FINAL REPORT

CURTAINWALL PMU TESTING

UCS CURTAINWALL SYSTEM

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THOMAS BELL-WRIGHT
INTERNATIONAL CONSULTANTS

UCS Curtainwall System
Report Date: 9/24/17 10:09 AM
File: QK141
File Name: QK141 UCSCurtainwallSystem_FRmt

Accreditation

Testing

ISO/IEC 17025: General requirements for the competence of testing and calibration laboratories *with*

1. United Kingdom Accreditation Service (UKAS) - Testing Laboratory **: 4439**
2. GCC Accreditation Center (GAC) -Testing Laboratory : **ATL-0017**
   www.ukas.com www.gcc-accreditation.org

Memberships

Members of European Group of Organization for Fire Testing, Inspection and Certification

www.egolf.org.uk

Member of International Trade Council

www.thetradecouncil.com

Member of Association for Specialist Fire Protection

www.asfp.org.uk

Member of Centre for Window and Cladding Technology

www.cwct.co.uk

The work which is a subject of this document falls wholly or partly under the accreditation marked below:

ISO 17025 UKAS ✓

ISO 17025 GAC ☐

Non-accredited test ☐

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1. General Parameters

PROJECT NAME	UCS Curtainwall System	
TEST SEQUENCE		
Test 1	Air Infiltration Test	ASTM E 283-04
Test 2	Static Water Penetration Test	ASTM E 331-00
Test 3	Dynamic Water Penetration Test	AAMA 501.1-05
Test 4	Structural Performance Test	ASTM E 330-14
Test 5	Air Infiltration Test	ASTM E 283-04
Test 6	Static Water Penetration Test	ASTM E 331-00
Test 7	Structural Proof Load Test @ 1.5 times Design Load	ASTM E 330-14
Test 8	Structural Load Test to Failure	ASTM E 330-14

RELEVANT INFORMATION	
Type	UCS Curtainwall System
Materials	
Glass Type	Double Glazed Unit
Glass Thickness	28mm (6+16AS+6)
Specimen Size	3.4 m (w) x 7 m (h)
Flat/Curve	Flat and Vertical

Client	Boston Aluminum & Glass Company LLC
Main Contractor	Not applicable
Alum. Contractor	Not applicable
Consultant	Not applicable

2. Witnesses

NAME	COMPANY	TELEPHONE
Ebrahim Mohammed Qadhi	Boston Aluminum	0558996611
Mohammad Ibrahim	EEF	0506361577
Arash Mohammad	National Aluminum	0506347043
Syed Nasir	National Aluminum	0565749098
Abdulrahman Ebrahim	Boston Aluminum	0562227117
Sayed Riyaz Ahmed	Boston Aluminum	0505769001
Mohammed Ebrahim Qadhi	Boston Aluminum	0562225885
Esmail Ebrahim	Boston Aluminum	0563388225

3. Curtainwall Test Result

Testing results were all recorded as mentioned below with reference to the test sheets attached, witnessed by representatives listed above during the course of testing.

4. Test Summary

4.1. Test History

No.	TEST	DATE & TIME	PASS / FAIL
1	Air Infiltration Test, ASTM 283-04	July 17, 2017 9:56 AM	PASSED

The specimen was blanked off with polyethylene sheet to achieve the extraneous leakage Q_E, often referred to as chamber leakage. The blower was initially set to produce the required negative chamber pressure and after it has stabilized, the differential pressure in the conical inlet nozzles was read and this figure was converted to a volume flow in m^3/hr. The achieved leakage for the chamber and the specimen are listed below:

- Differential test pressure = 300 Pascals
- Permitted leakage for fixed glazing = 1.08 $m^3/hr/m^2$
- Specimen Area = 23.1 m^2
- Total allowable leakage for the curtainwall= 24.95 m^3/hr

Results:

- Specimen sealed with polyethylene sheet, Extraneous air leakage (Q_E) = 65.29 m^3/hr
- Total air leakage (Q_T) for chamber plus specimen = 70.25 m^3/hr
- Specimen air leakage (Q_S) = 4.82 m^3/hr at standard condition, less than the Permissible (24.95 m^3/hr) and so the test was recorded passed.

2	Static Water Penetration Test, ASTM E 331-00	July 17, 2017 10:10 AM	PASSED

The specimen was covered with 72 water spray nozzles spaced on a uniform grid and located at a uniform distance from the test specimen, delivered a minimum rate of 3.4 $L/m^2.min$. A total of 90.8 L/min was sprayed during the test duration.

- Differential test pressure = 720 Pascals
- Test duration = 15 minutes

No water leakage was observed during the test. The test was recorded passed.

3	Dynamic Water Penetration Test, ASTM E 331-00	July 17, 2017 10:34 AM	PASSED

The water spray rack remained the same as the static water test and the wind generator positioned along center width of the lower end of the specimen.

- The dynamic pressure applied was 720 Pascals
- During the test duration, representatives stayed inside the chamber to observe the curtain wall performance until the test was completed for 15 minutes.
- No water leakage was observed and the test was considered passed.

4	Structural Performance Test, ASTM E 330-14	July 17, 2017 10:34 AM	PASSED

Six linear displacement transducers (LDT) were positioned in place along internal side of the specimen to measure deflection values of horizontal and vertical members of the specimen.
Maximum deflection allowed was L/175, so obtained by deducting the average readings of the outermost gauges from the middle gauge of the member being measured.
The following transducers were positioned as follows:

LDT Numbers	Location
1-2-3	Along the mullion
4-5-6	Along the transom

The test procedure mentioned in the method statement was followed. The test was initially carried out

in the positive wind load direction, i.e. negative chamber pressure (at 50 % = 952 Pascals and at 100 % = 1905 Pascals). In the process of 100 % load application, the load was held for 10 seconds at the maximum and deflections were recorded. After a recovery period of 1 minute residual deformations were taken. There was no visual failure noted and the maximum deflection readings were found within the allowable limit. Test was recorded passed.
Immediately the negative wind load direction followed applied 50% of the negative wind load = 952 Pascal then at 100% = 1905 Pascal (i.e. positive chamber pressure) was carried out in the same procedure. After completion of the test there were no adverse effect or any kind of failure noted on the specimen and the maximum deflections were found within allowable range and the test was recorded passed.

Max. Applied Load, kPa	L Value, mm		Allowable Deflection Framing, L/175		Max. Net Deflection Recorded along member, mm	
	Mullion	Transom	Mullion	Transom	1-2-3	4-5-6
(+) 1.905	3370	900	17.54	5.14	6.92	0.60
(-) 1.905					8.47	1.36

Refer to Structural performance test sheet for further reference.

5	Air Infiltration Test, ASTM 283-04 (Post-Structural)	July 17, 2017 11:15 AM	PASSED

The specimen was blanked off with polyethylene sheet to achieve the extraneous leakage Q_E, often referred to as chamber leakage. The blower was initially set to produce the required negative chamber pressure and after it has stabilized, the differential pressure in the conical inlet nozzles was read and this figure was converted to a volume flow in m^3/hr. The achieved leakage for the chamber and the specimen are listed below:
Results:

- Specimen sealed with polyethylene sheet, Extraneous air leakage (Q_E) = 65.29 m^3/hr
- Total air leakage (Q_T) for chamber plus specimen = 73.52 m^3/hr
- Specimen air leakage (Q_S) = 7.99 m^3/hr at standard condition, less than the Permissible (24.95 m^3/hr) and so the test was recorded passed.

