Technical Report

Title: Product weathertightness testing of a sample of MC 600 Curtain Walling for Smart Systems Limited

Report No: N950-12-16555

TECHNOLOGY CENTRE

Technical Report

Title: Product weathertightness testing of a sample of MC 600 Curtain Walling for Smart Systems Limited

Client: Smart Systems Ltd, Arnolds Way, Yatton, North Somerset, BS49 4QN

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UKAS TESTING 0057

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CONTENTS

1 INTRODUCTION

This report describes tests carried out at the Technology Centre at the request of Smart Systems.

The test sample consisted of a sample of curtain walling manufactured by Smart Systems.

The tests were carried out during June 2012 and were to determine the weathertightness of the test sample. The test methods were in accordance with the CWCT Standard Test Methods for building envelopes, 2005, for:

Air permeability.

Watertightness – static pressure, dynamic pressure and hose.

Wind resistance – serviceability & safety.

The testing was carried out in accordance with Technology Centre Method Statement C4307/MS rev 0.

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

The results are valid only for sample(s) tested and the conditions under which the tests were conducted.

Technology Centre is accredited to ISO/IEC 17025:2008 by the United Kingdom Accreditation Service as UKAS Testing Laboratory No.0057.

Technology Centre is certified by BSI for:

- ISO 9001:2008 Quality Management System,
- ISO 14001:2004 Environmental Management System,
- BS OHSAS 18001:2007 Occupational Health and Safety Management System.

The tests were witnessed wholly or in part by:

Dan White - Smart Systems Limited
Mark Walford - Smart Systems Limited

2 CLASSIFICATION OF TEST RESULTS

TABLE 1

Test	Standard	Classification / Declared value
Air permeability	CWCT	A4
Watertightness	CWCT	R7
Wind resistance	CWCT	± 2400 pascals serviceability ± 3600 pascals safety

3 DESCRIPTION OF TEST SAMPLE

3.1 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.

The sample measured 7.2 m wide by 8.0 m high and comprised 30 double glazed units in a grid work of 180 mm mullion and 110 mm transom aluminium alloy sections.

The system was zone drained via each transom. The system used pre molded EPDM corner gaskets (part code ACMC628) which were sealed to the back gasket (part code ACSC212) using an EPDM rubber solution (part code ACMX09830).

The system used the same vertical and horizontal co-ex pressure plates. The pressure plates were secured via a series of fixation plates (part code ACDK066) and fixing screws (part code ACMC610) and sealed at the mullion/transom connections.

All the double glazed units were clear toughened 6-16-6 28 mm thick.

