



Air Test Report

*As-found and Sealed Window Test in Music Rooms 18 and 19
at
Risedale Sports and Community College, Hipswell Road
Catterick Garrison, DL9 4BD*

Ref: BO 05-12-28515 WT1
Issue Date: 15th July 2012

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Details of Elements Tested

Elements Tested: 4 x Windows in Music Room 18 6 x Windows in Music Room 19	Test Method:	B (Building envelope)
	Test Engineer:	Brian Outhwaite
Located In: Risedale Sports and Community College, Hipswell Road, Catterick Garrison, DL9 4BD	Heating:	N/A
	Ventilation:	N/A
Est. Year Built: 2012		
Test Date: 11 th July 2012		

Method of Testing

Each of the rooms was tested in two separate scenarios:

1. As-found – Ventilation ducts were installed were closed, calibrated air moving equipment installed, and the room tested. Used to benchmark the room performance.
2. With sealing to windows - The horizontal pivot windows were sealed using Quattro Seal only, with no additional sealing occurring anywhere else in the room since scenario 1. The equipment used is the same as in scenario 1.

The volume flow rate recorded between the two scenarios, is a direct response to the Quattro Seals applied to the windows.

Results

Music Room 18

As-found:

Volume Flow, Q_{50}:	1,456.0 m³.h⁻¹ @ 50 Pa
Effective Leakage Area:	0.073 m ² @ 50 Pa
Correlation of results, r^2 :	0.9887
Slope, n :	0.71
Air Flow Coefficient, C_{env} :	90.54 m ³ .h ⁻¹ .Pa ⁻ⁿ
Intercept, C_L :	89.93 m ³ .h ⁻¹ .Pa ⁻ⁿ

With sealing to Windows:

Volume Flow, Q_{50}:	1,012.5 m³.h⁻¹ @ 50 Pa
Effective Leakage Area:	0.050 m ² @ 50 Pa
Correlation of results, r^2 :	0.9995
Slope, n :	0.72
Air Flow Coefficient, C_{env} :	61.48 m ³ .h ⁻¹ .Pa ⁻ⁿ
Intercept, C_L :	61.08 m ³ .h ⁻¹ .Pa ⁻ⁿ

Music Room 19

As-found: **Volume Flow, Q_{50} :** **1,882.5 m³.h⁻¹ @ 50 Pa**
 Correlation of results, r^2 : 0.9941
 Slope, n : 0.65
Air Flow Coefficient, C_{env} : 150.9 m³.h⁻¹.Pa⁻ⁿ
 Intercept, C_L : 149.7 m³.h⁻¹.Pa⁻ⁿ

With sealing to Windows: **Volume Flow, Q_{50} :** **1,070.8 m³.h⁻¹ @ 50 Pa**
 Effective Leakage Area: 0.053 m² @ 50 Pa
 Correlation of results, r^2 : 0.9988
 Slope, n : 0.73
Air Flow Coefficient, C_{env} : 63.02 m³.h⁻¹.Pa⁻ⁿ
 Intercept, C_L : 62.69 m³.h⁻¹.Pa⁻ⁿ

Analysis and Summary

The reduction in volume air flow between the as-found and with the Quattro Seal applied to the windows is 443.5 m³.h⁻¹ @ 50 Pa for Music Room 18, which assuming equal leakage through each is 110.9 m³.h⁻¹ @ 50 Pa. The total flow passing through each window (i.e. as-found) assuming an equal distribution was 364.0 m³.h⁻¹ @ 50 Pa. Therefore the reduction in air exfiltration at 50 Pascals due to the Quattro Seal applied to the window equates to a 30.4% for Music Room 18.

The windows leakage improvement also saw similar levels of improvement once normalised (i.e. leakage improvement per window). The total flow rate improvement was 811.7 m³.h⁻¹ @ 50 Pa, which equates to 135.3 m³.h⁻¹ @ 50 Pa per window, the base rate measured at 50 Pa per window is 313.8 m³.h⁻¹. This is equal to an improvement in the integrity of the window of 43%.

The calculated values assume that the volume flow measured in the as-found scenarios were based upon all the leakage passing through the window units alone. This is a pessimistic assumption, and therefore can be viewed as a cautious quote in regards to the percentile improvement stated.