6	Static Water Penetration Test, ASTM E 331-00 (Post-Structural)	July 17, 2017 11:19 AM	PASSED

The specimen was covered with 65 water spray nozzles spaced on a uniform grid and located at a uniform distance from the test specimen, delivered a minimum rate of 3.4 L/m^2.min. A total of 81.7 L/min was sprayed during the test duration.

- Differential test pressure = 720 Pascals
- Test duration = 15 minutes

No water leakage was observed during the test. The test was recorded passed.

7	Structural Proof Load test, ASTM E 330-14	July 17, 2017 11:37 AM	PASSED

Six linear displacement transducers (LDT) were kept in the same position.
The deformation was obtained by deducting the average readings of the outermost gauges from the middle gauge of the member being measured.
The following transducers were positioned the same as follows:

LDT Numbers	Location

1-2-3	Along the mullion
4-5-6	Along the Transom

The test was first carried out in the positive wind load direction, i.e. negative chamber pressure (at 75 % = 1428 Pascals and at 150 % = 2857 Pascals). At the peak pressure of 150 % load, the pressure was held for 10 seconds and deflections were recorded. After a recovery period of 1 minute residual deformations were taken. There was no visual failure noted and so the test was recorded passed.

The test procedures was followed with the negative wind load direction, applied 1428 Pascals at 75 % and 2857 Pascals at 150 % (i.e. positive chamber pressure). The test pressure at maximum 150% was sustained by the specimen without showing any breakage or adverse effect to constitute failure and the deformations of the framing members measured for reference.

Max. Applied Load, kPa	L Value, mm		Allowable Deformation L/500		Net Deformation Recorded along member, mm	
	1-2-3	4-5-6	1-2-3	4-5-6	1-2-3	4-5-6
(+) 2.857	3370	900	6.14	1.8	0.13	0.29
(-) 2.857					0.18	0.56

Refer to Structural performance test sheet for further reference.

8	Structural Load Test to Failure	July 17, 2017 11:56 AM	PASSED

The specimen was subject to maximum positive chamber pressure it can hold. It was then recorded that the specimen held up to 7156 Pascal prior to chamber failure. No visual damage /breakage was visible on the specimen.

4.2. Description of Modification or Adjustments

Structural Load Test to Failure was added at the end of the test sequence.

4.3. Compliance Statement

The semi-unitized curtainwall system (UCS) was tested as described in this document in conformance with the project requirement, with results of each test mentioned herein as recorded.
The test results are valid for the conditions under which the specimen was tested.

This Final Report is respectfully submitted by:
Thomas Bell-Wright International Consultants

Prepared By:

_____

Joselito Adoan
Testing Engineer

Checked and Reviewed by:

_____

Clarence Facun
Testing Manager

5. Test Performance and Requirements

Test	Criteria	Reference
A. Test Briefing B. Visual Inspection		
Preliminary Loading	50% of the inward design pressure, held for 10 seconds.	
1. Air Infiltration Test Test pressure Permitted leakage fixed glazing	ASTM E 283-04 300 Pa 1.08 $m^3/hr/m^2$	AAMA 501-05. Section 2.3
2. Static Water Penetration Test Test Pressure Fixed Wall Leakage Details	ASTM E 331-00 720 Pa No uncontrolled water penetrating assemblies	AAMA 501-05. Section 2.4
3. Dynamic Water Penetration Test Dynamic test pressure Leakage Details	AAMA 501.1-05 720 Pa No uncontrolled water penetrating assemblies	AAMA 501-05. Section 2.5
4. Structural Performance Test Test Pressure (inward and outward directions) Acceptable Deflection	ASTM E 330-14 ±1.905 Pa L/175	AAMA 501-05. Section 2.9
5. Air Infiltration Test Test pressure Permitted leakage fixed glazing	ASTM E 283-04 300 Pa 1.08 $m^3/hr/m^2$	AAMA 501-05. Section 2.3
6. Static Water Penetration Test Test Pressure Fixed Wall Leakage Details	ASTM E 331-00 720 Pa No uncontrolled water penetrating assemblies	AAMA 501-05. Section 2.4
7. Structural Performance Test @ 150 %	ASTM 330-14	AAMA 501-05. Section 2.9

Test Pressure (inward and outward directions) Acceptable Deformation	± 2.857 Pa 0.2 % of the span	

Additional material on Curtain Wall testing can be found at www.bell-wright.com — Resources — Downloads — Aluminum and Glass Testing Techniques.pdf