PHOTO 1010817

TEST SAMPLE ELEVATION

PHOTO 1010956

STEEL SUPPORT BRACKET

3.2 CONTROLLED DISMANTLING

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

PHOTO 1010960

FRAME COVER CAPS REMOVED

PHOTO 1010961

VIEW AT BASE OF MULLION

PHOTO 1010963

SAMPLE DURING DISMANTLE

PHOTO 1010965

FRAME WITH GLASS REMOVED

PHOTO 1010966

SUPPORT STEELWORK

PHOTO 1010970

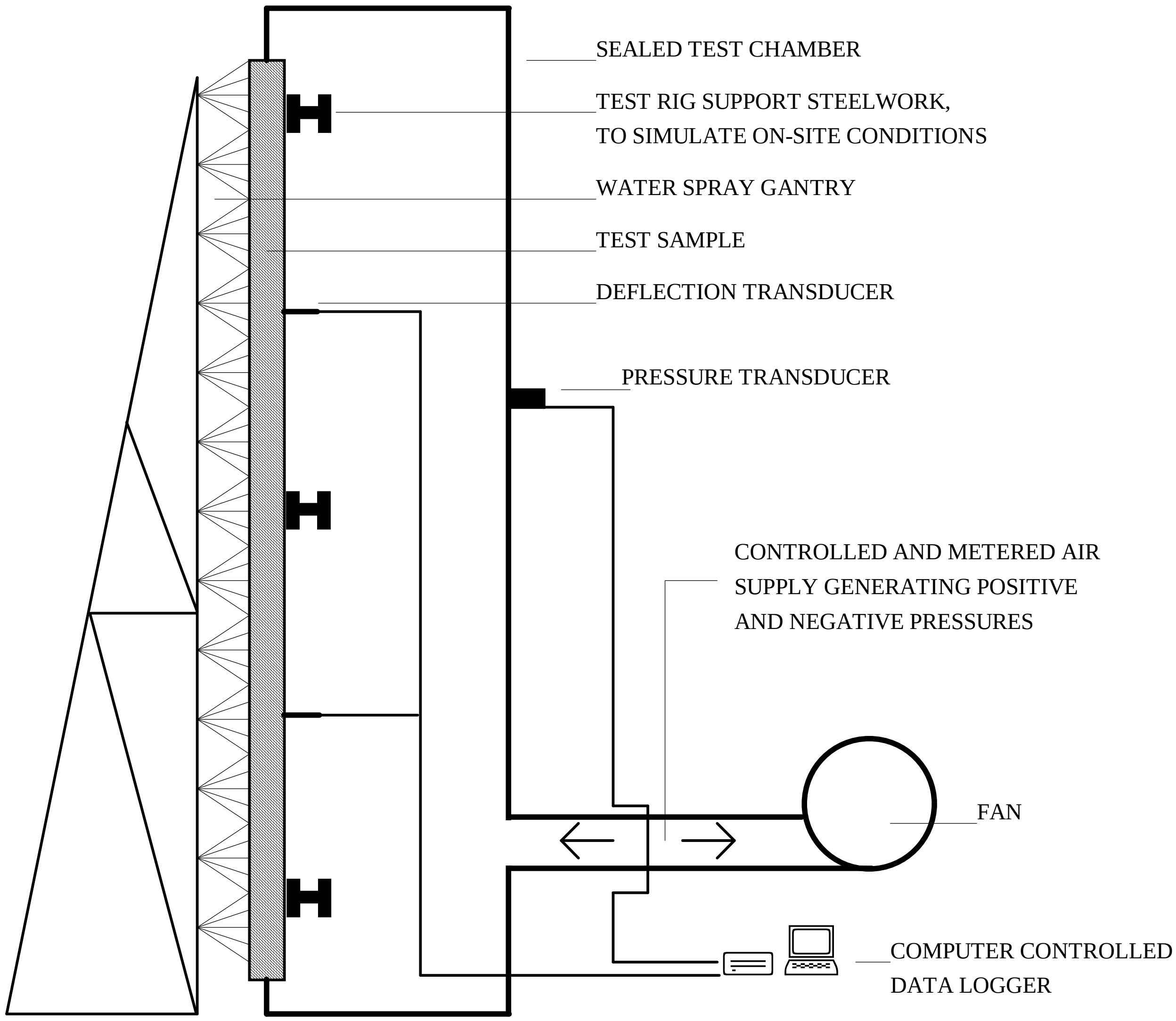
BOTTOM CORNER OF SAMPLE WITH GLASS REMOVED

4 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 Smart Systems installed the sample on the test rig. See Figure 1.

FIGURE 1

TEST RIG SCHEMATIC ARRANGEMENT



SECTION THROUGH TEST RIG

5 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

(9) Controlled dismantle

Prior to starting the formal test sequence above, pre-testing using the static pressure watertightness test procedure (2) was carried out. See the relevant sections of this report for details.