Appendix A: Test Data

Test Date: 11 July 2012
 Test Time: 10:15

Engineer Controlling Test: BO

Test No: 1

Type of Test Undertaken: Pressurisation

Engineer Locations: Inside the building under test.

Pre Test Conditions

Atmospheric Conditions

Windspeed: 0.5 m/s
 Internal Temperature #1: 20.9 °C
 Internal Temperature #2: °C
 Internal Temperature #3: °C
 Internal Temperature #4: °C
 Internal Temperature #5: °C
 Location of Reading Centre of Room
 External Temperature: 15.3 °C
 Barometric Pressure: 991 mbar

Fan Off Pressures

Manometer Number	#1	#2	#3	#4	#5
Gauge Serial Number	724005A				
Readings (Pa)	0.4				
	0.3				
	0.0				
	-0.2				
	0.0				

Corrected Values
 Average Positive Values, $Dp_{0,1+}$ 0.4 Pa
 Average Negative Values, $Dp_{0,1-}$ -0.2 Pa
 Total Average Values, $Dp_{0,1}$ 0.1 Pa

Post Test Conditions

Atmospheric Conditions

Windspeed: 0.6 m/s
 Internal Temperature #1: 21.3 °C
 Internal Temperature #2: °C
 Internal Temperature #3: °C
 Internal Temperature #4: °C
 Internal Temperature #5: °C
 Location of Reading Centre of Room
 External Temperature: 15.9 °C
 Barometric Pressure: 991 mbar

Fan Off Pressures

Manometer Number	#1	#2	#3	#4	#5
Gauge Serial Number	724005A				
Readings (Pa)	-0.8				
	-0.4				
	-0.3				
	0.3				
	0.2				

Corrected Values
 Average Positive Values, $Dp_{0,2+}$ 0.3 Pa
 Average Negative Values, $Dp_{0,2-}$ -0.5 Pa
 Total Average Values, $Dp_{0,2}$ -0.2 Pa

Average Test Conditions

Corrected Average Internal Temperature: 20.9 °C
 Corrected Average External Temperature: 15.4 °C
 Corrected Average Barometric Pressure: 993.3 mbar
 Internal Air Density, ρ_i : 1.17 kg.m⁻³
 External Air Density, ρ_e : 1.20 kg.m⁻³
 Assumed Relative Humidity: 50%

Summary of Element Test Results

Flow @ 50Pa, Q_{50} m ³ .h ⁻¹	Effective Leakage Area, A m ²	Flow Exponent, n	Flow Coeff, C_{env} m ³ .h ⁻¹ .Pa ⁻ⁿ	Air Leakage Coeff, C_L m ³ .h ⁻¹ .Pa ⁻ⁿ	Correlation r^2
1,455.9	0.073	0.71	90.54	89.93	0.9887