6. Program

09:30 AM Briefing

10:00 AM Air Infiltration Test

10:30 AM Static Water Penetration Test

11:00 AM Dynamic Water Penetration Test

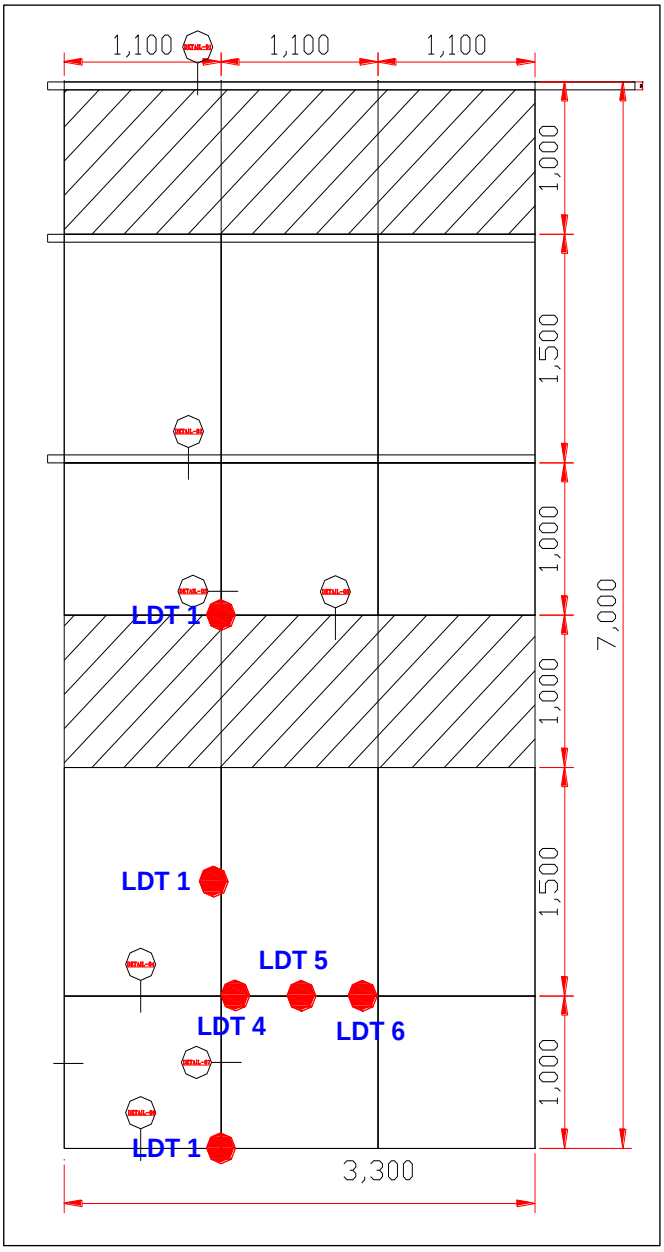
11:30 AM Structural Performance Test

12:00 PM Air Infiltration Test

12:30 PM Static Water Penetration Test

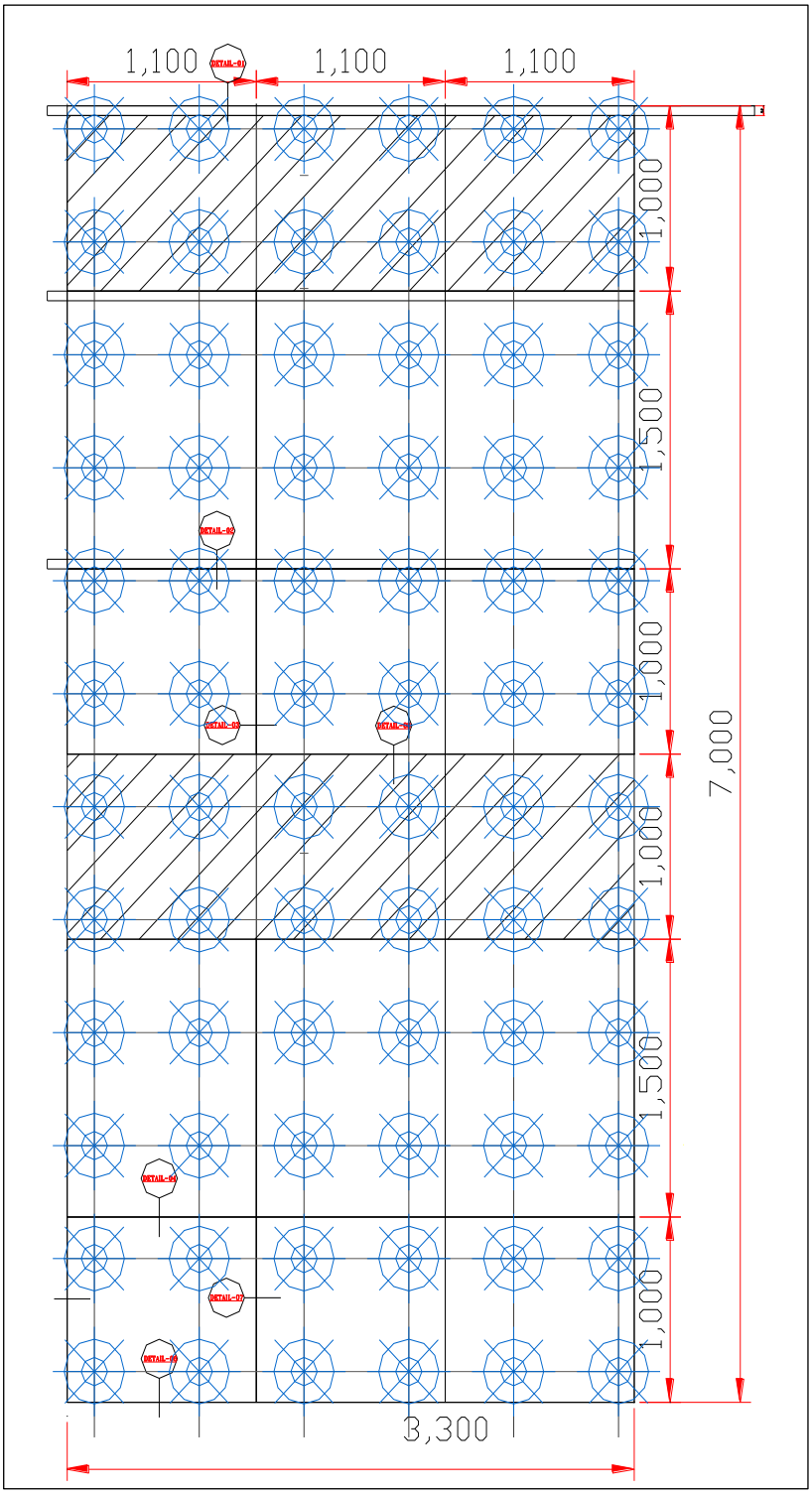
01:00 PM Structural Proof load Test

7. Mock-up Diagram

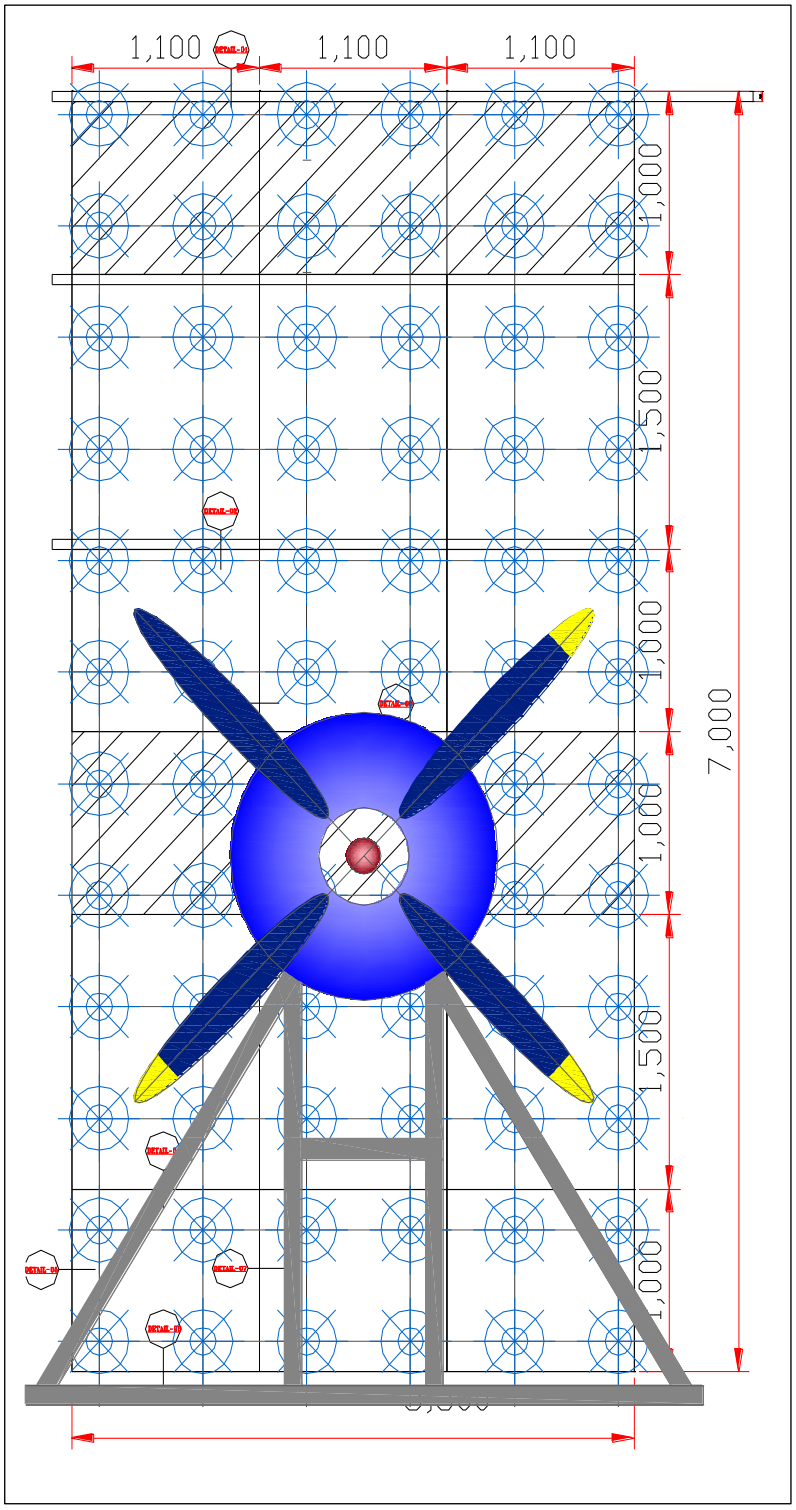


Linear Displacement Transducer

LDT Number	Location
1-2-3	Along mullion
4-5-6	Along transom



Water Spray Rack Set Up - Static Water Penetration Test



Wind Generator Set-up - Dynamic Water Penetration Test

8. Specification Compliance

Testing will be carried out under the direction of the Testing Engineers of TBWIC in compliance with the requirements of the project.

