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## **Air Change Rate Test Report:**

*New-build detached house, at Berins Hill  
Ipsden, near Oxford*

Ref: PJJ 02-05-1552 T1&2  
Date: 25<sup>th</sup> July 2005

Prepared for:

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Paul Jennings - Supervising Senior Engineer



# Air Leakage Test Report

**Report on the Air Leakage Testing of a new-build detached house, built by Sustainable Construction, at Berins Hill in Ipsden, near Oxford, on 8<sup>th</sup> March & 30<sup>th</sup> June 2005**



**Test Result:** Excellent

*Paul Jennings*

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**Paul Jennings**  
**Building & Enclosure Integrity Specialist**  
**Stroma Technology Limited, July 2005**  
REF.: PJJ 02-05-1552 T1&2



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## 1.0 Summary

### 1.1 Results & Calculations

Air leakage testing of a new-build detached house, recently built by Sustainable Construction at Berins Hill in Ipsden near Oxford, was undertaken on the 8<sup>th</sup> of March and the 30<sup>th</sup> of June 2005. The principle objective of the testing was to quantify the leakage of the building and hence establish whether it achieved a satisfactory level of air leakage. From our experience, the Building Regulations Part L1 (England & Wales, 2002) Air Permeability target of 10.0 m<sup>3</sup>/hr/m<sup>2</sup>@ 50 Pa is far too lax a target, and more typical Air Permeability targets for low energy buildings not incorporating heat recovery ventilation are 5.0 and sometimes 3.0 m<sup>3</sup>/hr/m<sup>2</sup>@ 50 Pa. When buildings incorporate full mechanical ventilation with heat recovery we recommend a maximum Air Permeability of 1.5 m<sup>3</sup>/hr/m<sup>2</sup>@ 50 Pa. Although unfortunately a target Air Permeability value was not specified as part of the original documentation, the relatively recent initiation of the project would indicate that an appropriate target value was 3.0 m<sup>3</sup>/hr/m<sup>2</sup>@ 50 Pa.

Testing was carried out in accordance with the CIBSE standard TM23: Testing Buildings for Air Leakage, using a calculated volume of 313 cubic metres and a total surface area of 416 square metres for the entire building. The results achieved in the series of tests carried out on this house are detailed below and overleaf:

Test	Test Details	Airflow at 50 Pascals (m <sup>3</sup> /hour)	Hourly Air Change Rate (ACH @ 50 Pa)	Equivalent Leakage Area (m <sup>2</sup> at 50 Pa)	Air Permeability (m <sup>3</sup> /hour/m <sup>2</sup> @ 50 Pa)
One	8 <sup>th</sup> March, preliminary single-point depressurization test, as found.	1,410	4.50	0.0705	3.39
Two	30 <sup>th</sup> June, preliminary single-point depressurization test after sealing waste pipes.	1,160	3.71	0.0580	2.79
Three	Single-point depressurization test after sealing cooker hood extract.	1,118	3.57	0.0559	2.69
Four	Single-point depressurization test after sealing two ducts where extracts are to be fitted.	1,029	3.29	0.0514	2.47
Five	30 <sup>th</sup> June, full multi-point acceptance depressurization test.	1,019	3.26	0.0509	2.45
Six	Single-point depressurization test after opening 11 trickle vents.	1,300	4.15	0.0650	3.12



Test	Test Details	Airflow at 50 Pascals (m <sup>3</sup> /hour)	Hourly Air Change Rate (ACH @ 50 Pa)	Equivalent Leakage Area (m <sup>2</sup> at 50 Pa)	Air Permeability (m <sup>3</sup> /hour/m <sup>2</sup> @ 50 Pa)
Seven	Single-point depressurization test after sealing an open 80 mm diameter inlet to gas fire.	1,274	4.07	0.0637	3.06
Eight	Single-point depressurization test after opening 8 slot vents across the heads of the Velux roof lights.	1,820	5.82	0.0910	4.38

## 1.2 Comments & Recommendations

### 1.2.1 Air Permeability

The final result of the air leakage testing (Test Five) of the nearly completed building was an Air Permeability of 2.45 cubic metres of airflow per hour per square metre of total surface area, at an imposed pressure difference of 50 Pascals (AP = 2.45 m<sup>3</sup>/hr/m<sup>2</sup>@ 50 Pa).

This is much better than the current Building Regulations (Part L1, 2000) specification for new domestic buildings of a maximum Air Permeability of 10 cubic metres of airflow per hour per square metre of total surface area, at an imposed pressure difference of 50 Pascals (AP ≤ 10 m<sup>3</sup>/hr/m<sup>2</sup>@ 50 Pa). Moreover, this readily meets the target of 3.0 m<sup>3</sup>/hr/m<sup>2</sup>@ 50 Pa that we would apply to a similar – i.e. without heat recovery ventilation – building commenced today. Hence an Air Leakage Certificate has been issued for this building, a copy of which is provided in Appendix One.

Localized air leakage problems were identified during the preliminary testing in March, which are discussed in the main body of this report, and a number of additional tests were also carried out to quantify by subtraction the air leakage through a range of elements.

### 1.2.2 Effect of Temporary Sealing

The table below and overleaf details and discusses the changes in the Air Permeability and the effective leakage area between the eight different tests carried out:

Comparison Details	Change in Air Permeability (m <sup>3</sup> /hour/m <sup>2</sup> @ 50 Pa)	Change in Equivalent Leakage Area (m <sup>2</sup> at 50 Pa)	Notes & comments
1) Test 5, final acceptance and Test 1, preliminary.	- 0.94	- 0.0196	Improvement from completion of building & remedial sealing to edge leaks of tanking.
2) Test 3, after sealing cooker hood and Test 2.	- 0.10	- 0.0021	Quantifies leakage through cooker hood.
3) Test 4, after sealing two extracts and Test 3.	- 0.22	- 0.0045	Quantifies leakage through two 100mm diameter extract ducts.



Comparison Details	Change in Air Permeability (m <sup>3</sup> /hour/m <sup>2</sup> @ 50 Pa)	Change in Equivalent Leakage Area (m <sup>2</sup> at 50 Pa)	Notes & comments
4) Test 7, after sealing open inlet, and Test 6.	- 0.06	- 0.0013	Quantified effective leakage through 80mm diameter hole – cross-sectional area of approx. 0.005 m <sup>2</sup> , hence 26% open.
5) Test 5 and Test 4, difference between multi-point and single-point test.	- 0.002	- 0.0005	Very little difference.
6) Test 6 and Test 5, effect of unsealing 11 trickle vents.	+ 0.67	+ 0.0141	Approx. 0.0013 m <sup>2</sup> effective area per trickle vent.
7) Test 8 and Test 7, effect of unsealing 8 vents at the heads of Velux windows.	+ 1.32	+ 0.0273	Approx. 0.0034 m <sup>2</sup> effective area per vent across Velux windows.

### 1.2.3 Test Conditions

A small existing pressure differential of + 2.0 Pa was measured during the preliminary testing in March, apparently wind-induced, but no such differential was measured during the final series of tests. The barometric pressure was normal, at approximately 101,500 Pa, whilst windspeeds were light – less than 1.0 m/s throughout.

A Retrotec K4A single-fan blower-door system was mounted in one of the entrance doorways to the upper floor of the house. Pressure measuring devices were located inside the building, and an external pressure tap extended to directly monitor the pressure difference across the building envelope.

Internal and external temperatures were monitored and recorded. Internal doors (where fitted) were wedged open for the duration of the testing to ensure that the building acted as a single volume.

### 1.2.4 Leakage Sites

Numerous leakage sites were identified during the preliminary testing and are discussed further in the main body of this report. Whilst the overall level of leakage was satisfactory, there were some localized problem areas, particularly around the edges of the tanking on the lower floor which we considered required attention. These were addressed during the completion of the building prior to the final testing, and the significant improvement measured at that time clearly indicates that the remedial sealing works were largely effective.

### 1.2.5 Repeat Air Leakage Testing

We do not consider it necessary to carry out any further air leakage testing upon the new house at Berins Hill.



## 2.0 Introduction

Air leakage testing uses one or more calibrated portable fan(s) mounted in an adjustable door system to impose a series of steady state pressure differentials upon a building or dwelling. For each pressure differential the corresponding flow of air through the fan unit(s) is measured, and the series of pairs of measurements are plotted to give the leakage characteristics of the building. These are normally expressed as:

- 1) the hourly airflow at fifty Pascals imposed pressure differential ( $\text{m}^3/\text{hr} @ 50 \text{ Pa}$ )
- 2) the hourly air change rate at fifty Pascals imposed pressure differential ( $\text{ACH} @ 50 \text{ Pa}$ );
- 3) the equivalent (or effective) leakage area of the volume under test ( $\text{m}^2$ ), represented as a single sharp-edged orifice at a standard pressure differential of either 10 or 4 Pascals;
- 4) the air leakage index, which is the hourly airflow at 50 Pascals pressure difference per unit area of the building's exposed surface area ( $\text{m}^3/\text{hour}/\text{m}^2 @ 50 \text{ Pa}$ ).
- 5) the air permeability, which is the hourly airflow at 50 Pascals pressure difference per unit area of the building's total surface area ( $\text{m}^3/\text{hour}/\text{m}^2 @ 50 \text{ Pa}$ ).