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 1200 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 and 600 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 adhesive tape (polythene sheet as mentioned in CWCT clause 5.10.3.1 was not used on this occasion) 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 samples.

The test was then repeated using negative pressure differentials.

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 for fixed panels.

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 was 57.6 m^2.

6.5 RESULTS

TABLE 2

Pressure differential (pascals)	Measured air flow through sample (m^3/hour/m)			
	Test 1 Date: 25 June 2012		Test 4 Date: 26 June 2012	
	Infiltration	Exfiltration	Infiltration	Exfiltration
50	0.04	0.01	0.00	0.00
100	0.04	0.02	0.00	0.00
150	0.05	0.02	0.00	0.00
200	0.07	0.10	0.00	0.00
300	0.11	0.11	0.00	0.00
450	0.15	0.20	0.00	0.00
600	0.20	0.18	0.19	0.17
Temperatures	Ambient = 24°C Chamber = 24°C		Ambient = 24°C Chamber = 18°C	

The results are shown graphically in Figures 2 and 3.

FIGURE 2

Air infiltration – test results

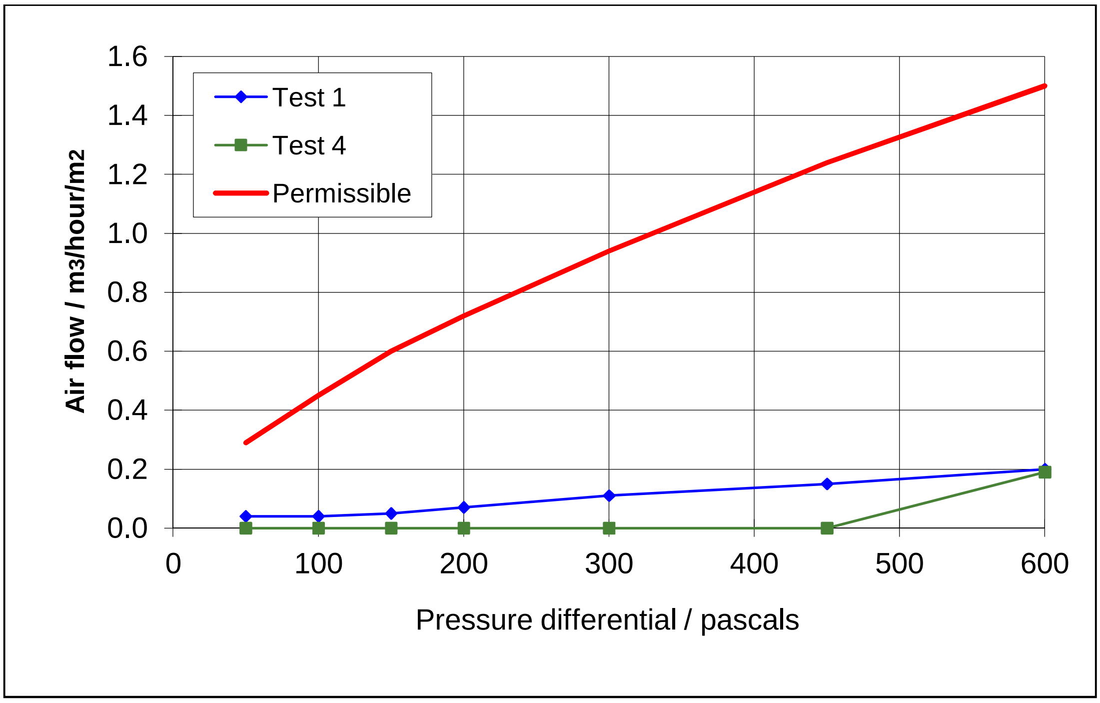
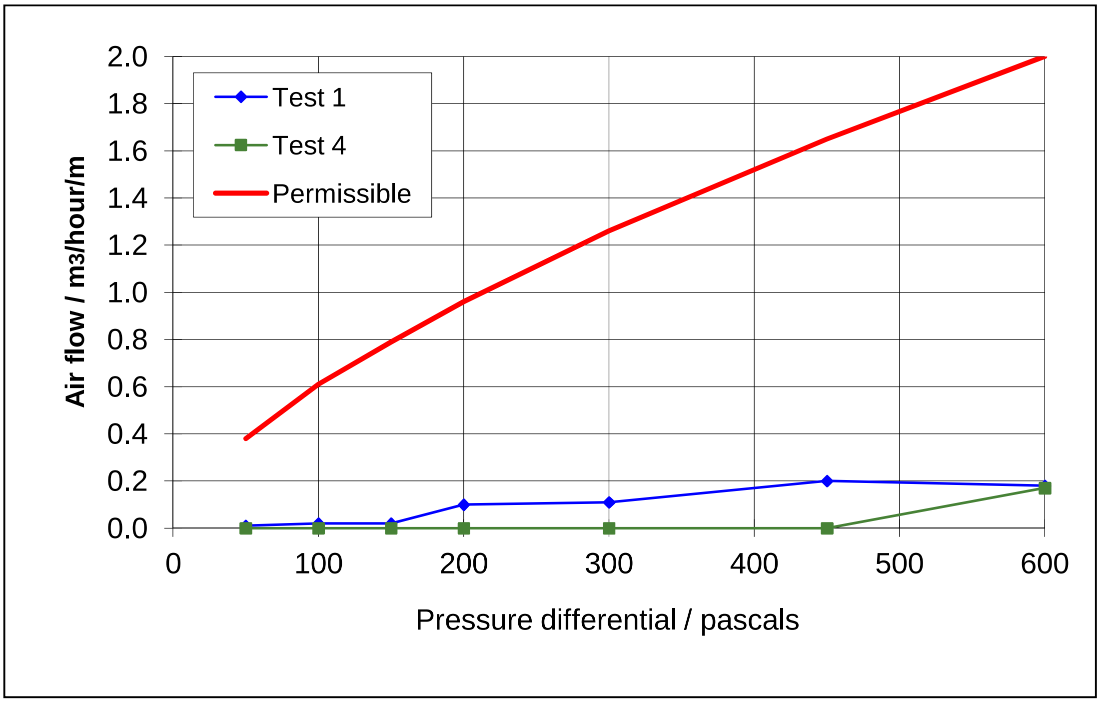