9. Test Procedures

Specimen verification: Prior to start of the test, the Testing Engineer shall verify to the witnesses that the mock-up has the correct file number label stuck on the test chamber similar to the file number identified on the Method Statement.

9.1. Air Infiltration Test ASTM E 283-04

9.1.1. Chamber calibration

a. The air leakage measured initially represents the leakage from the specimen plus any leakage from the Testing chamber, access door, etc. If the total is greater than that allowed, the chamber leakage is evaluated alone by sealing off the specimen. This sealing will be done with plastic sheet and tape, from the outside. The reading for the chamber leakage so obtained is subtracted from the reading without the specimen sealed to give the figure for the specimen alone. Note that the calibration of the chamber is not required by the standard if the total leakage is less than the allowable.

9.1.2. Preparation

a. Calculate the area of the specimen within the chamber, and calculate allowable leakage.

b. Connect the 3-phase blower, the conical inlet nozzle and the pressure sensor to the chamber.

9.1.3. Test Procedure

a. Record temperature, humidity and barometric pressure.

b. Open and close operable window(s) 5 times (where applicable).

c. Apply the test pressure 300 Pascals (negative chamber pressure) and allow to stabilize for some time then record flow rate. A total of 5 readings shall be recorded and the average shall be used for the result.

d. If leakage is greater than the allowable, temporarily seal the outside of specimen with polyethylene sheet and non-permeable tape, checking visually that proper sealing is achieved.

e. Apply again the same test pressure and allow to stabilize for some time and record flow rate for 5 times and use the average for the result. This initial result will be accounted as the extraneous leakage or often referred to as chamber leakage.

f. Without opening the chamber access door or disturbing any other seals, remove the temporary sealing from the specimen exterior.

g. Apply again the same test pressure and allow to stabilize for some time and record flow rate for 5 times and use the average for the result.

h. If the difference in the measured average flow rate is less than the calculated allowable, the infiltration test will be recorded as a pass.

9.2. Static Water Penetration Test ASTM E 331-00

9.2.1. Preparation

a. A spray rack will be deployed 450 mm away from the specimen surface on the exterior. It will consist of a vertical feeder pipe attached to an arrangement of row pipes with nozzles spaced 610 mm apart vertically. The flow rate of the spray rack depends on the total count of the nozzles used for the test. Each nozzle will produce 1/3 US gpm of water (equivalent spray rate of 3.4 L/min.m2), and the total amount of water spray required for the test is controlled by rotameter gauges in terms of volume flow. To limit the pressure difference between the top and bottom nozzles, the spray arrays are limited in height to a maximum of 5 meters. This ensures the maximum flow at the bottom and the minimum at the top are within the limits prescribed in the standard.
b. The entire specimen will be covered with 6 column and 12 rows of nozzles. A total of 24 gpm 90.85 liters/minute) of water spray will be applied to cover the entire specimen.
c. Check the water spray nozzle at the right rotameter setting and ensure all nozzles spray evenly. Checking procedures shall not wet the specimen if possible.
d. Allow the test witnesses and TBWIC representative to proceed inside the test chamber for test monitoring.
e. Ensure PMU elevation drawing with view from inside is with TBWIC representative for marking record if water leakage occurs during the test.

9.2.2. Test Procedure

a. Record temperature.
b. Adjust chamber pressure to negative 720 Pascals and mark the equipment setting.
c. Return pressure to zero.
d. Start the water spray and adjust the flow mentioned above.
e. Re-start the blower, record the time and adjust the chamber pressure to 720 Pascals, again if necessary.
f. After 15 minutes, return the pressure to zero in one step and turn off the water spray.
g. Inspect for leaks.

9.3. Dynamic water penetration test, AAMA 501.1-05

a. The required wind velocity to be developed by the wind generator shall be taken from the calibrated results established, equating the engine speed to the specified test pressure. (Note: the equivalent velocity pressure shall be calculated using the Ensewiler formula, P = 0.613 V^2, where V = wind velocity in m/s and P = the equivalent velocity pressure in Pascals.) The same spray rack set-up and flow adjustment as the one used for the static water penetration shall be used for the test.

9.3.1. Preparation

a. Install spray rack as for static test.
b. Locate wind generator and install restraint cables.
c. Issue hearing protectors and cordon off area in front of propeller.
d. One digital hand-held anemometer will be set ready to check/measure wind speed going to be generated.
e. Ensure PMU elevation with view from inside is with TBWIC representative for marking record if water leakage occurs during the test.

9.3.2. Test Procedure

a. Record temperature.

b. The wind generator will be started and warmed up approximately 10 minutes prior to the testing.

c. The test chamber door will be open and witnesses may enter or leave the chamber during the test, as they wish.

d. The engine running speed will be increased until it reaches the rpm value given in the calibration.

e. With the engine running, the same method of water spray in the static test will be started and adjusted as above.

f. After 15 minutes, the engine will be slowed to idle, and the water stopped.

g. The specimen will be inspected for leaks.

9.4. Structural Performance Test Method A, ASTM E 330-14

9.4.1. Preparation

a. Seven linear transducers will be installed on the interior of the specimen. These will be fixed near two successive anchorages on a typical mullion and midway between, on a transom, center of the glass panel.

b. For the mullion and the transom, the distance between the outermost transducers will be measured and recorded. This distance will be divided by allowable deflection to arrive at the permitted deflection.

9.4.2. Test Procedure

a. Open and close operable vents for 5 times (if applicable).

b. The pressure in the chamber will be decreased to 952 Pascals, 50% of the positive test load to set the anchorages, held for 10 seconds and returned to zero. (Positive test load = the pressure on the external side or exposed to weather is higher than pressure along internal side of the specimen).

c. After waiting for one minute, the reading of the transducer will be set to zero at the computer read program.

d. Pressure will be slowly decreased to 1905 Pascals, 100% of the positive design load, held for 10 seconds, the maximum reading of the transducers will be read.

e. The pressure is returned to zero after waiting for one minute, the residual readings on the transducers will be recorded.

f. The pressure in the chamber will be increased to 952 Pascals, 50% of the negative design load to set the anchorages, the maximum reading of the transducers will be read. (Negative test load = the pressure on the external side or exposed to weather is lesser than pressure along internal side of the specimen).

g. After waiting for one minute, the reading at our data acquisition software will be set to zero.

h. Pressure will be slowly increased to 1905 Pascals, 100% of the Negative design load, held for 10 seconds, and the deflection recorded.

i. Return the pressure to zero after waiting for one minute, the residual readings on the transducers will be recorded.

9.5. Structural Proof Load Test 1.5 X, Method A, ASTM E330-14

9.5.1. Preparation

j. The same Linear Displacement Transducers installed will be kept in place on the interior of the specimen for this test.
k. The distance between the outermost transducers, if moved will be measured and recorded as the L, length. This distance L will be divided by the allowable deformation to arrive at the permitted value.