The last of these is generally considered more suitable for larger industrial and commercial buildings because it takes account of the surface to volume ratio and therefore corrects to some extent for the natural tendency for larger buildings to achieve a better  $\text{ACH} @ 50 \text{ Pa}$ . Hence the airtightness target applied in the April 2000 revision of Part L of the Building Regulations (England & Wales), is expressed as a maximum Air Permeability of  $10 \text{ m}^3/\text{hour}/\text{m}^2 @ 50 \text{ Pa}$ .

More stringent airtightness requirements may apply if a building is specified to a more advanced standard, such as the case with low-energy and sustainable homes, where target maximum Air Permeability's of  $5.0$  or  $3.0 \text{ m}^3/\text{hour}/\text{m}^2 @ 50 \text{ Pa}$  are now normally applied. As discussed, the relatively recent initiation of the project would indicate that an appropriate target value was  $3.0 \text{ m}^3/\text{hour}/\text{m}^2 @ 50 \text{ Pa}$ .

## 3.0 Test Methodology & Procedure

Testing was undertaken in accordance with the CIBSE standard TM23: Testing Buildings for Air Leakage. The objectives of the testing were to (a) quantify the leakage of the building and hence establish whether it achieved a satisfactory level of air leakage and (b) to check for residual leakage sites.

As shown, the Retrotec blower-door system was fitted into the entrance door by means of an adjustable frame, secured in place, and was used to impose a series of steady state pressure differentials upon the volume under test, for which the corresponding airflow is calculated.

Set up and gauge zeroing were performed according to the manufacturer's instructions. The external pressure probe was positioned 3 to 5 meters away from the fan's airflow streams to ensure that turbulence did not affect the pressure measurements.





## 4.0 Building Data

In order to carry out an Air Leakage Test a number of parameters are required, which form the basis of the various calculations undertaken.

### 4.1 Required Information:

- Defined boundary of the heated envelope, and therefore which sections must be included or excluded e.g. exclude a cold roof void but include a warm roof void, exclude an unheated plant room
- The existence and configuration of building elements or services that may affect the air leakage of the building e.g. chimneys, extract fans, trickle vents
- The target that must be achieved e.g. Building Regulations Part L2, CIBSE Good Practice or Best Practice, Super E, AECB Factor 4 or Factor 8, client specification
- The building's volume
- The building's ground floor area
- The area of any exposed upper floors or soffits (e.g. above vehicular accessways)
- The wall area (including doors & windows)
- The roof area (including rooflights)
- The external barometric pressure at the time of the test
- The external wind speed at the time of the test
- Any existing pressure differential between the building and its surroundings
- The average internal and external temperatures

In addition the leakage characteristics of the building are required, and these are derived directly from the measurements of airflow and corresponding pressure difference made during the test.

### 4.2 Building Data

#### Collected for Building:

#### New house at Berins Hill, Ipsden

• Defined envelope:	2-storey, semi earth-sheltered detached house	
• Configuration:	Various configurations of vents & extracts, internal doors open.	
• Target:	Air Permeability $\leq 3.0$	$\text{m}^3/\text{sec}/\text{m}^2$ @ 50 Pa
• Building volume:	313	$\text{m}^3$
• Total surface area:	416	$\text{m}^2$
• Barometric pressure:	101,500	Pa
• Wind speed:	< 1.0	m/sec
• Average existing pressure differential:	+ 2.0 (preliminary) 0.0 (final)	Pa
• Internal temperature:	22 (final)	$^{\circ}\text{C}$
• External temperature:	20 (final)	$^{\circ}\text{C}$



## 5.0 Measurements & Results

### 5.1 Preliminary Air Leakage Testing, 8<sup>th</sup> March

Preliminary air leakage testing of the newbuild house at Berins Hill was undertaken on the 8<sup>th</sup> of March 2005. A preliminary single-point depressurization test was undertaken to check the overall leakage of the incomplete building, which was then inspected for leakage sites. The preliminary test demonstrated that a satisfactory level would be achieved once the building was complete, especially if some particular remedial sealing works were carried out, and therefore the undertaking of a full multi-point acceptance test was postponed.

A single Retrotec K4A blower-door system was mounted in the main entrance doorway to the upper floor.

#### 5.1.1 Preliminary Single-point Test, 8<sup>th</sup> March

The measurements and results of the preliminary single-point test are as follows:

Reading No.	Imposed Pressure Differential (Pa) (Corrected)	Airflow Through Fans (m <sup>3</sup> /hr)
1	- 52.0	1,446

The leakage characteristics derived from this pair of readings are detailed below:

Airflow @ 50 Pa: 1,410 m<sup>3</sup>/hour  
Equivalent leakage area: 0.030 m<sup>2</sup> (@ 4 Pa)

Dividing the hourly airflow at 50 Pa by the total surface area for the building of 416 m<sup>2</sup> gives an Air Permeability of 3.4 m<sup>3</sup>/hour/m<sup>2</sup> @ 50 Pa, slightly above the agreed target of 3.0 m<sup>3</sup>/hour/m<sup>2</sup> @ 50 Pa. Following the unsatisfactory preliminary test, a detailed examination of the house for leakage sites was undertaken whilst it was depressurized using the door fan equipment.

A full printout from the Energy 2001 software used for the testing is provided in Appendix One.

### 5.2 Preliminary Air Leakage Testing, 30<sup>th</sup> June

Further air leakage testing of the newbuild house at Berins Hill was undertaken on the 30<sup>th</sup> June 2005 as the building neared completion. All internal walls had then been plasterboarded, and remedial sealing works to the leakage sites identified in the initial test had also been completed. Once again, a preliminary single-point depressurization test was undertaken to check the overall leakage of the building, after which a series of further tests were carried out as temporary sealing works were undertaken to prepare the house for the final multi-point acceptance test. Details of these sequential single-point tests are provided overleaf.

Once again, a single Retrotec K4A blower-door system was used, and on this occasion it mounted in the side entrance doorway to the upper floor (rather than the main entrance door).



**5.2.1 Initial Single-point Test, 30<sup>th</sup> June, as found**

The measurements and results of the initial single-point test are as follows:

Reading No.	Imposed Pressure Differential (Pa) (Corrected)	Airflow Through Fans (m <sup>3</sup> /hr)
1	- 50.5	1,168

The leakage characteristics derived from this pair of readings are detailed below:

Airflow @ 50 Pa: 1,160 m<sup>3</sup>/ hour  
 Equivalent leakage area: 0.024 m<sup>2</sup> (@ 4 Pa)

Dividing the hourly airflow at 50 Pa by the total surface area for the building of 416 m<sup>2</sup> gives an Air Permeability of 2.8 m<sup>3</sup>/hour/m<sup>2</sup> @ 50 Pa, a significant improvement on the previous test and comfortably within the agreed target of 3.0 m<sup>3</sup>/hour/m<sup>2</sup> @ 50 Pa.

Following this test, the cooker hood extract was temporarily sealed with polythene and tape, as shown opposite, and a further single-point test was then carried out.



A full printout from the Energy 2001 software used for the test is again provided in Appendix One.

**5.2.2 Second Single-point Test, 30<sup>th</sup> June, with cooker hood sealed**

The measurements and results of the second single-point test on the 30<sup>th</sup> June are as follows:

Reading No.	Imposed Pressure Differential (Pa) (Corrected)	Airflow Through Fans (m <sup>3</sup> /hr)
1	- 52.5	1,154

The leakage characteristics derived from this pair of readings are detailed below:

Airflow @ 50 Pa: 1,118 m<sup>3</sup>/ hour  
 Equivalent leakage area: 0.023 m<sup>2</sup> (@ 4 Pa)

Dividing the hourly airflow at 50 Pa by the total surface area for the building of 416 m<sup>2</sup> gives a slightly improved Air Permeability of 2.7 m<sup>3</sup>/hour/m<sup>2</sup> @ 50 Pa, also comfortably within the agreed target of 3.0 m<sup>3</sup>/hour/m<sup>2</sup> @ 50 Pa. The difference between the two tests provides a useful indicator of the likely difference to be expected when a cooker hood extract of this type is left unsealed. Two incomplete extract fans were then sealed to simulate the conventional configuration of a new house for an acceptance air leakage test.

**5.2.3 Third Single-point Test, 30<sup>th</sup> June, with two extract vents sealed**

The measurements and results of the third single-point test on the 30<sup>th</sup> June are as follows:



Reading No.	Imposed Pressure Differential (Pa) (Corrected)	Airflow Through Fans (m <sup>3</sup> /hr)
1	- 57.5	1,127

The leakage characteristics derived from this pair of readings are detailed below:

Airflow @ 50 Pa: 1,029 m<sup>3</sup>/ hour  
 Equivalent leakage area: 0.022 m<sup>2</sup> (@ 4 Pa)

Dividing the hourly airflow at 50 Pa by the total surface area for the building of 416 m<sup>2</sup> gives a further slight improvement, now achieving an Air Permeability of 2.5 m<sup>3</sup>/hour/m<sup>2</sup> @ 50 Pa, substantially below the agreed target of 3.0 m<sup>3</sup>/hour/m<sup>2</sup> @ 50 Pa.