Calibration Information for Equipment Used

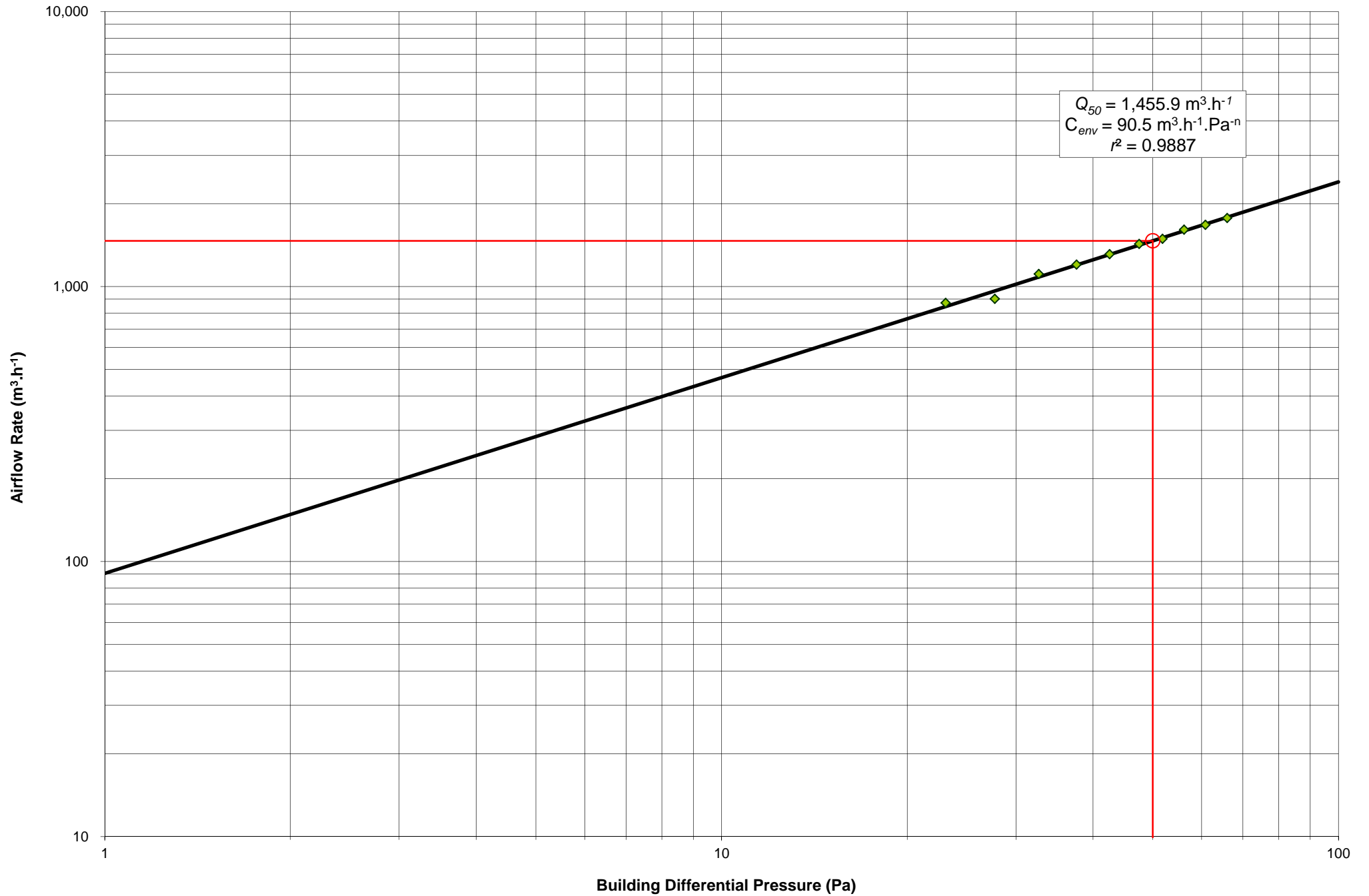
Serial Number	Equipment Type	Calib. Expiry Date
0703-90627-3	Anemometer	11 June 2013
GPB0021	Barometer	11 June 2013
726946	Thermometer	11 June 2013
724005A	Manometer (Build)	12 June 2013
724005B	Manometer (Fan)	12 June 2013
H01996	Fan	11 June 2013

Differential Building Pressures

Gauge #1:	724005A	Room Pressure	Dp _{0,1}	Dp _m										Dp _{0,2}
			0.1	22.8	27.4	32.3	37.2	42.1	47.0	51.3	55.6	60.2	65.3	-0.2
		Corrected (Pa)	0.1	23.0	27.7	32.6	37.6	42.5	47.5	51.8	56.1	60.8	65.9	-0.2
		Avg Corrected, Dp (Pa):		23.1	27.7	32.7	37.6	42.6	47.5	51.9	56.2	60.8	66.0	

Fan Flow Pressures and Volume Flow Rates

Type	Serial No.	Range	Gauge Ref												
T_5	H01996	Ring C8	724005B	Initial Static Pressure Fan Blanked Off	59.3	66.4	91.3	106.2	124.3	144.5	157.4	179.3	194.2	215.4	Final Static Pressure Fan Blanked Off
				Flow Pressure Corrected (Pa)	37.5	40.1	60.6	70.9	84.4	100.1	109.0	127.0	137.6	154.1	
				Flow, Q _{c1} (m ³ /s)	0.24	0.24	0.30	0.33	0.36	0.39	0.40	0.44	0.45	0.48	
				Total Flow, Q _{env} (m ³ /hr)	872	902	1,110	1,201	1,312	1,429	1,491	1,611	1,677	1,775	
				Error (%)	3.1%	-6.8%	2.5%	0.4%	0.4%	1.1%	-0.9%	1.1%	-0.5%	-0.6%	



Test Date: 11 July 2012
 Test Time: 12:37

Engineer Controlling Test: BO

Test No: 1.1

Type of Test Undertaken: Pressurisation

Engineer Locations: Inside the building under test.