9.5.2. Test Procedure

a. The pressure in the chamber will be decreased to 1428 Pascals, 75% of positive test load to set the anchorages, held for 10 seconds and return to zero pressure. (Positive test load = the pressure on the external side or exposed to weather is higher than pressure along internal side of the specimen).
b. After waiting for one minute, the reading of the transducer will be set to zero at the computer read program.
c. Pressure will be slowly decreased to 2857 Pascals, 150% of the Positive test load and held for 10 seconds.
d. The pressure then will be returned to zero and after one minute at least, the residual readings of the transducers will be recorded to constitute the net deformation.
e. The pressure in the chamber will then be increased to 1428 Pascals, 75% of the Negative test load to set the anchorages, held for ten seconds and return to zero pressure. (Negative test load = the pressure on the external side or exposed to weather is lesser than pressure along internal side of the specimen).
f. After waiting for one minute, the reading at the data acquisition software will be set to zero.
g. Pressure will be slowly increased to 2857 Pascals, 150% of the Negative test load, held for 10 seconds, and the maximum and net deflections recorded for information.
h. Return the pressure to zero and after waiting for one minute at least, the residual readings of the transducers will be recorded to constitute the net deformation.

Equipment used for the test as enumerated below which requires calibration are all covered by valid calibration certificates.

a. A 3-phase high pressure centrifugal blower with speed controller and damper to control the pressure within the chamber. This will be connected to the chamber via a transition piece and 2 meters of 20 cm flexible duct. Speed is controlled by varying the frequency in steps of 0.1 Hz at the controller and by a remote knob control.
b. Conical inlet nozzles for measurement of air flow.
c. Data acquisition electronic equipment. Consists of 3 electronic manometers, 6 displacement transducers and software to read data, all are integrated into the excel sheet forms included herein.
d. A wind generator manually operated from a 9 cylinders radial airplane engine driving a 3.6 m 4 blade propeller, creates positive dynamic pressure to the test specimen.

10. Test Worksheets

Air Infiltration Test ASTM E283 - 04 — Project Name: **UCS Curtainwall System**

This is the first test in sequence, and the initial running of this test — Client: **Boston Aluminium & Glass Company LLC** — File: **QK141**

Thomas Bell-Wright International Consultants, Dubai

TEST CRITERIA		
Specimen height	7.00	m
Specimen width	3.30	m
Specimen area	23.10	m²
Length of opening joint	0.00	m
Permitted leakage, area	1.08	m³/hr/m²
Permitted leakage, opening joint	0.00	m³/hr/m

PRESSURE & FLOW			
Test pressure	75 Pa(Win)	300	Pa (CW)
Total permitted leakage		**24.95**	m³/hr
Required accuracy (5%)		± 1.25	m³/hr

INPUT CONNECTION		
Conical Inlet Nozzle Dia.	55.91	mm
Pressure Tdr. Range	500	Pa
Pressure Tdr. Uncertainty	2.8	Pa
Chamber Connection	LDT 2	
Nozzle Connection	LDT 1	

INSTANTANEOUS VALUES		
Ambient Temperature	39	ºC
Barometric Pressure	1014	mb
Relative Humidity	0.27	
Chamber Pressure	**301.36**	Pa
Nozzle Pressure	40.54	Pa
Input Data Check	1	

CALCULATED VALUES		
Ambient Air Density	1.13	kg/m³
Standard Air Density	1.20	kg/m³
Reynolds Number	25,228	
Check Value	67.55	m³/hr
Air Flow at ambient conditions	70.02	m³/hr
Adjust to exact Test Pressure	67.65	m³/hr
Uncertainty	± 1.38	m³/hr

UNCERTAINTY		
Method, from BS848	0.4912	m³/hr
Nozzle pressure	2.3362	m³/hr
Nozzle diameter	0.1356	m³/hr
Barometric pressure	0.1341	m³/hr
Temperature	0.1198	m³/hr
Relative Humidity	0.0271	m³/hr
Total uncertainty	1.3845	m³/hr

MEAN LEAKAGE AT AMBIENT CONDITIONS		
Extraneous leakage at ambient conditions	65.29	m³/hr
Uncertainty of Extraneous Leakage	± 1.54	m³/hr
Total leakage at ambient conditions	70.25	m³/hr
Uncertainty of Total Leakage	± 1.39	m³/hr
Specimen leakage at ambient conditions	4.96	m³/hr

After completion of the testing, the data was saved at 9:59, in C:\Documents and Settings\user\Desktop\Projects\2017\Boston\[Boston.xls] Air Inf

Testing Engineer: ***Joselito Adoan***

Date: **17-Jul-17**

AIR INFILTRATION TEST RESULT		
Specimen Leakage at Standard Conditions	**4.82**	m³/hr
Standard Uncertainty (68% confidence)	± 2.07	m³/hr
Expanded Uncertainty (95% confidence)	± 4.06	m³/hr

MEAN LEAKAGE DATA

This sheet will average up to 10 readings of Extraneous Leakage and Total Leakage, and display the mean values below.

	Readings	Temp	Bar	RH	Dia	Chamber	Nozzle	Air Flow	Adjusted	Uncert'y	Time	Date
Extraneous	4	39 ºC	1014 mb	0.27	55.91 mm	300 Pa	36 Pa	65.29 m³/hr	65.29 m³/hr	± 1.54 m³/hr	9:56 AM	17-Jul-17
Total	5	39 ºC	1014 mb	0.27	55.91 mm	310 Pa	42 Pa	70.25 m³/hr	70.25 m³/hr	± 1.39 m³/hr	9:59 AM	17-Jul-17

File No: QK141

Static Water Penetration Test ASTM E331 - 00

Project Name: UCS Curtainwall System

This is the second test in sequence, and the initial running of this test

Client: Boston Aluminium & Glass Company LLC

File: QK141

Thomas Bell-Wright International Consultants, Dubai

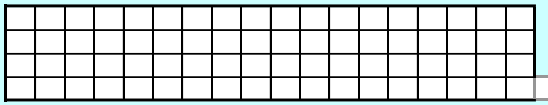
TEST CRITERIA		
Specimen height	7.000	m
Specimen width	3.300	m
Specimen area	23.10	m²
Test pressure	720	Pa
Accuracy ±	14	Pa

INSTANTANEOUS VALUES		
Ambient Temperature	39.0	°C
Barometric Pressure	1,014	mb
Relative Humidity	27%	
Chamber Pressure	**720**	**Pa**
Uncertainty ±	2.8	Pa

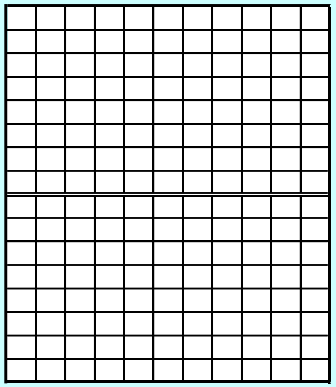
TIMER DATA	
Start Time	10:10:31
Current Time	10:28:08
Elapsed Time	15:00
Time to Go	00:00
Finish Time	
Test Duration	15.0 Min
	15:00

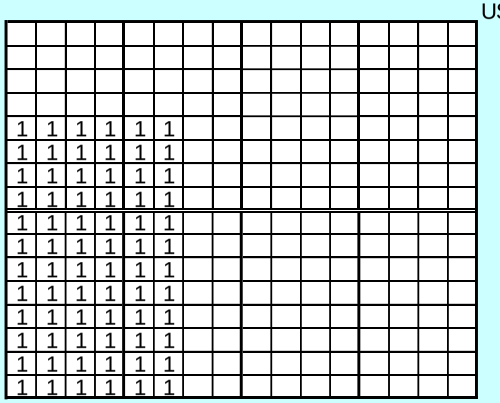
The diagrams below represent the two main types of spray racks plus one free-form (for irregular areas). Each square is 61cm and the nozzle delivers one third of a US gallon per minute. A one has been placed in the squares where nozzles will be activated. Totals for the flow rates for the upper and lower portions of the spray racks are shown below the diagrams.