The difference between the two tests provides a useful indicator of the likely difference to be expected when two 4" diameter extract ducts (without fans fitted) are left unsealed, as illustrated to the right:



Since the house was now in the correct configuration for a full acceptance test, a full multi-point test was then carried out.

### 5.3 Full Multi-point Acceptance Test, 30<sup>th</sup> June

The measurements and results of the full multi-point depressurization test are as follows:

Reading No.	Imposed Pressure Differential (Pa) (Corrected)	Airflow Through Fan (m <sup>3</sup> / hour) (Corrected)	Percentage Error from Curve Fit
1	- 60.5	1,191	+ 1.9
2	- 59	1,140	- 0.6
3	- 57.5	1,124	- 0.2
4	- 53.5	1,069	- 0.1
5	- 50.5	1,017	- 0.9
6	- 44.5	926	- 1.3
7	- 36	803	- 0.4
8	- 33	746	- 1.4
9	- 27	662	+ 0.8
10	- 24.5	623	+ 1.7
11	- 21.5	561	+ 0.7

The final leakage characteristics for the full multi-point acceptance test derived from this set of readings are detailed below:

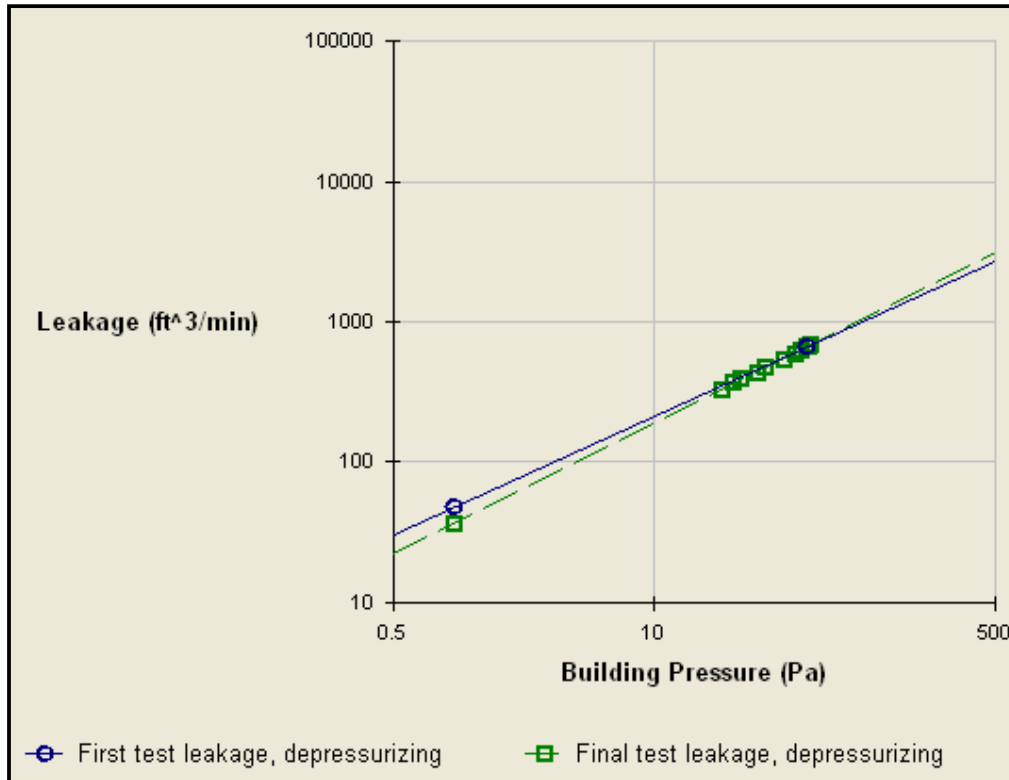
Airflow @ 50 Pa: 1,018 m<sup>3</sup>/ hour



Equivalent leakage area: 0.018 m<sup>2</sup> (@ 10 Pa)

Dividing the hourly airflow at 50 Pa by the total surface area for the building of 416 m<sup>2</sup> gives a final Air Permeability of 2.45 m<sup>3</sup>/hour/m<sup>2</sup> @ 50 Pa, substantially within the agreed specification for the completed building. The correlation factor was 99.9 and the standard error was 1.88%.

These measurements are displayed on a log-log graph of airflow against pressure differential below. The log-log least-squares curve fit gives a slope, or “n-value” of 0.71 and a “leakage rate” intercept of 62.2 m<sup>3</sup>/ hour/ Pa<sup>n</sup>.



Full printouts from the Energy 2001 software used for the testing are provided in Appendix One.

**5.4 Further Investigative Single-point Acceptance Testing, 30<sup>th</sup> June**

**5.4.1 Fourth single-point Test, 30<sup>th</sup> June, after opening 11 trickle vents**

The measurements and results of the fourth single-point test are as follows:

Reading No.	Imposed Pressure Differential (Pa) (Corrected)	Airflow Through Fans (m <sup>3</sup> /hr)
1	- 51.0	1,317

The leakage characteristics derived from this pair of readings are detailed below:

Airflow @ 50 Pa: 1,300 m<sup>3</sup>/ hour  
 Equivalent leakage area: 0.027 m<sup>2</sup> (@ 4 Pa)



Dividing the hourly airflow at 50 Pa by the total surface area for the building of 416 m<sup>2</sup> gives an Air Permeability of 3.1 m<sup>3</sup>/hour/m<sup>2</sup> @ 50 Pa, indicating the relatively small ventilation provided by 11 trickle vents. By subtraction, this corresponds to an effective open area of just 13 cm<sup>2</sup> per trickle vent, less than half the apparent size of the open vent.

At the Berins Hill House, and in fact generally throughout most new housing, this is because trickle vents leak substantially even when closed, commonly by as much as half the fully open ventilation rate. The picture shows one of the trickle vents at the Berins Hill House, where leakage was found (a) between the backplate and the wooden window frame and (b) around the opening section even when it was pushed hard back against the backplate.



A further single-point test was then carried out after an overlooked additional leakage site, the 3” diameter inlet hole where a room-sealed gas fire is to be fitted, was temporarily sealed.

**5.4.2 Fifth single-point Test, 30<sup>th</sup> June, after sealing additional hole**

The measurements and results of the fifth single-point test are as follows:

Reading No.	Imposed Pressure Differential (Pa) (Corrected)	Airflow Through Fans (m <sup>3</sup> /hr)
1	- 52.0	1,307

The leakage characteristics derived from this pair of readings are detailed below:

Airflow @ 50 Pa: 1,274 m<sup>3</sup>/ hour  
 Equivalent leakage area: 0.027 m<sup>2</sup> (@ 4 Pa)

Dividing the hourly airflow at 50 Pa by the total surface area for the building of 416 m<sup>2</sup> still gives an Air Permeability of 3.1 m<sup>3</sup>/hour/m<sup>2</sup> @ 50 Pa, indicating the small size and essentially negligible impact of the hole involved. Eight slot vents across the tops of the Velux rooflights were then opening before a final test was carried out.

**5.4.3 Final single-point Test, 30<sup>th</sup> June, after opening 8 Velux vents**

The measurements and results of the seventh and final single-point test are detailed overleaf.

Reading No.	Imposed Pressure Differential (Pa) (Corrected)	Airflow Through Fans (m <sup>3</sup> /hr)
1	- 44.5	1,687

The leakage characteristics derived from this pair of readings are detailed below:



Airflow @ 50 Pa:	1,820 m <sup>3</sup> /hour
Equivalent leakage area:	0.038 m <sup>2</sup> (@ 4 Pa)

Dividing the hourly airflow at 50 Pa by the total surface area for the building of 416 m<sup>2</sup> still gives an Air Permeability of 4.4 m<sup>3</sup>/hour/m<sup>2</sup> @ 50 Pa, substantially above the agreed Air Permeability target of 3.0 m<sup>3</sup>/hour/m<sup>2</sup> @ 50 Pa.

By subtraction, this corresponds to an effective open area of some 34 cm<sup>2</sup> per slot vent across the top of the Velux windows, indicating that these are substantially more effective than the trickle vents provided. Because the Velux ventilators are situated at high level, they would normally be allowing air to vent from the dwelling as it rises due to stack effect.



## 6.0 Comments & Recommendations

### 6.1 Air Permeability

The agreed target air leakage for the completed building was an Air Permeability not exceeding 3.0 cubic metres of airflow per hour per square metre of total surface area, at an imposed pressure difference of 50 Pascals ( $AP \leq 5.0 \text{ m}^3/\text{hr}/\text{m}^2 @ 50 \text{ Pa}$ ). This is considerably more onerous than the Building Regulations (England & Wales) (Part L1, 2000) specification for new domestic buildings of a maximum Air Permeability of 10 cubic metres of airflow per hour per square metre of total surface area, at an imposed pressure difference of 50 Pascals ( $AP \leq 10 \text{ m}^3/\text{hr}/\text{m}^2 @ 50 \text{ Pa}$ ).

With a final Air Permeability value in the full multi-point acceptance test of 2.45, the Berins Hill House clearly met this standard by a substantial margin. Hence an Air Leakage Certificate has been issued for this building, a copy of which is provided in Appendix One.