FIGURE 3

Air exfiltration – 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 pattern with a spray angle between 90° and 120°. 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 full-cone of water droplets with a nominal spray angle 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.

PHOTO 1010854

WIND GENERATOR

7.4 PROCEDURE

7.4.1 Watertightness – static

Three positive pressure pulses of 1200 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. 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 4.

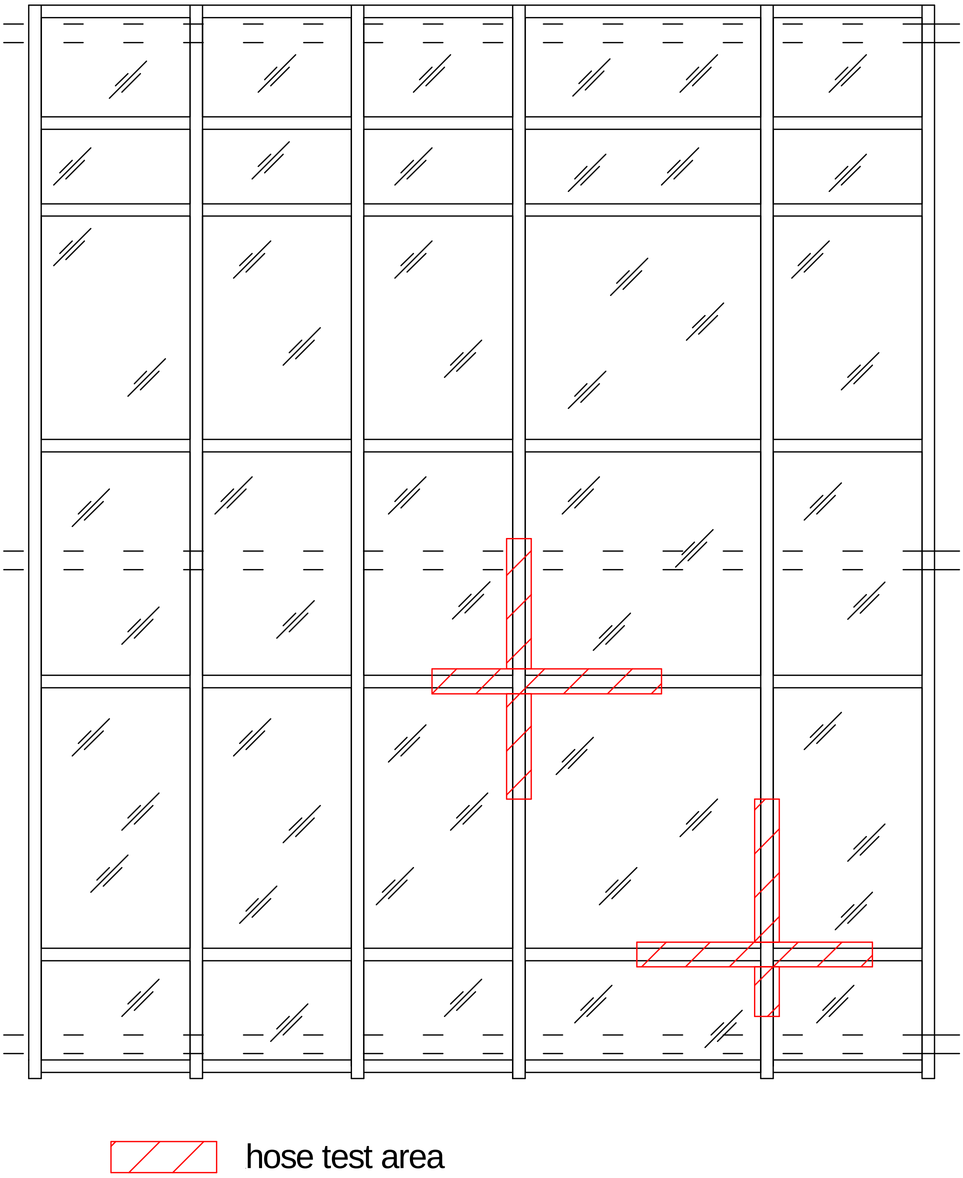
7.5 PASS/FAIL CRITERIA

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 4

HOSE TEST AREAS

External View



7.6 RESULTS

Test 2 (Static pressure pre-test) Date: 22 June 2012

For water leakage locations please refer to Figure 5.

At a pressure differential of 100 pascals, a small flow of water was observed from the transom pad at location 1.

After 1 minute at a pressure differential of 150 pascals, steady dripping was observed from the transom pad at location 2.

After 2 minutes at a pressure differential of 200 pascals, slow dripping was observed from the transom pad at location 3.

After 1 minute at a pressure differential of 300 pascals slow dripping was observed from the transom pad at location 4.

Chamber temperature=19°C
Ambient temperature =18°C
Water temperature =16°C

Remedial work

The following remedial work was carried out by Smart Systems

The internal mullion/transom connections were sealed with silicone sealant.

Test 2 (Static pressure) Date: 25 June 2012

No water penetration was observed throughout the test.

Chamber temperature= 22°C
Ambient temperature = 17°C
Water temperature = 16°C

Test 5 (Static pressure) Date: 26 June 2012

No water penetration was observed throughout the test.

Chamber temperature= 26°C
Ambient temperature = 18°C
Water temperature = 17°C

Test 6 (Dynamic pressure) Date: 26 June 2012

No water penetration was observed throughout the test.

Chamber temperature= 25°C
Ambient temperature = 18°C
Water temperature = 17°C

Test 7 (Hose) Date: 26 June 2012

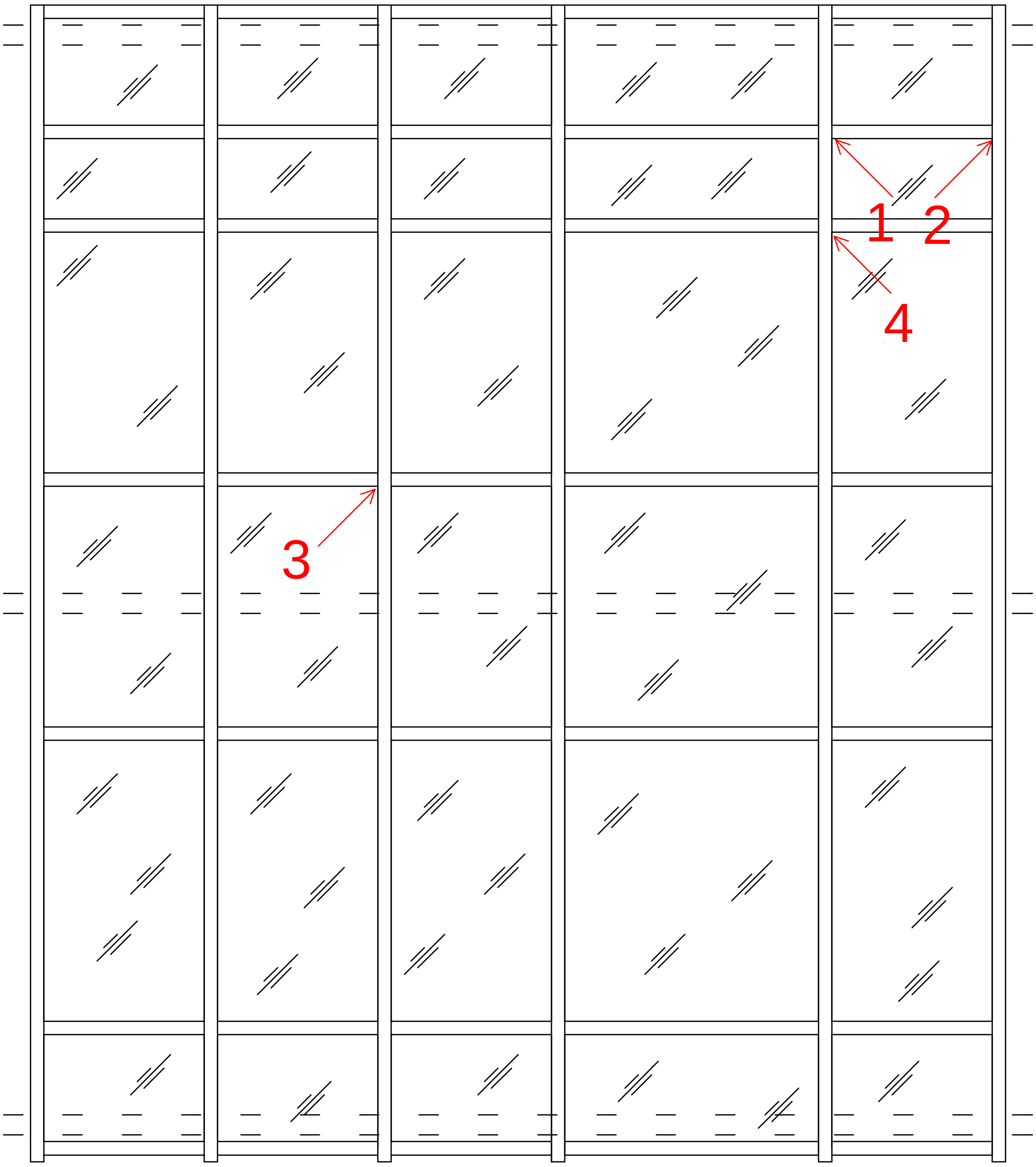
No water penetration was observed throughout the test.