PRESSURE UNCERTAINTY		
Pressure Tdr. Range	500	Pa
Pressure Tdr. Uncertainty	2.8	Pa



0.00 US gpm





Upper Half:	0.00 US gpm	Upper Half:	5.33	2.67	0.00	0.00 US gpm
Lower Half:	0.00 US gpm	Lower Half:	10.67	5.33	0.00	0.00 US gpm

After completion of the testing, the data was saved at 10:28, in C:\Documents and Settings\user\Desktop\Projects\2017\Boston\[Boston.xls]St. Water

Observations:

Date: 17-Jul-17

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Dynamic Water Penetration Test AAMA 501.1-05 Project Name: UCS Curtainwall System

This is the third test in sequence, and the initial running of this test **Client: Boston Aluminium & Glass Company LLC** **File: QK141**

Thomas Bell-Wright International Consultants, Dubai

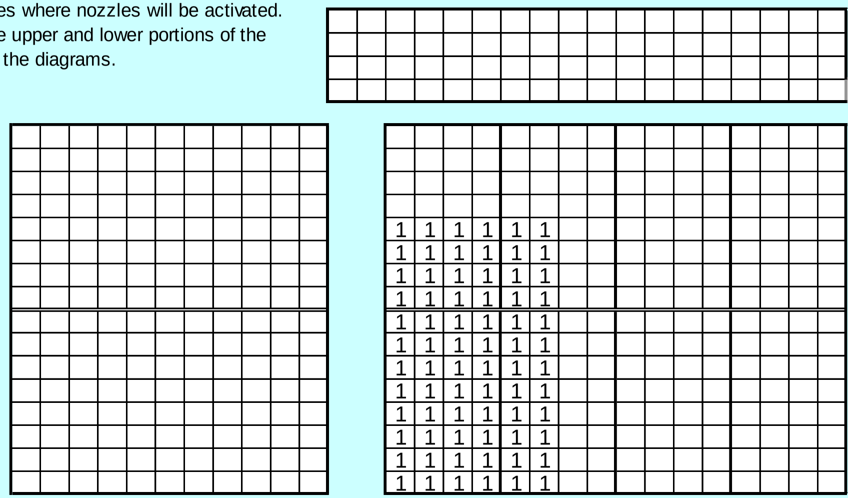
TEST CRITERIA		
Specimen height	7.000	m
Specimen width	3.300	m
Specimen area	23.10	m²
Test pressure	720	Pa
Accuracy ±	14	Pa

INSTANTANEOUS VALUES		
Ambient Temperature	25.0	ºC
Barometric Pressure	1,013	mb
Relative Humidity	25%	
Dynamic Pressure	**720**	**Pa**
Uncertainty ±	2.8	Pa

TIMER DATA		
Start Time	10:34:30	
Current Time	10:49:38	
Elapsed Time	15:00	
Time to Go	00:00	
Finish Time		
Test Duration	15.0	Min
	15:00	

The diagrams below represent the two main types of spray racks plus one free-form (for irregular areas). Each square is 61cm and the nozzle delivers one third of a US gallon per minute. A one has been placed in the squares where nozzles will be activated. Totals for the flow rates for the upper and lower portions of the spray racks are shown below the diagrams.

PRESSURE UNCERTAINTY		
Pressure Tdr. Range	500	Pa
Pressure Tdr. Uncertainty	2.8	Pa



0.00 US gpm

Upper Half:	0.00	US gpm	Upper Half:	5.33	2.67	0.00	0.00	US gpm
Lower Half:	0.00	US gpm	Lower Half:	10.67	5.33	0.00	0.00	US gpm

After completion of the testing, the data was saved at 10:49, in C:\Documents and Settings\user\Desktop\Projects\2017\Boston\[Boston.xls]Dynamic

Observations: Nc

Joselito Adoan

Date: 17-Jul-17

File No: QK141

Structural Load Test ASTM E330 - 02 | **Project Name:** | **UCS Curtainwall System**

This is the third test in sequence, and the initial running of this test | **Client:** | **Boston Aluminium & Glass Company LLC** | **File:** QK141

Thomas Bell-Wright International Consultants, Dubai

TEST CRITERIA		
Mullion Length	3.070	m
Transom Length	0.900	m
Allowable Mull. Deform'n	17.54	mm
Allowable Trans. Deform'n	5.14	mm
Design Pressure	1,905	Pa
Accuracy ±	± 38	Pa

PRESSURE UNCERTAINTY		
Pressure Tdr. Range	± 12,000	Pa
Pressure Tdr. Uncertainty	± 75	Pa

INSTANTANEOUS VALUES		
Ambient Temperature	39.0	℃
Barometric Pressure	1,014	mb
Relative Humidity	27%	
Chamber Pressure	**1,905**	**Pa**
Uncertainty ±	± 75	Pa
Timer (Zero)	14:00	

Zero Pressure | Zero LDTs | Start Recorder | Stop Recorder

Residual (-) | Capture Data

Clear

Current Values

LDT 1: -3.49

LDT 2: -5.33

LDT 3: -5.02

LDT 4: -5.17

LDT 5: -7.16

LDT 6: -7.78

VIEW FROM OUTSIDE — Deflections in mm

Mullion			Transom		
LDT	(+)	(-)	LDT	(+)	(-)
1	1.98	-2.27	3	3.65	-4.12
2	9.73	-11.66	4	7.77	-9.63
3	3.65	-4.12	5	10.69	-12.42
Net	**6.92**	**-8.47**	Net	**-0.60**	**-1.36**

Testing Engineer

Joselito Adoan

Date: **July 17, 2017**

Finish & Save Data

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File No: QK141

Air Infiltration Test ASTM E283 - 04 — Project Name: **UCS Curtainwall System**

This is the fourth test in sequence, and the initial running of this test — Client: **Boston Aluminium & Glass Company LLC** — File: **QK141**

Thomas Bell-Wright International Consultants, Dubai

TEST CRITERIA

Specimen height	7.00	m
Specimen width	3.30	m
Specimen area	23.10	m²
Length of opening joint	0.00	m
Permitted leakage, area	1.08	m³/hr/m²
Permitted leakage, opening joint	0.00	m³/hr/m

INSTANTANEOUS VALUES

Ambient Temperature	39	ºC
Barometric Pressure	1014	mb
Relative Humidity	0.27	
Chamber Pressure	**300.68**	Pa
Nozzle Pressure	46.4	Pa
Input Data Check	1	

PRESSURE & FLOW

Test pressure	75 Pa(Win)	300	Pa (CW)
Total permitted leakage		**24.95**	m³/hr
Required accuracy (5%)		± 1.25	m³/hr

CALCULATED VALUES

Ambient Air Density	1.13	kg/m³
Standard Air Density	1.20	kg/m³
Reynolds Number	27,001	
Check Value	72.29	m³/hr
Air Flow at ambient conditions	74.93	m³/hr
Adjust to exact Test Pressure	73.63	m³/hr
Uncertainty	± 1.32	m³/hr

INPUT CONNECTION

Conical Inlet Nozzle Dia.	55.91	mm
Pressure Tdr. Range	500	Pa
Pressure Tdr. Uncertainty	2.8	Pa
Chamber Connection	LDT 2	
Nozzle Connection	LDT 1	