### 6.2 Effect of Temporary Sealing

The table below details and discusses the changes in the Air Permeability and the effective leakage area between the eight different tests carried out:

Comparison Details	Change in Air Permeability ( $\text{m}^3/\text{hour}/\text{m}^2 @ 50 \text{ Pa}$ )	Change in Equivalent Leakage Area ( $\text{m}^2 \text{ at } 50 \text{ Pa}$ )	Notes & comments
1) Test 5, final acceptance and Test 1, preliminary.	- 0.94	- 0.0196	Improvement from completion of building & remedial sealing to edge leaks of tanking.
2) Test 3, after sealing cooker hood and Test 2.	- 0.10	- 0.0021	Quantifies leakage through cooker hood.
3) Test 4, after sealing two extracts and Test 3.	- 0.22	- 0.0045	Quantifies leakage through two 100mm diameter extract ducts.
4) Test 7, after sealing open inlet, and Test 6.	- 0.06	- 0.0013	Quantified effective leakage through 80mm diameter hole – cross-sectional area of approx. $0.005 \text{ m}^2$ , hence 26% open.
5) Test 5 and Test 4, difference between multi-point and single-point test.	- 0.002	- 0.0005	Very little difference.
6) Test 6 and Test 5, effect of unsealing 11 trickle vents.	+ 0.67	+ 0.0141	Approx. $0.0013 \text{ m}^2$ effective area per trickle vent.
7) Test 8 and Test 7, effect of unsealing 8 vents at the heads of Velux windows.	+ 1.32	+ 0.0273	Approx. $0.0034 \text{ m}^2$ effective area per vent across Velux windows.



### **6.3 Test Conditions**

No existing pressure differential was measured during the testing, either wind-induced or due to stack effect (rising warm air) in the building. The barometric pressure was normal, at approximately 101,500 Pa, whilst windspeeds were light – less than 1.0 m/s on average.

A Retrotec K4A single-fan blower-door system was mounted in the main entrance doorway for the 8<sup>th</sup> March test and in the side entrance doorway for the 30<sup>th</sup> June test, in both cases on the upper floor. Pressure measuring devices were located inside the building, and an external pressure tap was extended to directly monitor the pressure difference across the building envelope.

### **6.4 Leakage Sites**

Numerous leakage sites were identified during the initial preliminary testing in March, and are discussed further in the following section of this report. Whilst the overall level of leakage was satisfactory, there were some localized problem areas, particularly on the lower floor, which were successfully addressed prior to the repeat testing in June.

### **6.5 Repeat Air Leakage Testing**

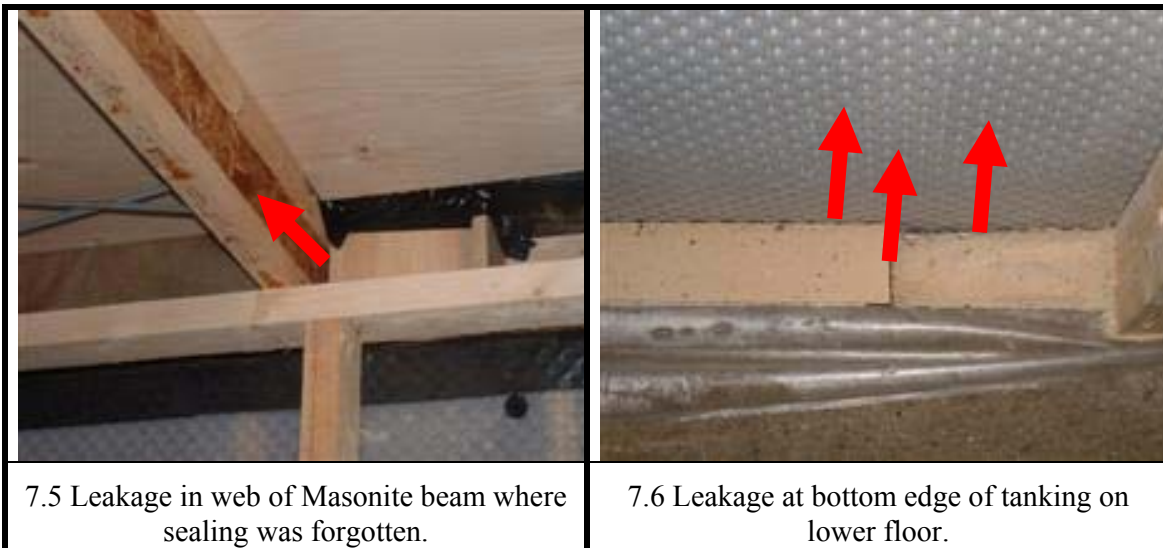
We do not consider it necessary to carry out any repeat air leakage testing upon the house at Berins Hill.



## 7.0 Leakage Inspection

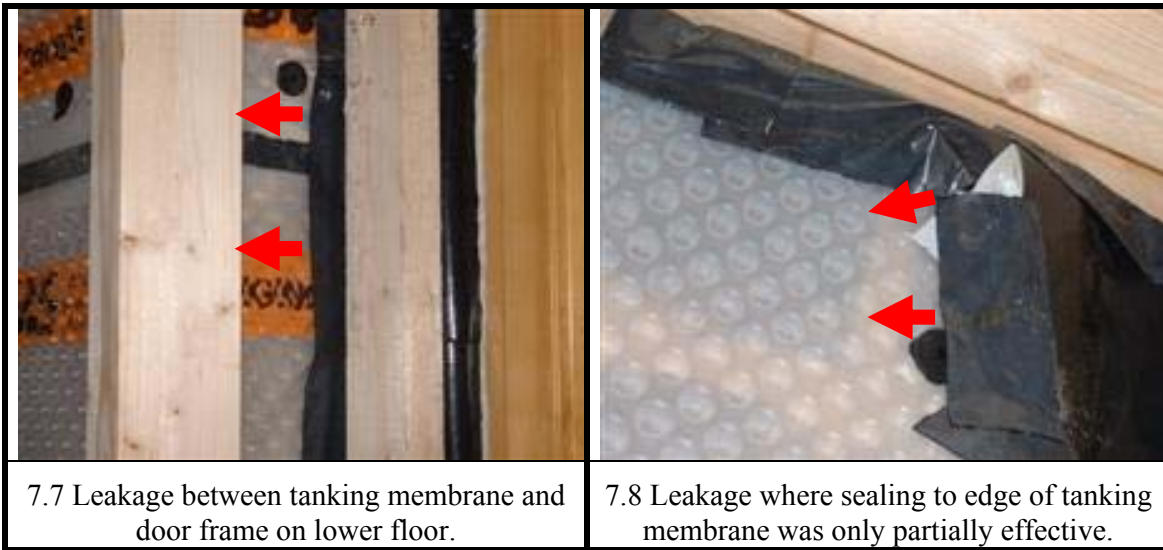
A detailed inspection for leakage sites was undertaken during the initial preliminary testing on the 8<sup>th</sup> of March. The following comments (with supporting photos), relate to the details identified during the inspection as being pertinent to the air barrier. They are given as representative of the overall relevant details within the building and are presented in no particular order of importance. The leakage around joists and Masonite beams (7.4 & 7.5) was readily addressed by further taping to the edges of the membrane. More difficult was the leakage at the edges of the tanking membrane, with the rigid corrugations and the nature of the membrane making it difficult to achieve an effective seal (7.6, 7.7 & 7.8). On future projects we would recommend the use of a non-corrugated tanking membrane at the edges of sections which form part of the external air barrier and therefore need to be effectively sealed to other elements of the building. It was also noted that there was a substantial amount of leakage around the trickle vents, even when closed (7.3).

A photograph showing a doorway with a yellow frame set into a grey brick wall. Two red arrows point to the gap between the bottom of the door frame and the ground.	A close-up photograph of a timber window frame. Two red arrows point to the joints between different sections of the frame.
<p>7.1 Leakage beneath incomplete doorway.</p>	<p>7.2 Leakage at joints between timber window sections and frames.</p>
A photograph of a window with a yellow frame. Two red arrows point to the area around the closed trickle vents.	A photograph showing a wooden joist projecting from a wall. A red arrow points to the gap between the joist and the wall where a membrane is not properly sealed.
<p>7.3 Leakage around trickle vents even when closed.</p>	<p>7.4 Leakage where membrane not sealed to projecting joists.</p>



7.5 Leakage in web of Masonite beam where sealing was forgotten.

7.6 Leakage at bottom edge of tanking on lower floor.



7.7 Leakage between tanking membrane and door frame on lower floor.

7.8 Leakage where sealing to edge of tanking membrane was only partially effective.



## **Appendix One**

### **Air Leakage Certificate**



=====

# Air Leakage Test Certificate

=====

This is to confirm that the:

## New detached house at Berins Hill, Ipsden, near Oxford

Achieved a satisfactory Air Permeability, when tested to the CIBSE TM23 standard,  
of:

**2.45 m<sup>3</sup>/hr/m<sup>2</sup> @ 50 Pa**

Date of Acceptance Test:	30 <sup>th</sup> June 2005
Test Engineer:	Paul Jennings, Stroma Technology
Volume:	313 m <sup>3</sup>
Total Surface Area:	416 m <sup>2</sup>
Existing Pressure Differential:	0.0 Pa
Airflow at 50 Pa:	1,018 m <sup>3</sup> /hour
Equivalent Leakage Area:	0.018 m <sup>2</sup> (@ 4 Pa pressure differential)

Signed: Paul Jennings Paul Jennings, Test Engineer 30<sup>th</sup> June 2005 Date

Note: On the date of the Air Leakage Test, the building under test satisfied the agreed target, by achieving an Air Permeability that does not exceed 3.0 cubic metres per hour per square metre of surface area @ 50 Pa imposed pressure differential ( AP ≤ 3.0 m<sup>3</sup>/hr/m<sup>2</sup> @ 50 Pa). Testing was carried out in conformance with the CIBSE TM23 standard. However it must be noted that subsequent modifications and changes to the building, including drying and shrinkage, movement, future modifications, ongoing wear and tear and inadequate maintenance, will give rise to additional leakage and a reduced level of airtightness. Contact Stroma for further guidance.