Pre Test Conditions

Atmospheric Conditions

Windspeed: 0.7 m/s
 Internal Temperature #1: 20.9 °C
 Internal Temperature #2: °C
 Internal Temperature #3: °C
 Internal Temperature #4: °C
 Internal Temperature #5: °C
 Location of Reading: Centre of Room
 External Temperature: 17.2 °C
 Barometric Pressure: 991 mbar

Fan Off Pressures

Manometer Number	#1	#2	#3	#4	#5
Gauge Serial Number	724005A				
Readings (Pa)	-1.2				
	-1.1				
	0.3				
	1.1				
	-0.2				

Corrected Values
 Average Positive Values, $Dp_{0,1+}$: 0.7 Pa
 Average Negative Values, $Dp_{0,1-}$: -0.8 Pa
 Total Average Values, $Dp_{0,1}$: -0.2 Pa

Post Test Conditions

Atmospheric Conditions

Windspeed: 0.8 m/s
 Internal Temperature #1: 21.5 °C
 Internal Temperature #2: °C
 Internal Temperature #3: °C
 Internal Temperature #4: °C
 Internal Temperature #5: °C
 Location of Reading: Centre of Room
 External Temperature: 17.9 °C
 Barometric Pressure: 992 mbar

Fan Off Pressures

Manometer Number	#1	#2	#3	#4	#5
Gauge Serial Number	724005A				
Readings (Pa)	-0.2				
	0.0				
	0.1				
	0.5				
	0.2				

Corrected Values
 Average Positive Values, $Dp_{0,2+}$: 0.3 Pa
 Average Negative Values, $Dp_{0,2-}$: -0.2 Pa
 Total Average Values, $Dp_{0,2}$: 0.1 Pa

Average Test Conditions

Corrected Average Internal Temperature: 21.0 °C
 Corrected Average External Temperature: 17.4 °C
 Corrected Average Barometric Pressure: 993.6 mbar
 Internal Air Density, ρ_i : 1.17 kg.m⁻³
 External Air Density, ρ_e : 1.19 kg.m⁻³
 Assumed Relative Humidity: 50%

Summary of Building Test Results

Flow @ 50Pa, Q_{50} m ³ .h ⁻¹	Effective Leakage Area, A m ²	Flow Exponent, n	Flow Coeff, C_{env} m ³ .h ⁻¹ .Pa ⁻ⁿ	Air Leakage Coeff, C_L m ³ .h ⁻¹ .Pa ⁻ⁿ	Correlation r^2
1,012.5	0.050	0.72	61.48	61.08	0.9995

Calibration Information for Equipment Used

Serial Number	Equipment Type	Calib. Expiry Date
0703-90627-3	Anemometer	11 June 2013
GPB0021	Barometer	11 June 2013
726946	Thermometer	11 June 2013
724005A	Manometer (Build)	12 June 2013
724005B	Manometer (Fan)	12 June 2013
H01996	Fan	11 June 2013