Chamber temperature= 25°C
Ambient temperature = 18°C
Water temperature = 17°C

FIGURE 5

WATER LEAKAGE LOCATIONS

External view



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 6.

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 differential pulses of 1200 pascals were applied to prepare the sample. The displacement transducers were then zeroed.

The sample was subjected to one positive pressure differential pulse from 0 to 2400 pascals to 0. The pressure was increased in four equal increments each maintained for 15 ±5 seconds. Displacement readings were taken at each increment. Residual deformations were measured on the pressure returning to zero.

Any damage or functional defects were recorded.

The test was then repeated using a negative pressure of -2400 pascals.

8.3.2 Wind Resistance – safety

Three positive pressure differential pulses of 1200 pascals were applied to prepare the sample. The displacement transducers were then zeroed.

The sample was subjected to one positive pressure differential pulse from 0 to 3600 pascals to 0. The pressure was increased as rapidly as possible but not in less than 1 second and maintained for 15 ±5 seconds. Displacement readings were taken at peak pressure. Residual deformations were measured on the pressure returning to zero.

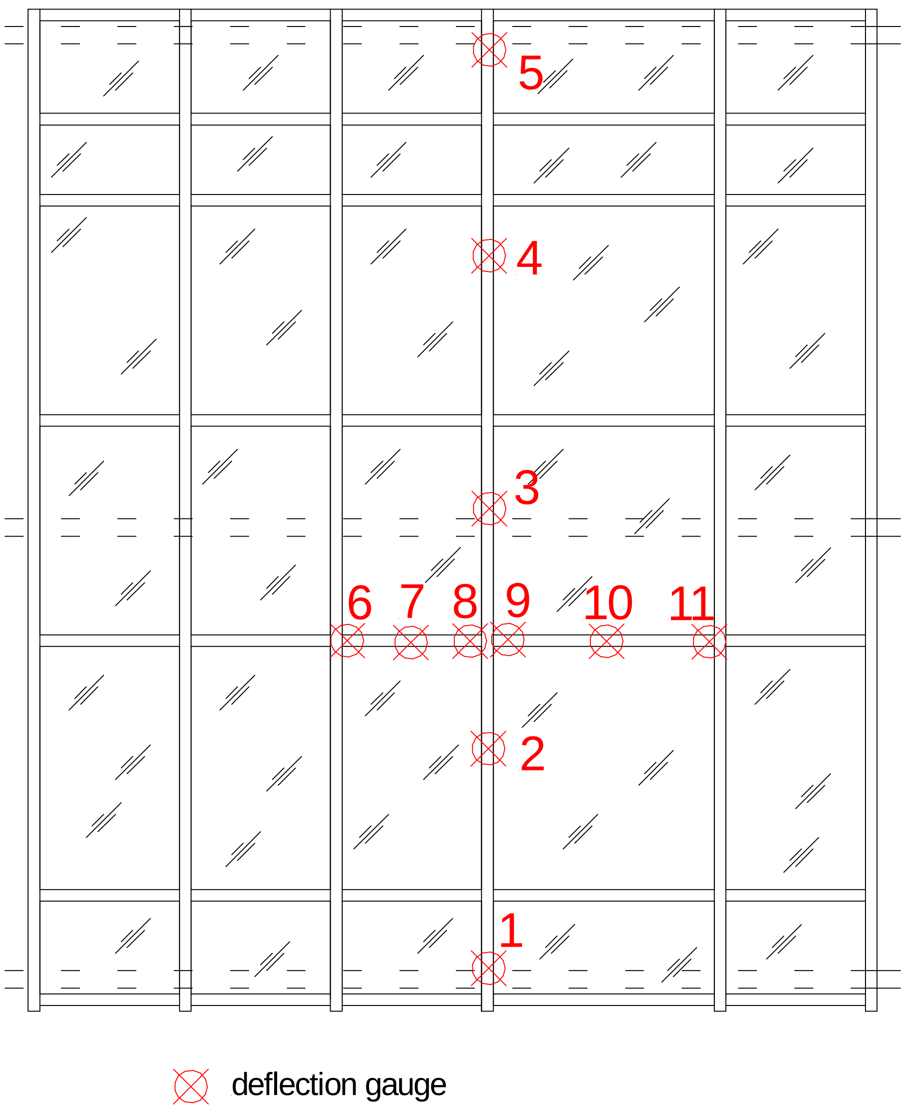
Any damage or functional defects were recorded.

The test was then repeated using a negative pressure of – 3600 pascals.

FIGURE 6

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	Mullion	3700	L/300+5 = 17.3	1 mm
4	Mullion	3800	L/300+5 = 17.6	1 mm
7	Transom	1295	L/200 = 6.4	1 mm
10	Transom	1950	L/200 = 9.7	1 mm

8.5 RESULTS

<u>Test 3 (serviceability)</u> Date: 26 June 2012

The deflections measured during the wind resistance test, at the positions shown in Figure 6, are shown in Tables 3 and 4.

Summary Table:

Gauge number	Member	Pressure differential (Pa)	Measured deflection (mm)	Residual deformation (mm)
2	Mullion	2409 -2404	7.3	-0.5
4	Mullion	2409 -2404	11.7	-0.2
7	Transom	2409 -2404	0.5	0.0
10	Transom	2409 -2404	1.3	0.1

No damage to the test sample was observed.