UNCERTAINTY

Method, from BS848	0.4963	m³/hr
Nozzle pressure	2.2216	m³/hr
Nozzle diameter	0.1476	m³/hr
Barometric pressure	0.1460	m³/hr
Temperature	0.1303	m³/hr
Relative Humidity	0.0295	m³/hr
Total uncertainty	1.3220	m³/hr

MEAN LEAKAGE AT AMBIENT CONDITIONS

Extraneous leakage at ambient conditions	65.29	m³/hr
Uncertainty of Extraneous Leakage	± 1.54	m³/hr
Total leakage at ambient conditions	73.52	m³/hr
Uncertainty of Total Leakage	± 1.35	m³/hr
Specimen leakage at ambient conditions	8.23	m³/hr

After completion of the testing, the data was saved at 11:15, in C:\Documents and Settings\user\Desktop\Projects\2017\Boston\[Boston.xls] Air Inf

Testing Engineer: ***Joselito Adoan***

Date: **17-Jul-17**

AIR INFILTRATION TEST RESULT

Specimen Leakage at Standard Conditions	**7.99**	m³/hr
Standard Uncertainty (68% confidence)	± 2.05	m³/hr
Expanded Uncertainty (95% confidence)	± 4.02	m³/hr

MEAN LEAKAGE DATA

This sheet will average up to 10 readings of Extraneous Leakage and Total Leakage, and display the mean values below.

	Readings	Temp	Bar	RH	Dia	Chamber	Nozzle	Air Flow	Adjusted	Uncert'y	Time	Date
Extraneous	4	39 ºC	1014 mb	0.27	55.91 mm	300 Pa	36 Pa	65.29 m³/hr	65.29 m³/hr	± 1.54 m³/hr	9:56 AM	17-Jul-17
Total	5	39 ºC	1014 mb	0.27	55.91 mm	306 Pa	46 Pa	73.52 m³/hr	73.52 m³/hr	± 1.35 m³/hr	11:15 AM	17-Jul-17

THOMAS BELL-WRIGHT INTERNATIONAL CONSULTANTS

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Static Water Penetration Test ASTM E331 - 00

Project Name: UCS Curtainwall System

This is the sixth test in sequence, and the initial running of this test

Client: Boston Aluminium & Glass Company LLC

File: QK141

Thomas Bell-Wright International Consultants, Dubai

TEST CRITERIA

Specimen height	7.000	m
Specimen width	3.300	m
Specimen area	23.10	m²
Test pressure	720	Pa
Accuracy ±	14	Pa

INSTANTANEOUS VALUES

Ambient Temperature	39.0	ºC
Barometric Pressure	1,014	mb
Relative Humidity	27%	
Chamber Pressure	**720**	**Pa**
Uncertainty ±	2.8	Pa

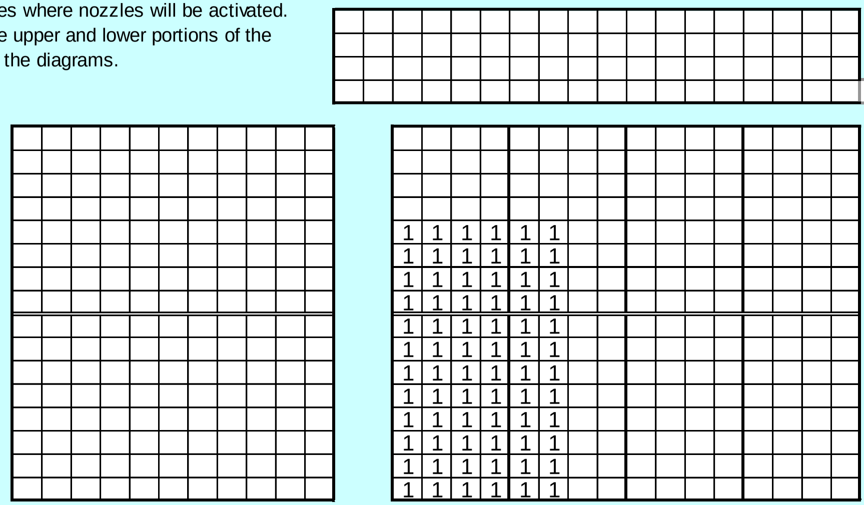
TIMER DATA

Start Time	11:23:21	
Current Time		
Elapsed Time	15:00	
Time to Go		
Finish Time		
Test Duration	15.0	Min
	15:00	

The diagrams below represent the two main types of spray racks plus one free-form (for irregular areas). Each square is 61cm and the nozzle delivers one third of a US gallon per minute. A one has been placed in the squares where nozzles will be activated. Totals for the flow rates for the upper and lower portions of the spray racks are shown below the diagrams.

PRESSURE UNCERTAINTY

Pressure Tdr. Range	500	Pa
Pressure Tdr. Uncertainty	2.8	Pa



Free-form: 0.00 US gpm

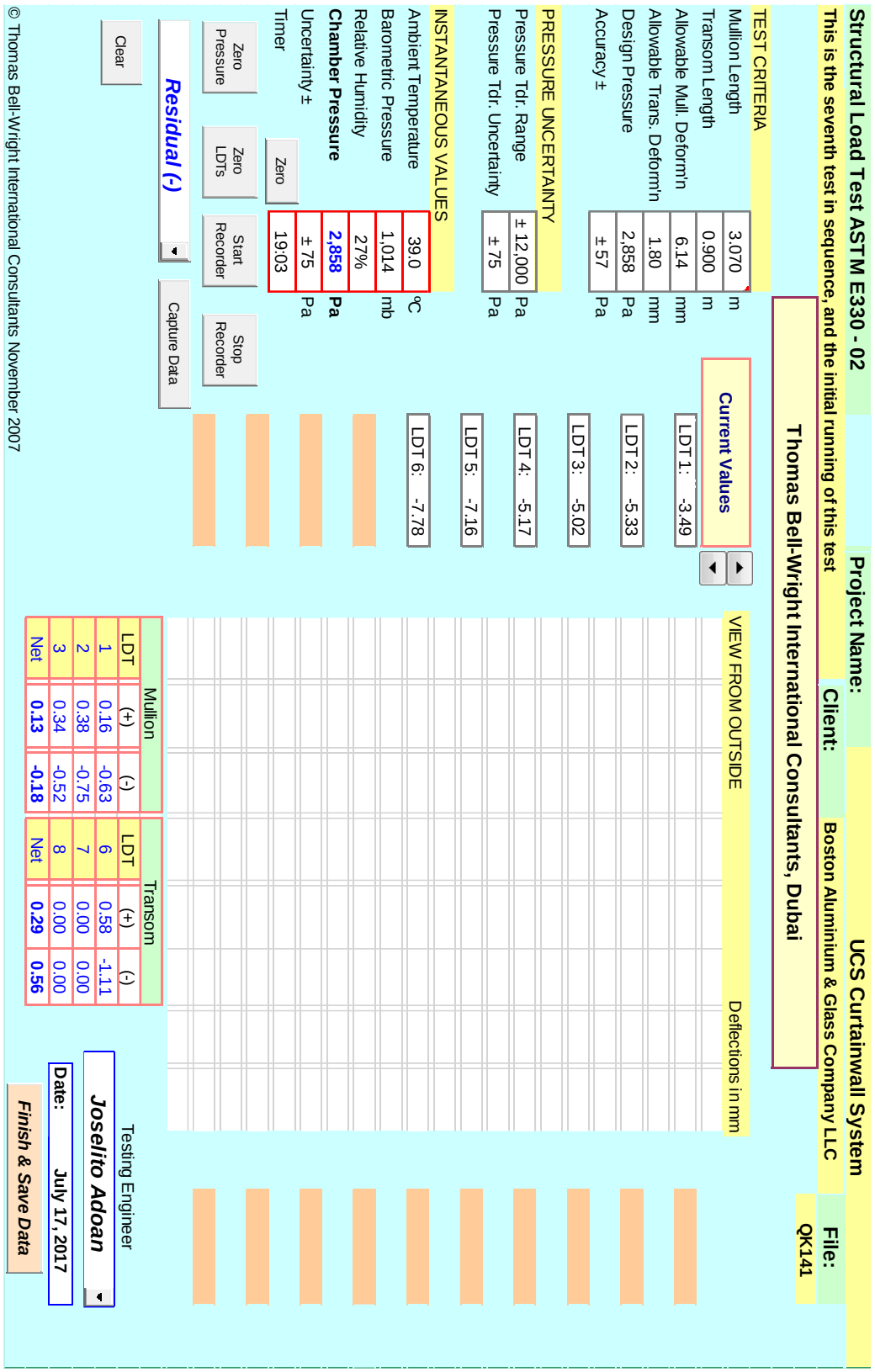
Upper Half:	0.00	US gpm	Upper Half:	5.33	2.67	0.00	0.00	US gpm
Lower Half:	0.00	US gpm	Lower Half:	10.67	5.33	0.00	0.00	US gpm