Differential Building Pressures

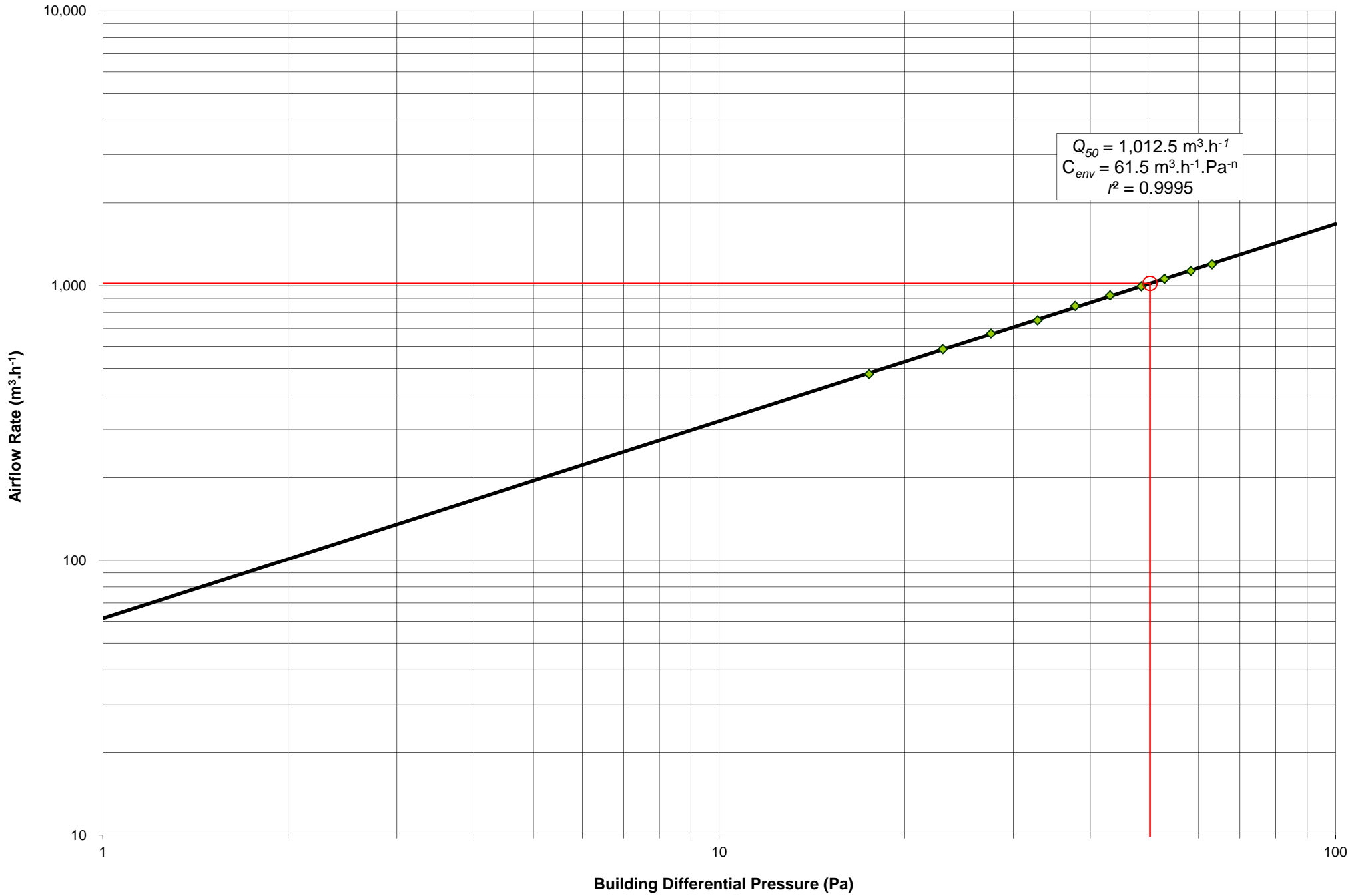
Gauge #1:	724005A	Room Pressure	Dp _m										Dp _{0,1}	Dp _{0,2}
			-0.2	17.3	22.8	27.3	32.5	37.4	42.6	47.9	52.2	57.6	62.4	0.1
		Corrected (Pa)	-0.2	17.5	23.0	27.6	32.8	37.8	43.0	48.4	52.7	58.2	63.0	0.1
		Avg Corrected, Dp (Pa):		17.5	23.1	27.6	32.9	37.8	43.1	48.4	52.8	58.2	63.1	

Fan Flow Pressures and Volume Flow Rates

Type	Serial No.	Range	Gauge Ref											
T_5	H01996	Ring C4	724005B	Flow Pressure	58.4	84.6	107.4	132.1	163.4	192.3	221.4	248.5	280.6	311.1
				Corrected (Pa)	42.2	63.4	82.1	102.1	129.2	153.4	177.8	201.2	228.5	254.8
				Flow, Q _{c1} (m ³ /s)	0.13	0.16	0.18	0.20	0.23	0.25	0.27	0.29	0.31	0.32
				Total Flow, Q _{env} (m ³ /hr)	476	587	670	749	845	923	995	1,060	1,131	1,196
				Error (%)	-0.9%	0.2%	0.6%	-0.7%	1.2%	0.7%	-0.1%	0.0%	-0.5%	-0.7%

Initial Static Pressure Fan Blanked Off

Final Static Pressure Fan Blanked Off



Test Date: 11 July 2012
 Test Time: 11:50

Engineer Controlling Test: BO

Test No: 1

Type of Test Undertaken: Pressurisation

Engineer Locations: Inside the building under test.