## Stroma Technology Limited

Ref: PJJ/ 02-05-1552 T2



## **Appendix Two**

### **Software Printouts**

# Air Leakage Report

Energy 2001 airtightness test program version 1.0(build 1.0.7)

Complies with UK standard TM23: 2000

By Retrotec, Inc, 2200 Queen Street, Bellingham, WA USA 98226 360-738-9835 www.retrotec.com

Software Licensed to: **Retrotec (Europe) Limited**

Building address **Berins Hill, Oxford, UK**  
 Name, Phone **Gavin Cook, 07985 117342**

Test number **1**

Calibration Certificate # **870** Certificate created **2004/05/05**

Test date/time	<b>2005/03/08 11:20</b>	Building Volume	<b>313.0 m<sup>3</sup></b>
Standard used	<b>TM23: 2000</b>	Exposed envelope area	<b>416.0 m<sup>2</sup></b>
Tester	<b>Paul Jennings</b>	Envelope area	<b>416.0 m<sup>2</sup></b>
Certified to Level:	<b>3 - Multiple blower tests</b>	Fireplace	<b>No fireplace</b>
Signature	.....	External doors & windows	<b>Closed</b>
Barometric pressure	<b>101,500.0 Pa.</b>	Exhaust Fans	<b>No exuast fans</b>
Windspeed Average	<b>1.0 m/sec</b>	Window air-conditioners	<b>No window A/C</b>
Combustion appliances	<b>Off</b>		
Internal doors & hatches	<b>Open</b>		
Ventilation openings	<b>none</b>		
Dryer	<b>None</b>		

RESULT	UNITS	First Test, Depressurize
Flow @ 50 Pa	m <sup>3</sup> /hr	<b>1,409.57</b>
Airchanges, ACH @ 50 Pa	m <sup>3</sup> /hr/m <sup>3</sup>	<b>4.50</b>
Air Leakage Index @ 50 Pa	m <sup>3</sup> /hr/m <sup>2</sup>	<b>3.39</b>
Permeability @ 50 Pa	m <sup>3</sup> /hr/m <sup>2</sup>	<b>3.39</b>
Effective Leakage Area @ 4 Pa, EflA	m <sup>2</sup>	<b>0.0295</b>
Equivalent Leakage Area @ 50 Pa	m <sup>2</sup>	<b>0.0705</b>

Notes **Initial single-point preliminary test.**

Witnesses

# DOOR FAN TEST -- First Test Leakage Data

Energy 2001 airtightness test program version 1.0(build 1.0.7)

Complies with UK standard TM23: 2000

By Retrotec, Inc, 2200 Queen Street, Bellingham, WA USA 98226 360-738-9835 www.retrotec.com

Software Licensed to: **Retrotec (Europe) Limited**

Building address **Berins Hill, Oxford, UK**  
 Name, Phone **Gavin Cook, 07985 117342**

Test number **1**

Calibration Certificate # **870** Certificate created **2004/05/05**

## First test of building leakage

Operator In the room Smoke moves out of the room Temperature during test (F)  
 Static pressure 2 Pa 61 inside 57 outside

### Depressurization

Take 10 readings at 60, 55, 50, 45, 40, 35, 30, 25, 20 & 15.

Blower range	Building pressure	-52
	Auto corrected BP	-52.6
Ring C8	Flow pressure	112
	Auto corrected FP	114.2
	Corrected flow (m <sup>3</sup> /hr)	-1,446

### Depressurization

Q m <sup>3</sup> /hr	@ pa	EfLA m <sup>2</sup>	Slope, n	Intercept, C m <sup>3</sup> /hr/Pa <sup>n</sup>	Correlation %	Standard Error, %	EqLA @ 50Pa m <sup>2</sup>
<b>1,409.57</b>	<b>50</b>	<b>0.0295</b>	<b>0.65</b>	<b>110.855</b>	<b>NA</b>	<b>NA</b>	<b>0.0705</b>

Technician: **Paul Jennings** Certified to Level: **3 - Multiple blower tests**  
 Yes Level 1 – Understanding the technicalities of airtightness in buildings  
 Yes Level 2 – Single blower door-fan testing of buildings  
 Yes Level 3 – Multiple blower door-fan testing of buildings

# DOOR FAN TEST -- Graph

Energy 2001 airtightness test program version 1.0(build 1.0.7)

Complies with UK standard TM23: 2000

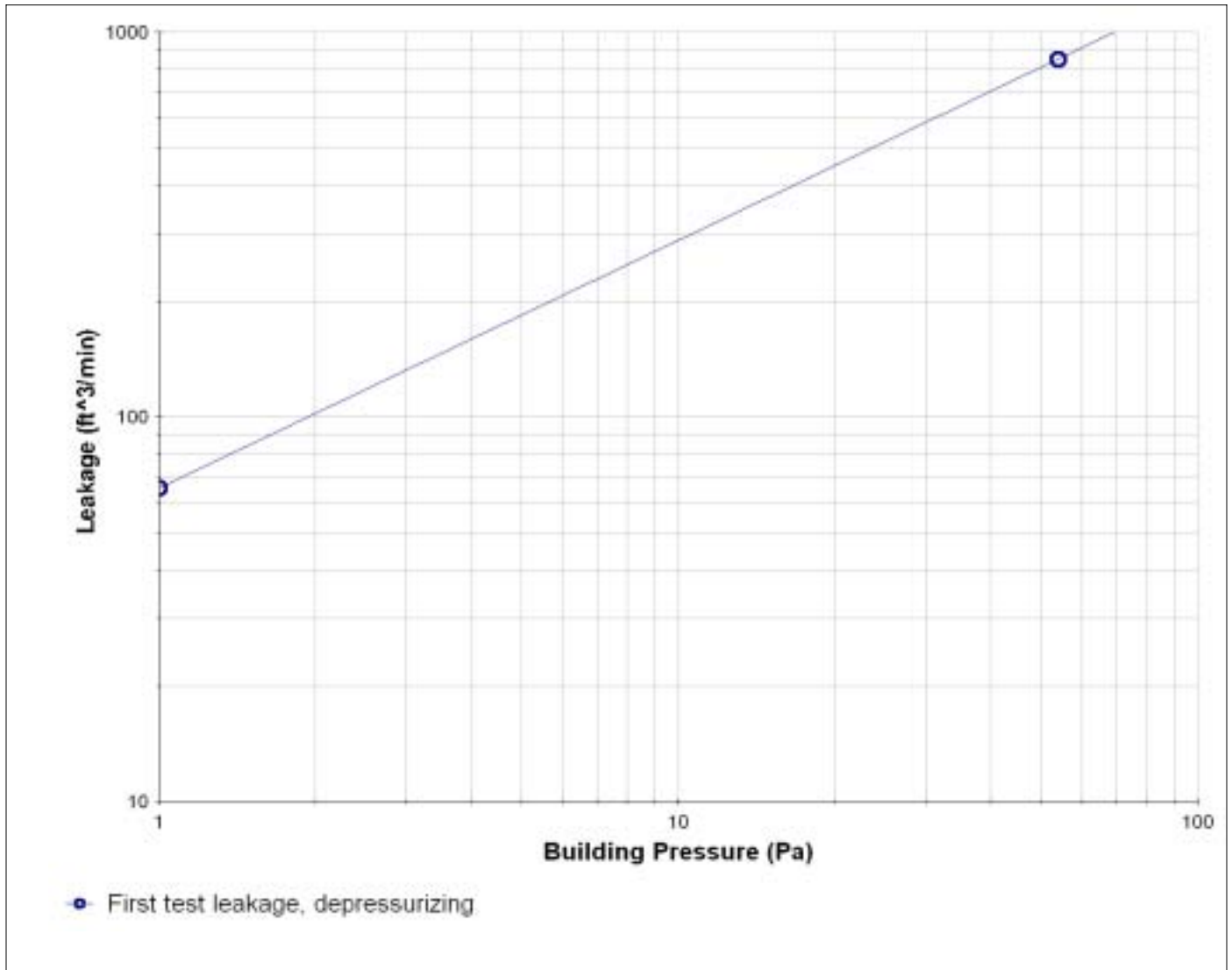
By Retrotec, Inc, 2200 Queen Street, Bellingham, WA USA 98226 360-738-9835 www.retrotec.com