After completion of the testing, the data was saved at 11:34, in C:\Documents and Settings\user\Desktop\Projects\2017\Boston\[Boston.xls]St. Water

Observations:

Joselito Adoan

Date: 17-Jul-17


Structural Load Test ASTM E330 - 02
This is the seventh test in sequence, and the initial running of this test
Project Name:
UCS Curtainwall System
Client:
Boston Aluminium & Glass Company LLC
File:
QK141
Thomas Bell-Wright International Consultants, Dubai
TEST CRITERIA
Mullion Length 3.070 m
Transom Length 0.900 m
Allowable Mull. Deform'n 6.14 mm
Allowable Trans. Deform'n 1.80 mm
Design Pressure 2,858 Pa
Accuracy ± ± 57 Pa
PRESSURE UNCERTAINTY
Pressure Tdr. Range ± 12,000 Pa
Pressure Tdr. Uncertainty ± 75 Pa
INSTANTANEOUS VALUES
Ambient Temperature 39.0 ºC
Barometric Pressure 1,014 mb
Relative Humidity 27%
Chamber Pressure 2,858 Pa
Uncertainty ± ± 75 Pa
Timer 19:03
Zero
Zero LDTs
Start Recorder
Stop Recorder
Zero Pressure
Residual (-)
Capture Data
Clear
Current Values
LDT 1: -3.49
LDT 2: -5.33
LDT 3: -5.02
LDT 4: -5.17
LDT 5: -7.16
LDT 6: -7.78
VIEW FROM OUTSIDE
Deflections in mm
Mullion
LDT (+) (-)
1 0.16 -0.63
2 0.38 -0.75
3 0.34 -0.52
Net 0.13 -0.18
Transom
LDT (+) (-)
6 0.58 -1.11
7 0.00 0.00
8 0.00 0.00
Net 0.29 0.56
Testing Engineer
Joselito Adoan
Date: July 17, 2017
Finish & Save Data
© Thomas Bell-Wright International Consultants November 2007

11. Photos

12.

Air Infiltration – Determination of Extraneous Air Leakage

Air Infiltration – Determination of Total Air Leakage

Static Water Penetration Test

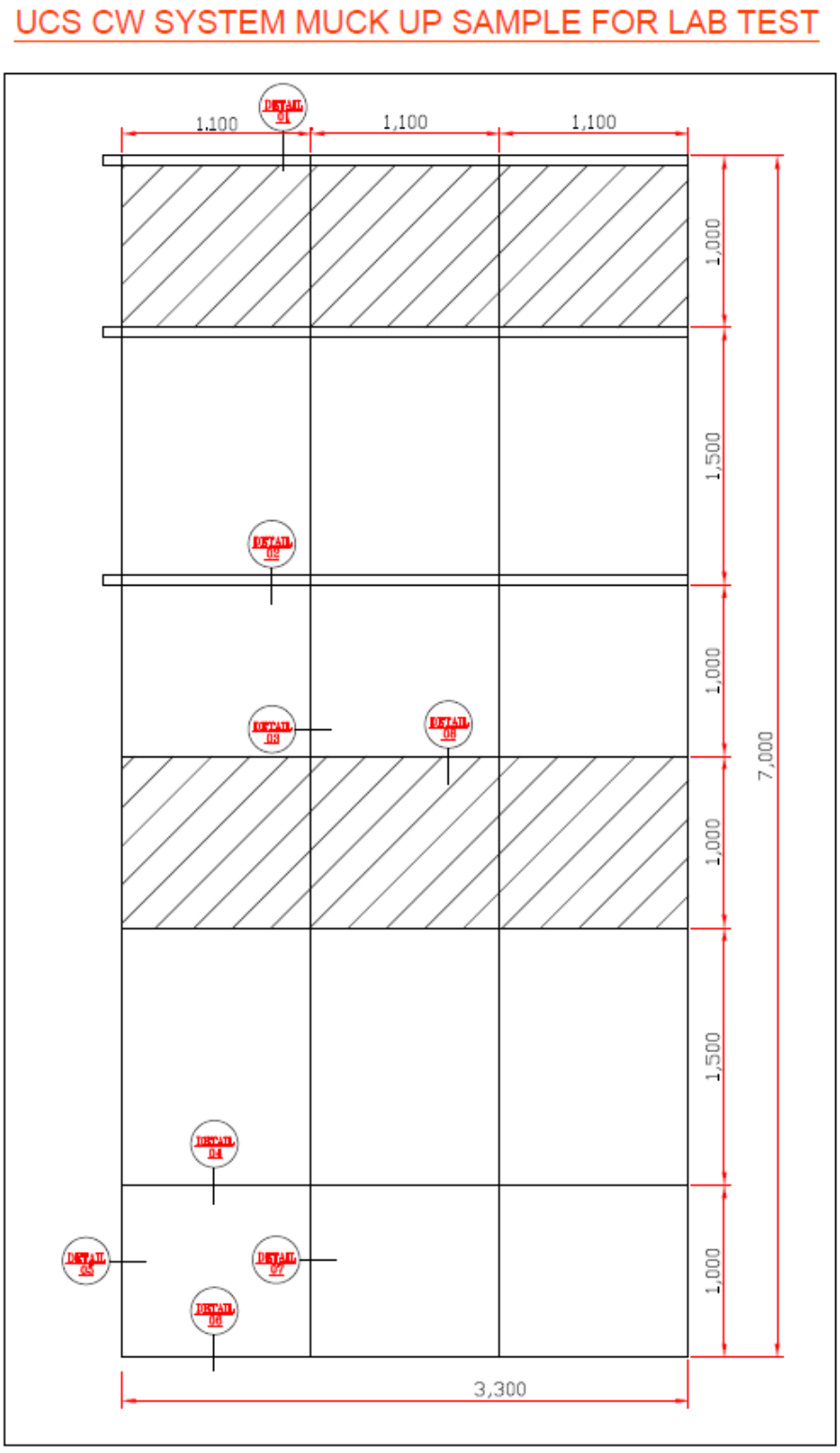
Dynamic Water Penetration Test

Linear Displacement Transducers

Linear Displacement Transducers

13. Drawings

No drawing number provided.



-End of Final Report-