Pre Test Conditions

Atmospheric Conditions

Windspeed: 0.6 m/s

Internal Temperature #1: 20.9 °C
 Internal Temperature #2: °C
 Internal Temperature #3: °C
 Internal Temperature #4: °C
 Internal Temperature #5: °C

Location of Reading
 Centre of Room

External Temperature: 16.4 °C

Barometric Pressure: 991 mbar

Fan Off Pressures

Manometer Number	#1	#2	#3	#4	#5
Gauge Serial Number	724005A				
Readings (Pa)	-0.5				
	-1.1				
	0.1				
	-0.4				
	1.0				

Corrected Values
 Average Positive Values, $Dp_{0,1+}$ 0.6 Pa
 Average Negative Values, $Dp_{0,1-}$ -0.7 Pa
 Total Average Values, $Dp_{0,1}$ -0.2 Pa

Post Test Conditions

Atmospheric Conditions

Windspeed: 0.5 m/s

Internal Temperature #1: 21.2 °C
 Internal Temperature #2: °C
 Internal Temperature #3: °C
 Internal Temperature #4: °C
 Internal Temperature #5: °C

Location of Reading
 Centre of Room

External Temperature: 16.6 °C

Barometric Pressure: 991 mbar

Fan Off Pressures

Manometer Number	#1	#2	#3	#4	#5
Gauge Serial Number	724005A				
Readings (Pa)	0.7				
	-0.3				
	0.5				
	0.0				
	0.1				

Corrected Values
 Average Positive Values, $Dp_{0,2+}$ 0.4 Pa
 Average Negative Values, $Dp_{0,2-}$ -0.3 Pa
 Total Average Values, $Dp_{0,2}$ 0.2 Pa

Average Test Conditions

Corrected Average Internal Temperature: 20.9 °C
 Corrected Average External Temperature: 16.3 °C

Internal Air Density, ρ_i : 1.17 kg.m⁻³
 External Air Density, ρ_e : 1.19 kg.m⁻³

Corrected Average Barometric Pressure: 993.2 mbar

Assumed Relative Humidity: 50%

Summary of Building Test Results

Flow @ 50Pa, Q_{50} m ³ .h ⁻¹	Effective Leakage Area, A m ²	Flow Exponent, n	Flow Coeff, C_{env} m ³ .h ⁻¹ .Pa ⁻ⁿ	Air Leakage Coeff, C_L m ³ .h ⁻¹ .Pa ⁻ⁿ	Correlation r^2
1,882.5	0.094	0.65	150.9	149.7	0.9941

Calibration Information for Equipment Used

Serial Number	Equipment Type	Calib. Expiry Date
0703-90627-3	Anemometer	11 June 2013
GPB0021	Barometer	11 June 2013
726946	Thermometer	11 June 2013
724005A	Manometer (Build)	12 June 2013
724005B	Manometer (Fan)	12 June 2013
H01996	Fan	11 June 2013