Software Licensed to: ***Retrotec (Europe) Limited***

Building address ***Berins Hill, Oxford, UK***  
Name, Phone ***Gavin Cook, 07985 117342***

Test number **1**

Calibration Certificate # **870** Certificate created **2004/05/05**



# Air Leakage Report

Energy 2001 airtightness test program version 1.0(build 1.0.7)

Complies with UK standard TM23: 2000

By Retrotec, Inc, 2200 Queen Street, Bellingham, WA USA 98226 360-738-9835 www.retrotec.com

Software Licensed to: **Retrotec (Europe) Limited**

Building address **Berins Hill, Oxford, UK**  
 Name, Phone **Gavin Cook, 07985 117342**

Test number **2**

Calibration Certificate # **870** Certificate created **2004/05/05**

Test date/time	<b>2005/06/30 13:54</b>	Building Volume	<b>313.0 m<sup>3</sup></b>
Standard used	<b>TM23: 2000</b>	Exposed envelope area	<b>416.0 m<sup>2</sup></b>
Tester	<b>Paul Jennings</b>	Envelope area	<b>416.0 m<sup>2</sup></b>
Certified to Level:	<b>3 - Multiple blower tests</b>	Fireplace	<b>No fireplace</b>
Signature	.....	External doors & windows	<b>Closed</b>
Barometric pressure	<b>101,500.0 Pa.</b>	Exhaust Fans	<b>Off</b>
Windspeed Average	<b>1.0 m/sec</b>	Window air-conditioners	<b>No window A/C</b>
Combustion appliances	<b>Off</b>		
Internal doors & hatches	<b>Open</b>		
Ventilation openings	<b>Closed</b>		
Dryer	<b>None</b>		

RESULT	UNITS	First Test, Depressurize	Final Test, Depressurize
Flow @ 50 Pa	m <sup>3</sup> /hr	<b>1,160.31</b>	<b>1,118.21</b>
Airchanges, ACH @ 50 Pa	m <sup>3</sup> /hr/m <sup>3</sup>	<b>3.71</b>	<b>3.57</b>
Air Leakage Index @ 50 Pa	m <sup>3</sup> /hr/m <sup>2</sup>	<b>2.79</b>	<b>2.69</b>
Permeability @ 50 Pa	m <sup>3</sup> /hr/m <sup>2</sup>	<b>2.79</b>	<b>2.69</b>
Effective Leakage Area @ 4 Pa, EflA	m <sup>2</sup>	<b>0.0243</b>	<b>0.0234</b>
Equivalent Leakage Area @ 50 Pa	m <sup>2</sup>	<b>0.0580</b>	<b>0.0559</b>

Notes **Initial single-point test after sealing waste; second single-point test after sealing cooker hood.**

Witnesses

# DOOR FAN TEST -- First Test Leakage Data

Energy 2001 airtightness test program version 1.0(build 1.0.7)

Complies with UK standard TM23: 2000

By Retrotec, Inc, 2200 Queen Street, Bellingham, WA USA 98226 360-738-9835 www.retrotec.com

Software Licensed to: **Retrotec (Europe) Limited**

Building address **Berins Hill, Oxford, UK**  
 Name, Phone **Gavin Cook, 07985 117342**

Test number **2**

Calibration Certificate # **870** Certificate created **2004/05/05**

## First test of building leakage

Operator In the room Smoke doesn't move Temperature during test (F)  
 Static pressure 0 Pa 72 inside 68 outside

### Depressurization

Take 10 readings at 60, 55, 50, 45, 40, 35, 30, 25, 20 & 15.

Blower range	Building pressure	-50.5
	Auto corrected BP	-51.1
Ring C4	Flow pressure	243
	Auto corrected FP	245
	Corrected flow (m <sup>3</sup> /hr)	-1,168

### Depressurization

Q m <sup>3</sup> /hr	@ pa	EfLA m <sup>2</sup>	Slope, n	Intercept, C m <sup>3</sup> /hr/Pa <sup>n</sup>	Correlation %	Standard Error, %	EqLA @ 50Pa m <sup>2</sup>
<b>1,160.31</b>	<b>50</b>	<b>0.0243</b>	<b>0.65</b>	<b>91.252</b>	<b>NA</b>	<b>NA</b>	<b>0.0580</b>

Technician: **Paul Jennings** Certified to Level: **3 - Multiple blower tests**  
 Yes Level 1 – Understanding the technicalities of airtightness in buildings  
 Yes Level 2 – Single blower door-fan testing of buildings  
 Yes Level 3 – Multiple blower door-fan testing of buildings

# DOOR FAN TEST -- Final Test Leakage Data

Energy 2001 airtightness test program version 1.0(build 1.0.7)

Complies with UK standard TM23: 2000

By Retrotec, Inc, 2200 Queen Street, Bellingham, WA USA 98226 360-738-9835 www.retrotec.com

Software Licensed to: **Retrotec (Europe) Limited**

Building address **Berins Hill, Oxford, UK**  
 Name, Phone **Gavin Cook, 07985 117342**

Test number **2**

Calibration Certificate # **870** Certificate created **2004/05/05**

## Final test of building leakage

Operator In the room Smoke doesn't move Temperature during test (F)  
 Static pressure 0 Pa 72 inside 68 outside

### Depressurization

Take 10 readings at 60, 55, 50, 45, 40, 35, 30, 25, 20 & 15.

Blower range	Building pressure	-52.5
	Auto corrected BP	-53.1
Ring C4	Flow pressure	238
	Auto corrected FP	240
	Corrected flow (m <sup>3</sup> /hr)	-1,154

### Depressurization

Q m <sup>3</sup> /hr	@ pa	EfLA m <sup>2</sup>	Slope, n	Intercept, C m <sup>3</sup> /hr/Pa <sup>n</sup>	Correlation %	Standard Error, %	EqLA @ 50Pa m <sup>2</sup>
<b>1,118.21</b>	<b>50</b>	<b>0.0234</b>	<b>0.65</b>	<b>87.941</b>	<b>NA</b>	<b>NA</b>	<b>0.0559</b>

Technician: **Paul Jennings** Certified to Level: **3 - Multiple blower tests**  
 Yes Level 1 – Understanding the technicalities of airtightness in buildings  
 Yes Level 2 – Single blower door-fan testing of buildings  
 Yes Level 3 – Multiple blower door-fan testing of buildings

# DOOR FAN TEST -- Graph

Energy 2001 airtightness test program version 1.0(build 1.0.7)

Complies with UK standard TM23: 2000

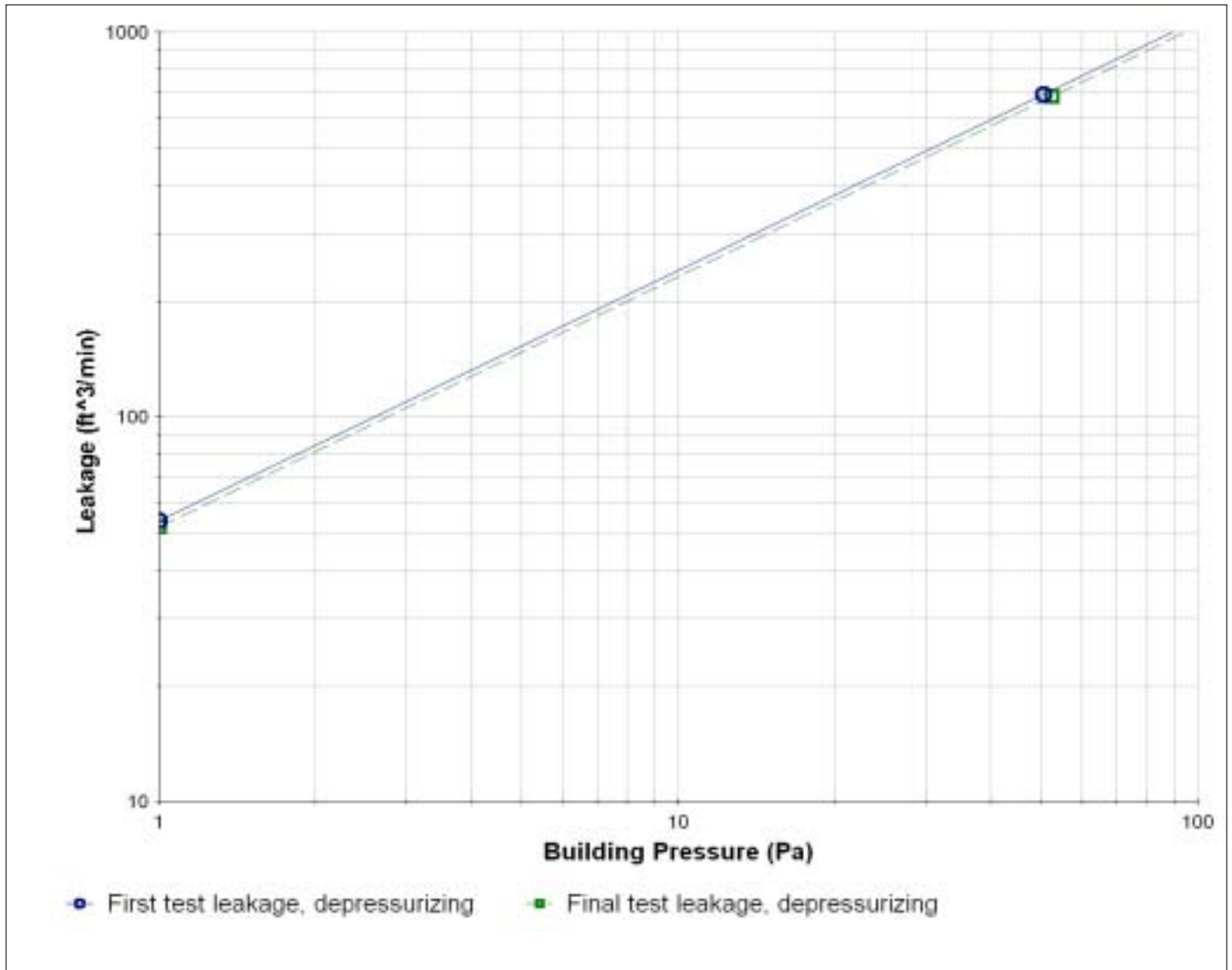
By Retrotec, Inc, 2200 Queen Street, Bellingham, WA USA 98226 360-738-9835 www.retrotec.com

