaced with new ones.

Test 2 (Static pressure pre-test) Date: 6 April 2004

No water penetration was observed throughout the test.

Chamber temperature= 14°C
Ambient temperature = 7°C
Water temperature = 11°C

Test 2 (Static pressure) Date: 8 April 2004

No water penetration was observed throughout the test.

Chamber temperature= 23°C
Ambient temperature = 4°C
Water temperature = 10°C

Test 5 (Static pressure) Date: 8 April 2004

No water penetration was observed throughout the test.

Chamber temperature= 20°C
Ambient temperature = 8°C
Water temperature = 11°C

Test 6 (Dynamic pressure) Date: 8 April 2004

No water penetration was observed throughout the test.

Chamber temperature= 18°C
Ambient temperature = 9°C
Water temperature = 11°C

Test 7 (Hose test) Date: 8 April 2004

No water penetration was observed throughout the test.

Chamber temperature= 18°C
Ambient temperature = 9°C
Water temperature = 11°C

8. WIND RESISTANCE TESTING

8.1 INSTRUMENTATION

8.1.1 Pressure

One static pressure tapping was provided to measure the chamber pressure and was located so that the readings were unaffected by the velocity of the air supply into or out of the chamber.

A pressure transducer, capable of measuring rapid changes in pressure to within 2% was used to measure the differential pressure across the sample.

8.1.2 Deflection

Displacement transducers were used to measure the deflection of principle framing members to an accuracy of 0.1 mm. The gauges were set normal to the sample framework at mid-span and as near to the supports of the members as possible and installed in such a way that the measurements were not influenced by the application of pressure or other loading to the sample. The gauges were located at the positions shown in Figure 9.

8.1.3 Temperature

Platinum resistance thermometers (PRT) were used to measure air temperatures to within 1°C.

8.1.4 General

Electronic instrument measurements were scanned by a computer controlled data logger, which also processed and stored the results.

All measuring instruments and relevant test equipment were calibrated and traceable to national standards.

8.2 FAN

The air supply system comprised a variable speed centrifugal fan and associated ducting and control valves to create positive and negative static pressure differentials. The fan provided essentially constant air flow at the fixed pressure for the period required by the tests and was capable of pressurising at a rate of approximately 600 pascals in one second.

8.3 PROCEDURE

8.3.1 Wind Resistance – serviceability

Three positive pressure pulses of 500 pascals were applied to prepare the sample. The displacement transducers were then zeroed.

Five positive pressure pulses from 0 to 2000 pascals to 0 were then applied.

Three negative pressure pulses of -500 pascals were applied to prepare the sample. The displacement transducers were then re-zeroed.

Five negative pressure pulses from 0 to -2000 pascals to 0 were then applied.

The pressure was applied as rapidly as possible but not in less than one second and maintained for 3 seconds. Displacement readings at peak and zero pressure were measured at the locations shown in Figure 9. Up to one hour was allowed for recovery before residual deformation was recorded.

8.3.2 Wind Resistance – safety

Three positive pressure pulses of 500 pascals were applied to prepare the sample. The displacement transducers were then zeroed.

One positive pressure pulse from 0 to 3000 pascals to 0 was then applied.

Three negative pressure pulses of -500 pascals were applied to prepare the sample. The displacement transducers were then re-zeroed.