Ambient temperature = 18°C
Chamber temperature =22°C

Test 8 (safety) Date: 26 June 2012

The deflections measured during the structural safety test, at the positions shown in Figure 6, are shown in Table 5.

No damage to the sample was observed.

Ambient temperature = 22°C
Chamber temperature = 23°C

TABLE 3

WIND RESISTANCE – POSITIVE **SERVICEABILITY** TEST RESULTS

Position	Pressure (pascals) / Deflection (mm)				
	600	**1200**	**1804**	**2409**	**Residual**
1	0.0	0.1	0.2	0.3	0.1
2	1.6	3.4	5.5	7.7	0.3
3	0.2	0.2	0.3	0.5	0.2
4	2.7	5.4	8.6	12.0	0.6
5	0.1	0.1	0.1	0.2	0.0
6	0.7	1.7	2.9	3.9	-0.1
7	0.9	2.1	3.5	4.8	0.1
8	0.9	2.0	3.3	4.7	0.2
9	1.0	2.2	3.6	5.0	0.2
10	1.3	2.8	4.4	6.2	0.2
11	1.0	2.0	3.2	4.6	0.1
2 *	1.5	3.2	5.3	7.3	0.2
4 *	2.6	5.3	8.4	11.7	0.5
7 *	0.1	0.2	0.4	0.5	0.0
10 *	0.3	0.6	1.0	1.3	0.1

* Mid-span reading adjusted between end support readings

TABLE 4

WIND RESISTANCE – NEGATIVE **SERVICEABILITY** TEST RESULTS

Position	Pressure (pascals) / Deflection (mm)				
	-604	**-1206**	**-1808**	**-2404**	**Residual**
1	0.0	-0.1	-0.3	-0.6	-0.4
2	-1.7	-3.7	-6.2	-8.8	-0.8
3	-0.1	-0.2	-0.5	-0.8	-0.2
4	-2.9	-6.4	-10.5	-14.3	-0.4
5	-0.1	-0.2	-0.3	-0.5	0.0
6	-0.7	-1.8	-3.2	-4.4	-0.5
7	-1.0	-2.3	-4.0	-5.6	-0.4
8	-0.9	-2.3	-4.0	-5.7	-0.5
9	-1.1	-2.5	-4.3	-5.8	-0.5
10	-1.3	-2.8	-4.7	-6.6	-0.6
11	-1.0	-1.8	-3.2	-4.9	-0.9
2 *	-1.6	-3.5	-5.8	-8.2	-0.5
4 *	-2.8	-6.2	-10.1	-13.7	-0.2
7 *	-0.1	-0.3	-0.4	-0.6	0.0
10 *	-0.3	-0.6	-1.0	-1.2	0.1

* Mid-span reading adjusted between end support readings

TABLE 5

WIND RESISTANCE - **SAFETY** TEST RESULTS

Position	Pressure (pascals) / Deflection (mm)			
	3619	Residual	-3613	Residual
1	1.2	0.8	-1.3	-0.9
2	12.6	2.2	-12.6	-1.8
3	0.8	0.8	-1.5	-0.8
4	19.0	0.5	-19.9	-0.4
5	0.4	0.0	-0.7	-0.1
6	5.8	-0.3	-5.3	0.0
7	7.4	0.3	-7.4	-0.5
8	7.5	0.8	-7.8	-0.9
9	8.1	0.9	-7.9	-1.0
10	9.9	1.2	-9.5	-1.3
11	8.3	1.5	-7.8	-1.8
2 *	11.6	1.4	-11.2	-0.9
4 *	18.5	0.1	-18.8	0.1
7 *	0.8	0.1	-0.8	0.0
10 *	1.7	0.0	-1.6	0.1