Software Licensed to: **Retrotec (Europe) Limited**

Building address **Berins Hill, Oxford, UK**  
Name, Phone **Gavin Cook, 07985 117342**

Test number **2**

Calibration Certificate # **870** Certificate created **2004/05/05**



# Air Leakage Report

Energy 2001 airtightness test program version 1.0(build 1.0.7)

Complies with UK standard TM23: 2000

By Retrotec, Inc, 2200 Queen Street, Bellingham, WA USA 98226 360-738-9835 www.retrotec.com

Software Licensed to: **Retrotec (Europe) Limited**

Building address **Berins Hill, Oxford, UK**  
 Name, Phone **Gavin Cook, 07985 117342**

Test number **2**

Calibration Certificate # **870** Certificate created **2004/05/05**

Test date/time	<b>2005/06/30 14:17</b>	Building Volume	<b>313.0 m<sup>3</sup></b>
Standard used	<b>TM23: 2000</b>	Exposed envelope area	<b>416.0 m<sup>2</sup></b>
Tester	<b>Paul Jennings</b>	Envelope area	<b>416.0 m<sup>2</sup></b>
Certified to Level:	<b>3 - Multiple blower tests</b>	Fireplace	<b>No fireplace</b>
Signature	.....	External doors & windows	<b>Closed</b>
Barometric pressure	<b>101,500.0 Pa.</b>	Exhaust Fans	<b>Sealed</b>
Windspeed Average	<b>1.0 m/sec</b>	Window air-conditioners	<b>No window A/C</b>
Combustion appliances	<b>Off</b>		
Internal doors & hatches	<b>Open</b>		
Ventilation openings	<b>Closed</b>		
Dryer	<b>None</b>		

RESULT	UNITS	First Test, Depressurize	Final Test, Depressurize
Flow @ 50 Pa	m <sup>3</sup> /hr	<b>1,028.79</b>	<b>1,016.08</b>
Airchanges, ACH @ 50 Pa	m <sup>3</sup> /hr/m <sup>3</sup>	<b>3.29</b>	<b>3.25</b>
Air Leakage Index @ 50 Pa	m <sup>3</sup> /hr/m <sup>2</sup>	<b>2.47</b>	<b>2.44</b>
Permeability @ 50 Pa	m <sup>3</sup> /hr/m <sup>2</sup>	<b>2.47</b>	<b>2.44</b>
Effective Leakage Area @ 4 Pa, EflA	m <sup>2</sup>	<b>0.0215</b>	<b>0.0179</b>
Equivalent Leakage Area @ 50 Pa	m <sup>2</sup>	<b>0.0514</b>	<b>0.0508</b>

Notes **Initial single-point test after sealing 2 extracts; second full multi-point acceptance test.**

Witnesses

# DOOR FAN TEST -- First Test Leakage Data

Energy 2001 airtightness test program version 1.0(build 1.0.7)

Complies with UK standard TM23: 2000

By Retrotec, Inc, 2200 Queen Street, Bellingham, WA USA 98226 360-738-9835 www.retrotec.com

Software Licensed to: **Retrotec (Europe) Limited**

Building address **Berins Hill, Oxford, UK**  
 Name, Phone **Gavin Cook, 07985 117342**

Test number **2**

Calibration Certificate # **870** Certificate created **2004/05/05**

## First test of building leakage

Operator In the room Smoke doesn't move Temperature during test (F)  
 Static pressure 0 Pa 72 inside 68 outside

### Depressurization

Take 10 readings at 60, 55, 50, 45, 40, 35, 30, 25, 20 & 15.

Blower range	Building pressure	-57.5
	Auto corrected BP	-58.1
Ring C4	Flow pressure	228
	Auto corrected FP	230
	Corrected flow (m <sup>3</sup> /hr)	-1,127

### Depressurization

Q m <sup>3</sup> /hr	@ pa	EfLA m <sup>2</sup>	Slope, n	Intercept, C m <sup>3</sup> /hr/Pa <sup>n</sup>	Correlation %	Standard Error, %	EqLA @ 50Pa m <sup>2</sup>
<b>1,028.79</b>	<b>50</b>	<b>0.0215</b>	<b>0.65</b>	<b>80.909</b>	<b>NA</b>	<b>NA</b>	<b>0.0514</b>

Technician: **Paul Jennings** Certified to Level: **3 - Multiple blower tests**  
 Yes Level 1 – Understanding the technicalities of airtightness in buildings  
 Yes Level 2 – Single blower door-fan testing of buildings  
 Yes Level 3 – Multiple blower door-fan testing of buildings

# DOOR FAN TEST -- Final Test Leakage Data

Energy 2001 airtightness test program version 1.0(build 1.0.7)

Complies with UK standard TM23: 2000

By Retrotec, Inc, 2200 Queen Street, Bellingham, WA USA 98226 360-738-9835 www.retrotec.com

Software Licensed to: **Retrotec (Europe) Limited**

Building address **Berins Hill, Oxford, UK**  
 Name, Phone **Gavin Cook, 07985 117342**

Test number **2**

Calibration Certificate # **870** Certificate created **2004/05/05**

## Final test of building leakage

Operator In the room Smoke doesn't move Temperature during test (F)  
 Static pressure 0 Pa 72 inside 68 outside

### Depressurization

Take 10 readings at 60, 55, 50, 45, 40, 35, 30, 25, 20 & 15.

Blower range	Building pressure	-60.5	-59	-57.5	-53.5	-50.5	-44.5	-42	-36	-33	-27	-24.5	-21.5
	Auto corrected BP	-61.1	-59.6	-58.1	-54.1	-51.1	-45.1	-42.5	-36.5	-33.5	-27.5	-25	-22.1
Ring C4	Flow pressure	252	233	227	207	189	158	138	120	105	84	75	62
	Auto corrected FP	254	235	229	209	191	160.4	140.8	122.6	106.8	84.7	75.3	61.6
	Corrected flow (m <sup>3</sup> /hr)	-1,191	-1,140	-1,124	-1,069	-1,017	-926	-863	-803	-746	-662	-623	-561
	Error %	2.1	-0.4	0.0	0.2	-0.6	-0.9	-3.8	0.0	-1.0	1.3	2.2	1.3

### Depressurization

Q m <sup>3</sup> /hr	@ pa	EfLA m <sup>2</sup>	Slope, n	Intercept, C m <sup>3</sup> /hr/Pa <sup>n</sup>	Correlation %	Standard Error, %	EqLA @ 50Pa m <sup>2</sup>
<b>1,016.08</b>	<b>50</b>	<b>0.0179</b>	<b>0.72</b>	<b>61.192</b>	<b>99.7</b>	<b>2.53</b>	<b>0.0508</b>

Technician: **Paul Jennings** Certified to Level: **3 - Multiple blower tests**  
 Yes Level 1 – Understanding the technicalities of airtightness in buildings  
 Yes Level 2 – Single blower door-fan testing of buildings  
 Yes Level 3 – Multiple blower door-fan testing of buildings

# DOOR FAN TEST -- Graph

Energy 2001 airtightness test program version 1.0(build 1.0.7)