Differential Building Pressures

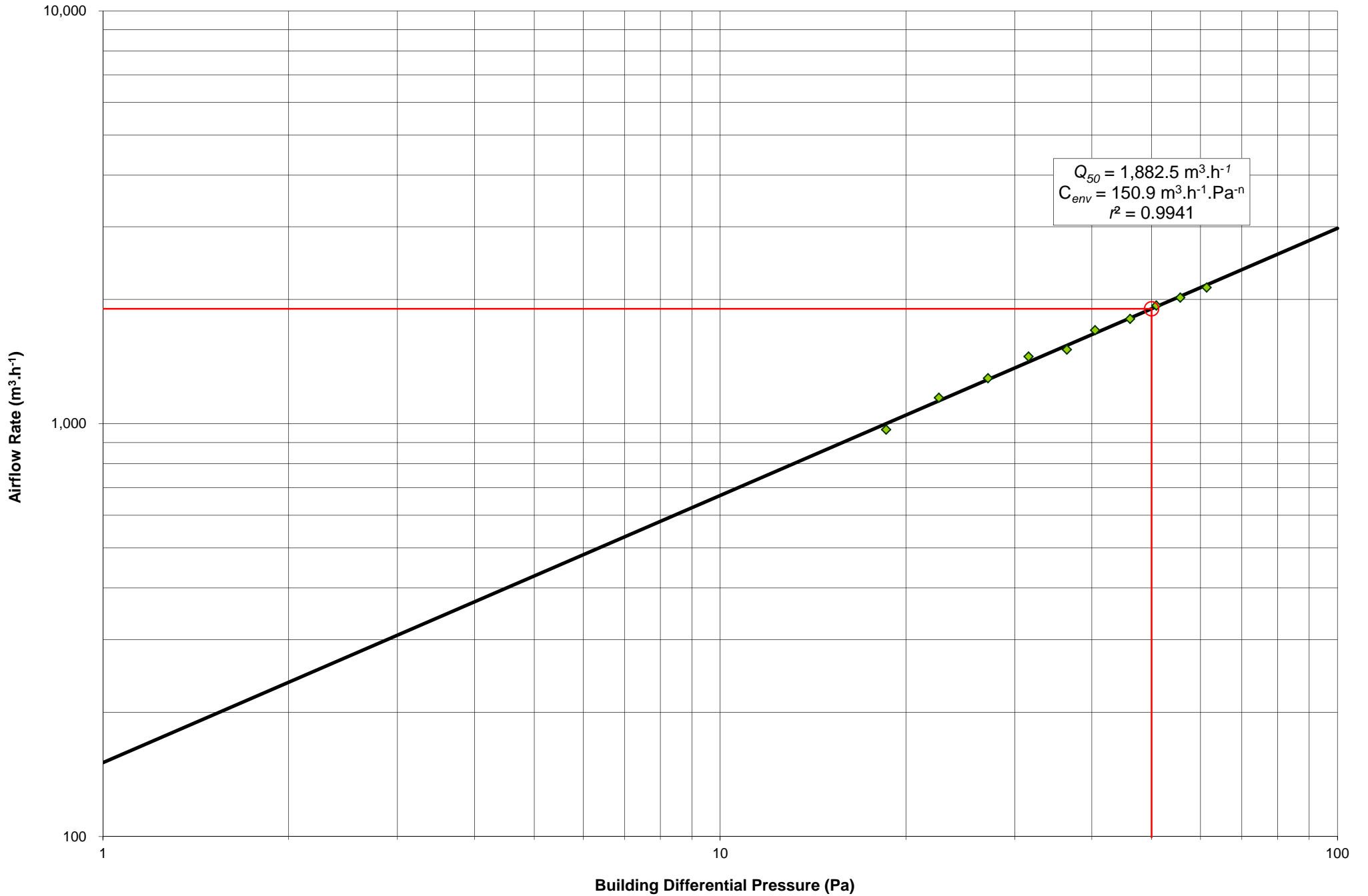
Gauge #1:	724005A	Room Pressure	Dp _{0,1}	Dp _m										Dp _{0,2}
			-0.2	18.4	22.4	26.9	31.3	36.1	40.1	45.7	50.4	55.1	60.8	0.2
		Corrected (Pa)	-0.2	18.6	22.6	27.2	31.6	36.5	40.5	46.1	50.9	55.6	61.4	0.2
		Avg Corrected, Dp (Pa):		18.6	22.6	27.2	31.6	36.4	40.5	46.1	50.9	55.6	61.4	

Fan Flow Pressures and Volume Flow Rates

Type	Serial No.	Range	Gauge Ref												
T_5	H01996	Ring C8	724005B												
			Flow Pressure												
			Corrected (Pa)	63.3	86.4	106.4	132.4	145.3	175.6	199.2	228.4	249.5	278.3		
			Flow, Q _{c1} (m ³ /s)	46.1	65.7	81.6	103.7	112.0	139.0	157.4	182.5	199.3	223.0		
			Total Flow, Q _{env} (m ³ /hr)	0.26	0.31	0.35	0.39	0.41	0.46	0.49	0.52	0.55	0.58		
			Error (%)	967	1,156	1,289	1,454	1,512	1,685	1,794	1,933	2,020	2,138		
				-3.3%	1.7%	0.8%	3.0%	-2.3%	1.7%	-0.4%	0.7%	-0.7%	-1.4%		

Initial Static Pressure Fan Blanked Off

Final Static Pressure Fan Blanked Off



Test Date: 11 July 2012
 Test Time: 13:25

Engineer Controlling Test: BO

Test No: 1.1

Type of Test Undertaken: Pressurisation

Engineer Locations: Inside the building under test.