* Mid-span reading adjusted between end support readings

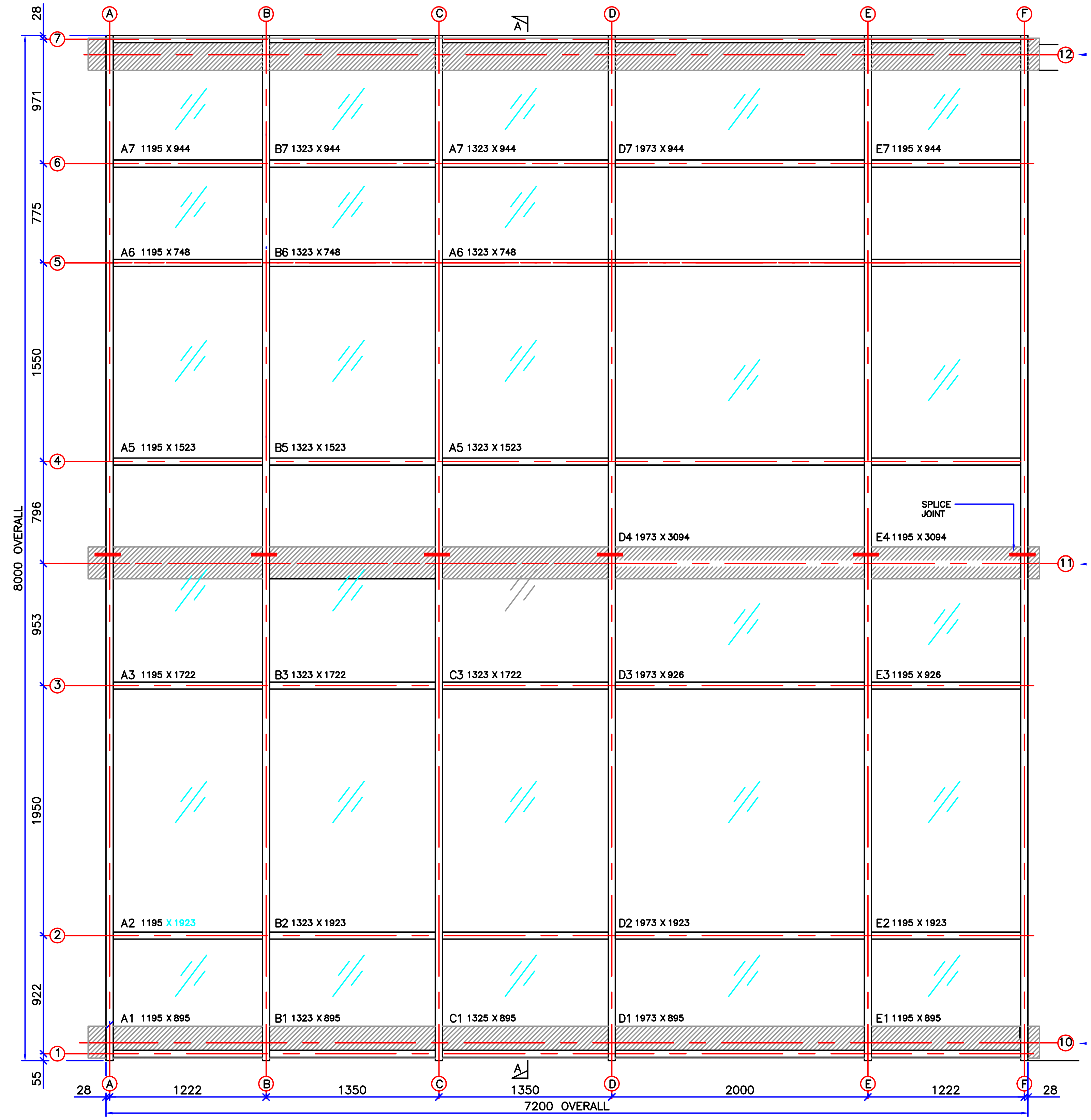
9 APPENDIX - DRAWINGS

The following 2 unnumbered pages are copies of Smart Systems drawings numbered:

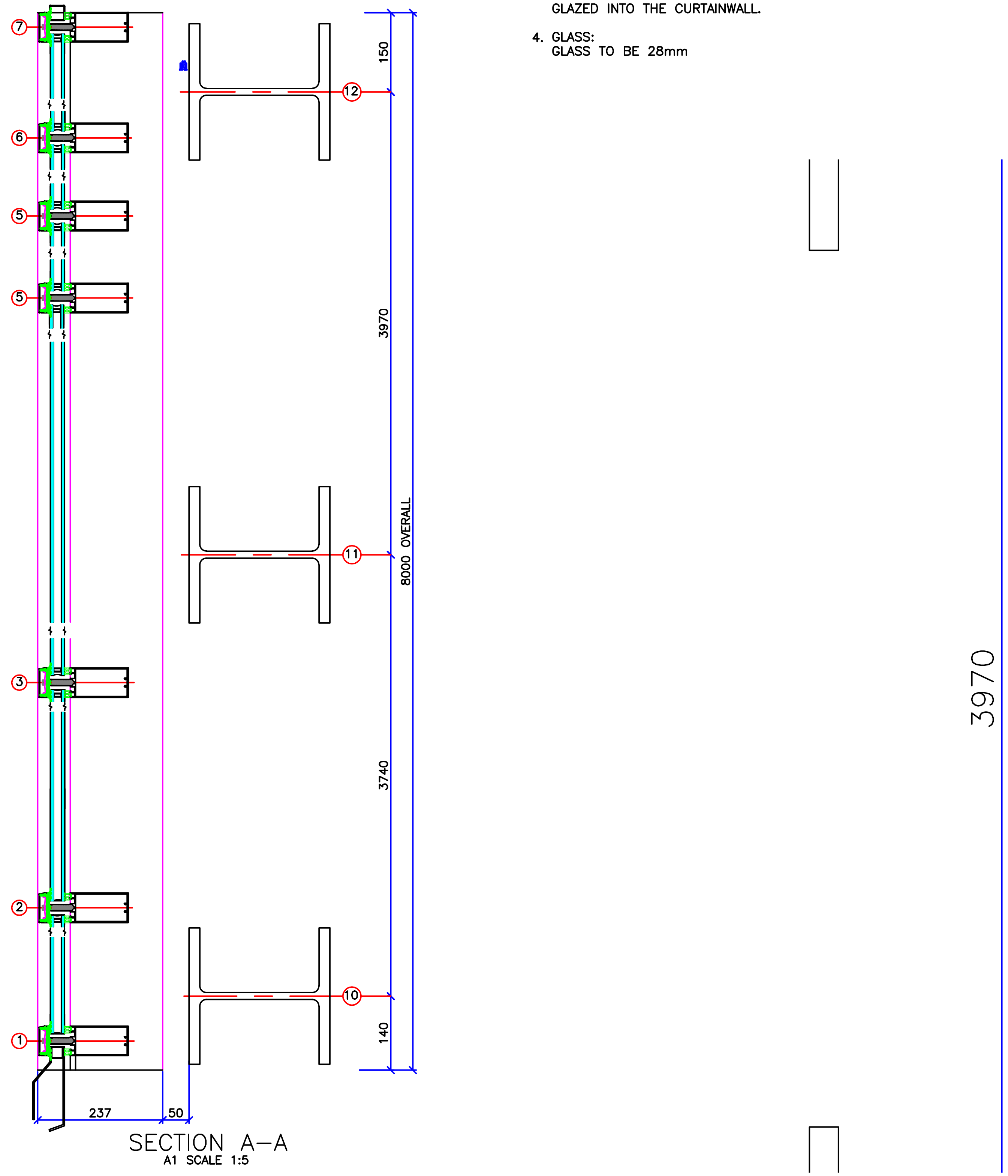
TG001-01 rev1 and an un-numbered transom drawing.