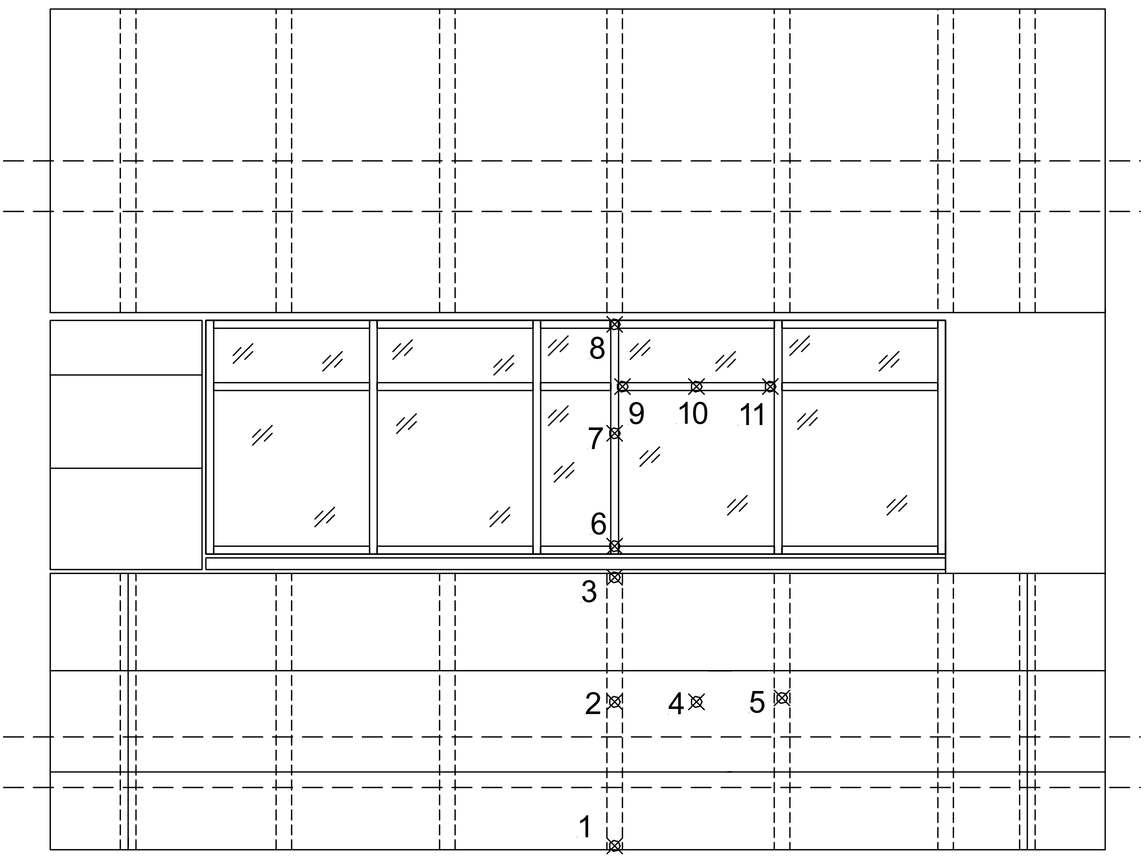
One negative pressure pulse from 0 to -3000 pascals to 0 was then applied.

The pressure was applied as rapidly as possible but not in less than one second and maintained for 3 seconds. Displacement readings at peak and zero pressure were measured at the locations shown in Figure 9. Up to one hour was allowed for recovery before residual deformation was recorded.

FIGURE 9

DEFLECTION GAUGE LOCATIONS

External View



8.4 PASS/FAIL CRITERIA

8.4.1 Calculation of permissible deflection

Gauge number	Member	Span (L) (mm)	Permissible deflection (mm)	Permissible residual deformation
2	Vertical frame	2200	L/200 = 11.0	1 mm
4	Horizontal panel	1200	L/200 = 6.0	1 mm
7	Mullion	1960	L/200 = 9.8	1 mm
10	Transom	1200	L/200 = 6.0	1 mm

8.5 RESULTS

Test 3 (serviceability) Date: 8 April 2004

The deflections measured during the wind resistance test, at the positions shown in Figure 9, are shown in Tables 3 and 4.

Summary Table:

Gauge number	Member	Pressure differential (Pa)	Measured deflection (mm)	Residual deformation (mm)
2	Vertical frame	1999 -1990	-1.3 1.0	-0.1 -0.6
4	Horizontal panel	1999 -1990	1.8 -1.7	0.4 -0.1
7	Mullion	1999 -1990	0.3 0.2	-0.2 0.1
10	Transom	1999 -1990	0.3 -0.2	0.0 0.0

On the first negative pulse, the fixing bolts pulled through the halfen channels on the bottom cladding.

Ambient temperature = 8°C
Chamber temperature = 19°C

Remedial work

The wrongly fitted hex head bolts were removed and the correct halfen bolts were fitted.

The test was then repeated from the beginning.

Test 7 (safety) Date: 8 April 2004

The deflections measured during the structural safety test, at the positions shown in Figure 9, are shown in Table 5.

No damage to the sample was observed.