Pre Test Conditions

Atmospheric Conditions

Windspeed: 0.5 m/s
 Internal Temperature #1: 20.9 °C
 Internal Temperature #2: °C
 Internal Temperature #3: °C
 Internal Temperature #4: °C
 Internal Temperature #5: °C
 Location of Reading: Centre of Room
 External Temperature: 16.3 °C
 Barometric Pressure: 991 mbar

Fan Off Pressures

Manometer Number	#1	#2	#3	#4	#5
Gauge Serial Number	724005A				
Readings (Pa)	-1.0				
	0.2				
	-0.2				
	-0.1				
	0.0				

Corrected Values
 Average Positive Values, $Dp_{0,1+}$: 0.2 Pa
 Average Negative Values, $Dp_{0,1-}$: -0.4 Pa
 Total Average Values, $Dp_{0,1}$: -0.2 Pa

Post Test Conditions

Atmospheric Conditions

Windspeed: 0.5 m/s
 Internal Temperature #1: 19.3 °C
 Internal Temperature #2: °C
 Internal Temperature #3: °C
 Internal Temperature #4: °C
 Internal Temperature #5: °C
 Location of Reading: Centre of Room
 External Temperature: 16.6 °C
 Barometric Pressure: 991 mbar

Fan Off Pressures

Manometer Number	#1	#2	#3	#4	#5
Gauge Serial Number	724005A				
Readings (Pa)	-0.3				
	-0.5				
	0.5				
	0.4				
	0.2				

Corrected Values
 Average Positive Values, $Dp_{0,2+}$: 0.4 Pa
 Average Negative Values, $Dp_{0,2-}$: -0.4 Pa
 Total Average Values, $Dp_{0,2}$: 0.1 Pa

Average Test Conditions

Corrected Average Internal Temperature: 19.9 °C
 Corrected Average External Temperature: 16.3 °C
 Corrected Average Barometric Pressure: 993.4 mbar
 Internal Air Density, ρ_i : 1.18 kg.m⁻³
 External Air Density, ρ_e : 1.19 kg.m⁻³
 Assumed Relative Humidity: 50%

Summary of Building Test Results

Flow @ 50Pa, Q_{50} m ³ .h ⁻¹	Effective Leakage Area, A m ²	Flow Exponent, n	Flow Coeff, C_{env} m ³ .h ⁻¹ .Pa ⁻ⁿ	Air Leakage Coeff, C_L m ³ .h ⁻¹ .Pa ⁻ⁿ	Correlation r^2
1,070.8	0.053	0.73	63.02	62.69	0.9988

Calibration Information for Equipment Used

Serial Number	Equipment Type	Calib. Expiry Date
0703-90627-3	Anemometer	11 June 2013
GPB0021	Barometer	11 June 2013
726946	Thermometer	11 June 2013
724005A	Manometer (Build)	12 June 2013
724005B	Manometer (Fan)	12 June 2013
H01996	Fan	11 June 2013

Differential Building Pressures

Gauge #1:	724005A	Room Pressure	Dp _{0,1}		Dp _m								Dp _{0,2}	
			-0.2	17.3	22.8	27.4	32.3	37.6	43.1	48.6	52.1	57.3	61.4	0.1
		Corrected (Pa)	-0.2	17.5	23.0	27.7	32.6	38.0	43.5	49.1	52.6	57.9	62.0	0.1
		Avg Corrected, Dp (Pa):		17.6	23.1	27.8	32.7	38.1	43.6	49.2	52.7	57.9	62.1	

Fan Flow Pressures and Volume Flow Rates

Type	Serial No.	Range	Gauge Ref												
T_5	H01996	Ring C4	724005B	Flow Pressure	65.3	89.4	116.6	140.4	175.3	209.3	248.4	275.3	312.1	339.8	
				Corrected (Pa)	49.2	68.2	91.4	110.8	141.1	170.3	204.7	228.6	261.0	285.1	
				Flow, Q _{c1} (m ³ /s)	0.14	0.17	0.19	0.21	0.24	0.26	0.29	0.31	0.33	0.34	
				Total Flow, Q _{env} (m ³ /hr)	513	607	705	778	880	969	1,065	1,127	1,206	1,262	
				Error (%)	1.8%	-1.3%	0.3%	-1.7%	-0.3%	-0.6%	0.1%	0.8%	0.7%	0.2%	

Initial Static Pressure Fan Blanked Off

Final Static Pressure Fan Blanked Off