END OF REPORT

DO NOT SCALE: IF IN DOUBT – ASK



SCREEN ELEVATION
A1 SCALE 1:20



SECTION A–A
A1 SCALE 1:5

NOTES

1. ALL DIMENSIONS IN MILLIMETERS UNLESS OTHERWISE NOTED.
2. 180mm MULLIONS TG449 AND 110mm BOX TRANSOM TG466 FROM EXTRUDED ALUMINUM ALLOY TO BE POWDER COATED TO BS6496 FINISH COLOUR 9010 GLOSS
3. TOP HUNG CASEMENT WINDOWS: WINDOWS WILL BE SMARTS SYSTEM VISOLINE + INTRUDER PROFILE. GLAZED INTO THE CURTAINWALL.
4. GLASS: GLASS TO BE 28mm

USED ON:	
MTL:	ALUMINIUM ALLOY
FINISH:	
REV:	REV1 28/11/2007

smart SYSTEMS

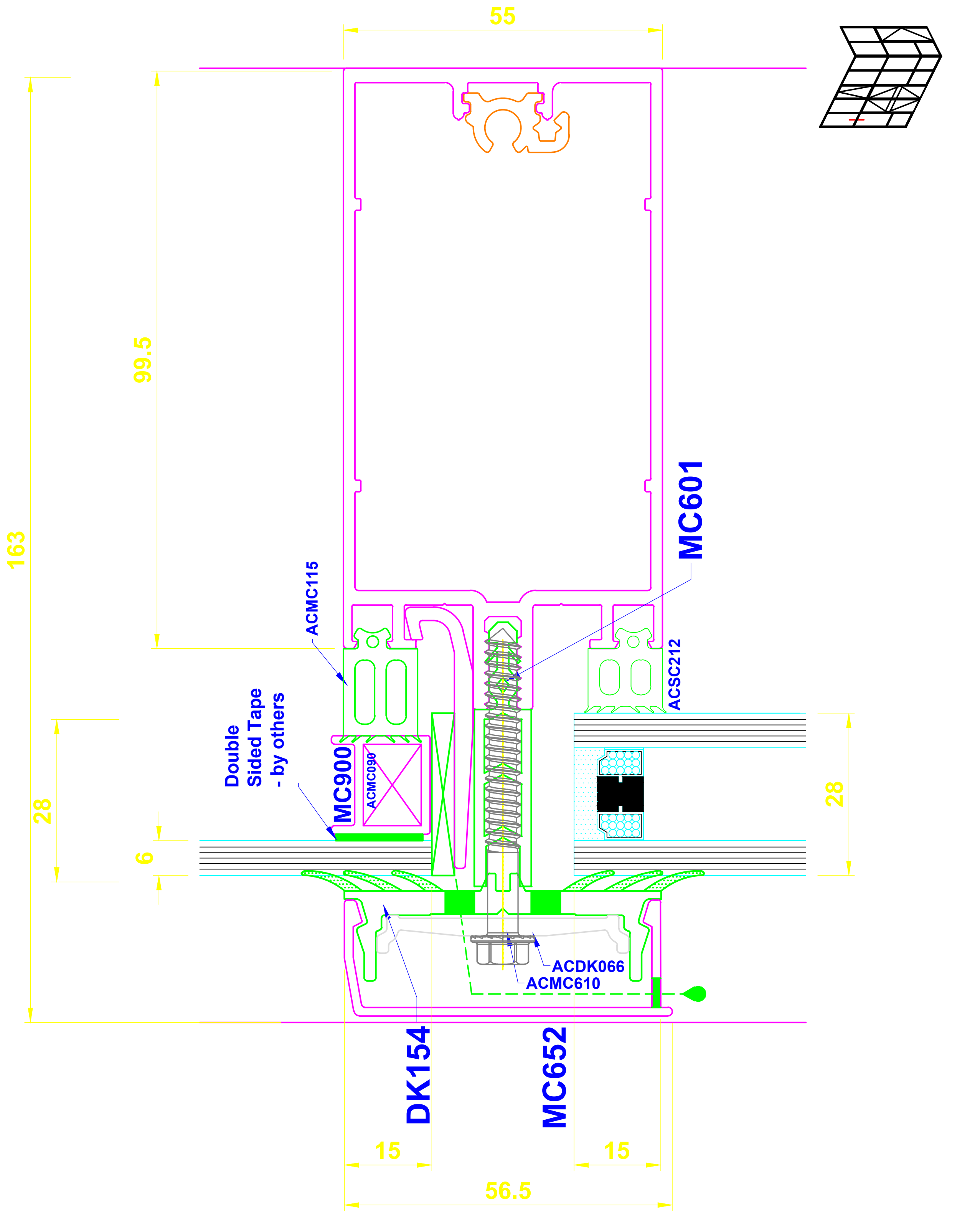
THIRD ANGLE PROJECTION

TITLE GENERAL DETAILS – Curtain Wall CWCT Testing Talor Woodrow

CUSTOMER –

DRAWN BY ALM	PROJECT No. TG001	DATE 26.11.07	DRAWING NUMBER TG001–01
CHECKED ALM	CLIENT –	A1 SCALE Varies	SIZE A1
APPROVED –	DIMENSIONS IN MILLIMETRES	SHEET 1 OF 1	REVISION 1

Transom Detail 5b



Do Not Scale From This Drawing

ISSUED : SEPTEMBER 2012

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