Ambient temperature = 11°C
Chamber temperature = 17°C

TABLE 3

WIND RESISTANCE – POSITIVE **SERVICEABILITY** TEST RESULTS

Position	Pressure (pascals) / Deflection (mm)					
	1996	1999	1989	1992	1983	Residual
1	3.4	3.4	3.4	3.4	3.4	0.1
2	10.2	10.3	10.4	10.3	10.4	0.5
3	19.8	19.9	20.0	20.0	20.1	0.9
4	7.7	7.7	7.8	7.9	7.9	0.8
5	1.5	1.5	1.6	1.6	1.6	0.4
6	20.8	20.9	21.1	21.1	21.2	1.1
7	16.1	16.2	16.3	16.3	16.4	0.7
8	10.8	10.9	11.0	11.0	11.0	0.7
9	13.9	14.0	14.2	14.1	14.2	0.7
10	12.6	12.7	12.8	12.8	12.8	0.7
11	10.7	10.7	10.9	10.8	10.9	0.7
2 *	-1.4	-1.3	-1.4	-1.4	-1.4	-0.1
4 *	1.8	1.8	1.9	1.9	2.0	0.4
7 *	0.3	0.3	0.3	0.3	0.3	-0.2
10 *	0.3	0.3	0.3	0.3	0.3	0.0

* Mid-span reading adjusted between end support readings

TABLE 4

WIND RESISTANCE – NEGATIVE **SERVICEABILITY** TEST RESULTS

Position	Pressure (pascals) / Deflection (mm)					
	-1985	**-1981**	**-1989**	**-1986**	**-1990**	**Residual**
1	-3.6	-3.6	-3.6	-3.5	-3.5	0.4
2	-11.9	-12.0	-12.2	-12.1	-12.3	-0.9
3	-22.7	-22.7	-22.9	-22.8	-23.0	-1.0
4	-8.6	-8.7	-8.9	-8.9	-9.0	-0.8
5	-2.1	-2.2	-2.2	-2.3	-2.3	-0.4
6	-25.2	-25.2	-25.5	-25.5	-25.6	-1.4
7	-18.8	-18.9	-19.1	-19.0	-19.1	-1.3
8	-12.6	-12.8	-12.9	-12.9	-13.0	-1.3
9	-16.4	-16.5	-16.7	-16.7	-16.8	-1.3
10	-14.9	-15.0	-15.2	-15.1	-15.2	-1.2
11	-13.0	-13.1	-13.2	-13.2	-13.2	-1.0
2 *	1.3	1.1	1.0	1.1	1.0	-0.6
4 *	-1.6	-1.7	-1.7	-1.7	-1.7	-0.1
7 *	0.1	0.1	0.1	0.1	0.2	0.1
10 *	-0.2	-0.2	-0.2	-0.2	-0.2	0.0

* Mid-span reading adjusted between end support readings

TABLE 5

WIND RESISTANCE - **SAFETY** TEST RESULTS

Position	Pressure (pascals) / Deflection (mm)			
	2987	Residual	-2993	Residual
1	3.9	-0.6	-5.2	0.8
2	15.4	1.0	-19.4	-1.8
3	29.8	1.6	-36.4	-3.1
4	12.2	1.4	-14.5	-1.8
5	2.5	0.7	-4.4	-1.3
6	31.2	1.9	-39.4	-3.5
7	24.1	1.7	-29.7	-2.8
8	15.9	1.6	-19.9	-2.3
9	20.8	1.7	-26.1	-2.6
10	18.8	1.6	-23.4	-2.5
11	15.8	1.4	-20.3	-2.2
2 *	-1.5	0.5	1.4	-0.7
4 *	3.3	0.6	-2.6	-0.2
7 *	0.5	-0.1	0.0	0.1
10 *	0.5	0.0	-0.2	0.0

* Mid-span reading adjusted between end support readings

9. APPENDIX - DRAWINGS

The following 17 unnumbered pages are copies of Alumet Systems drawings numbered:

1575-T-E-01revB,

1575-T-D-01revA,

1575-T-D-02revB,

1575-T-D-03revB,

1575-T-D-04revA,

1575-T-D-05revB,

1575-T-D-06revA,

1575-T-D-07revA,

1575-T-D-08revB,

1575-T-D-09revB,

1575-T-D-10revA,

1575-T-D-11revB,

1575-T-D-12revA,

1575-T-D-13revA,

1575-T-D-14revA,

1575-T-D-15revA,

1575-T-D-22revA.

END OF REPORT