Complies with UK standard TM23: 2000

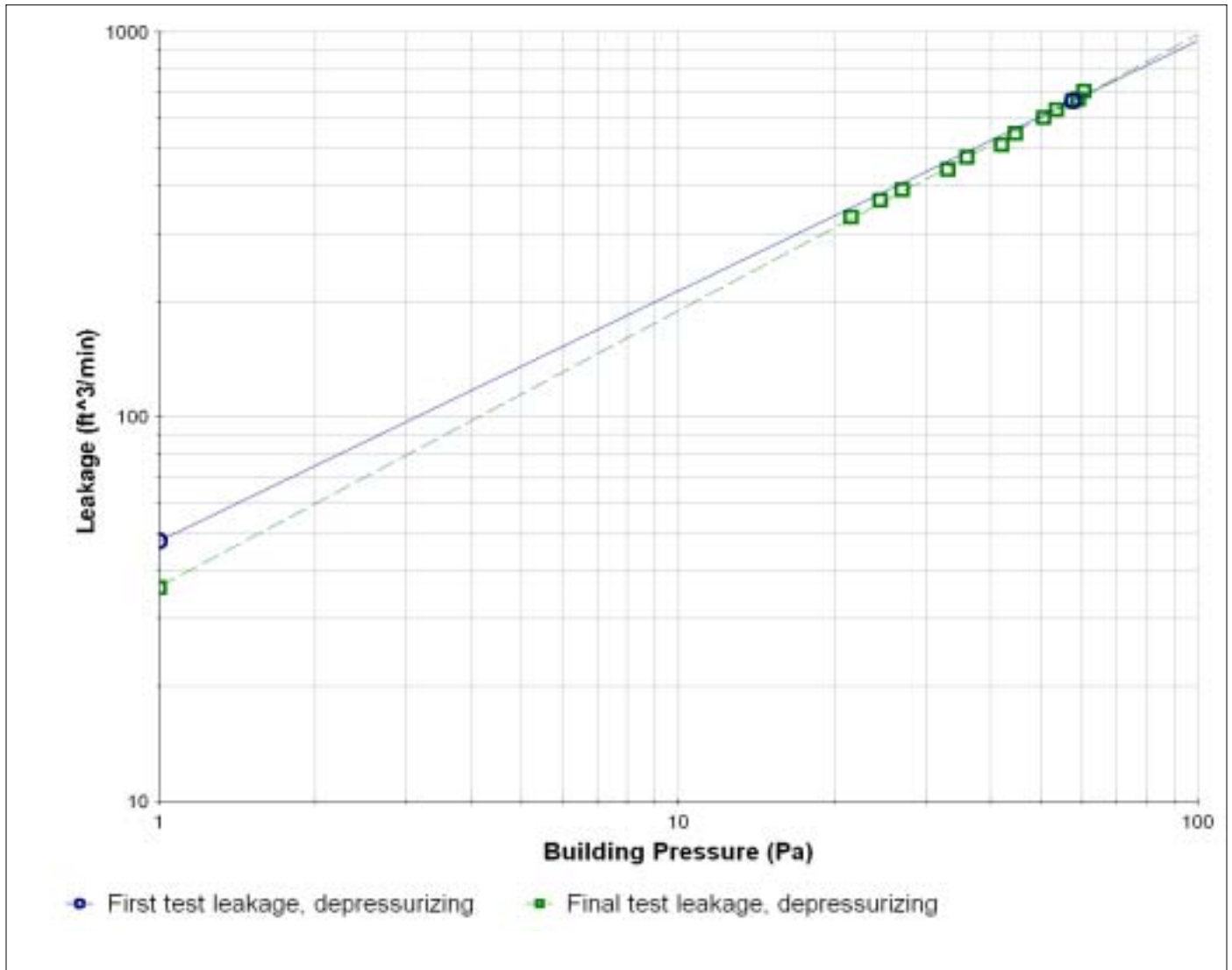
By Retrotec, Inc, 2200 Queen Street, Bellingham, WA USA 98226 360-738-9835 www.retrotec.com

Software Licensed to: **Retrotec (Europe) Limited**

Building address **Berins Hill, Oxford, UK**  
Name, Phone **Gavin Cook, 07985 117342**

Test number **2**

Calibration Certificate # **870** Certificate created **2004/05/05**



# Air Leakage Report

Energy 2001 airtightness test program version 1.0(build 1.0.7)

Complies with UK standard TM23: 2000

By Retrotec, Inc, 2200 Queen Street, Bellingham, WA USA 98226 360-738-9835 www.retrotec.com

Software Licensed to: **Retrotec (Europe) Limited**

Building address **Berins Hill, Oxford, UK**  
 Name, Phone **Gavin Cook, 07985 117342**

Test number **4**

Calibration Certificate # **870** Certificate created **2004/05/05**

Test date/time	<b>2005/07/02 16:24</b>	Building Volume	<b>313.0 m<sup>3</sup></b>
Standard used	<b>TM23: 2000</b>	Exposed envelope area	<b>416.0 m<sup>2</sup></b>
Tester	<b>Paul Jennings</b>	Envelope area	<b>416.0 m<sup>2</sup></b>
Certified to Level:	<b>3 - Multiple blower tests</b>	Fireplace	<b>No fireplace</b>
Signature	.....	External doors & windows	<b>Closed</b>
Barometric pressure	<b>101,500.0 Pa.</b>	Exhaust Fans	<b>Sealed</b>
Windspeed Average	<b>1.0 m/sec</b>	Window air-conditioners	<b>No window A/C</b>
Combustion appliances	<b>Off</b>		
Internal doors & hatches	<b>Open</b>		
Ventilation openings	<b>Open</b>		
Dryer	<b>None</b>		

RESULT	UNITS	First Test, Depressurize	Final Test, Depressurize
Flow @ 50 Pa	m <sup>3</sup> /hr	<b>1,299.98</b>	<b>1,273.87</b>
Airchanges, ACH @ 50 Pa	m <sup>3</sup> /hr/m <sup>3</sup>	<b>4.15</b>	<b>4.07</b>
Air Leakage Index @ 50 Pa	m <sup>3</sup> /hr/m <sup>2</sup>	<b>3.12</b>	<b>3.06</b>
Permeability @ 50 Pa	m <sup>3</sup> /hr/m <sup>2</sup>	<b>3.12</b>	<b>3.06</b>
Effective Leakage Area @ 4 Pa, EflA	m <sup>2</sup>	<b>0.0272</b>	<b>0.0266</b>
Equivalent Leakage Area @ 50 Pa	m <sup>2</sup>	<b>0.0650</b>	<b>0.0637</b>

Notes **Initial test after opening 11 trickle vents, followed by second test after sealing open 3" diameter inlet where gas fire is to be fitted.**

Witnesses

# DOOR FAN TEST -- First Test Leakage Data

Energy 2001 airtightness test program version 1.0(build 1.0.7)

Complies with UK standard TM23: 2000

By Retrotec, Inc, 2200 Queen Street, Bellingham, WA USA 98226 360-738-9835 www.retrotec.com

Software Licensed to: **Retrotec (Europe) Limited**

Building address **Berins Hill, Oxford, UK**  
 Name, Phone **Gavin Cook, 07985 117342**

Test number **4**

Calibration Certificate # **870** Certificate created **2004/05/05**

## First test of building leakage

Operator In the room Smoke doesn't move Temperature during test (F)  
 Static pressure 0 Pa 72 inside 68 outside

### Depressurization

Take 10 readings at 60, 55, 50, 45, 40, 35, 30, 25, 20 & 15.

Blower range	Building pressure	-51
	Auto corrected BP	-51.6
Ring C4	Flow pressure	301
	Auto corrected FP	303
	Corrected flow (m <sup>3</sup> /hr)	-1,317

### Depressurization

Q m <sup>3</sup> /hr	@ pa	EfLA m <sup>2</sup>	Slope, n	Intercept, C m <sup>3</sup> /hr/Pa <sup>n</sup>	Correlation %	Standard Error, %	EqLA @ 50Pa m <sup>2</sup>
<b>1,299.98</b>	<b>50</b>	<b>0.0272</b>	<b>0.65</b>	<b>102.237</b>	<b>NA</b>	<b>NA</b>	<b>0.0650</b>

Technician: **Paul Jennings** Certified to Level: **3 - Multiple blower tests**  
 Yes Level 1 – Understanding the technicalities of airtightness in buildings  
 Yes Level 2 – Single blower door-fan testing of buildings  
 Yes Level 3 – Multiple blower door-fan testing of buildings

# DOOR FAN TEST -- Final Test Leakage Data

Energy 2001 airtightness test program version 1.0(build 1.0.7)

Complies with UK standard TM23: 2000

By Retrotec, Inc, 2200 Queen Street, Bellingham, WA USA 98226 360-738-9835 www.retrotec.com

Software Licensed to: **Retrotec (Europe) Limited**

Building address **Berins Hill, Oxford, UK**  
 Name, Phone **Gavin Cook, 07985 117342**

Test number **4**

Calibration Certificate # **870** Certificate created **2004/05/05**

## Final test of building leakage

Operator In the room Smoke doesn't move Temperature during test (F)  
 Static pressure 0 Pa 72 inside 68 outside

### Depressurization

Take 10 readings at 60, 55, 50, 45, 40, 35, 30, 25, 20 & 15.

Blower range	Building pressure	-52
	Auto corrected BP	-52.6
Ring C4	Flow pressure	297
	Auto corrected FP	299
	Corrected flow (m <sup>3</sup> /hr)	-1,307

### Depressurization

Q m <sup>3</sup> /hr	@ pa	EfLA m <sup>2</sup>	Slope, n	Intercept, C m <sup>3</sup> /hr/Pa <sup>n</sup>	Correlation %	Standard Error, %	EqLA @ 50Pa m <sup>2</sup>
<b>1,273.87</b>	<b>50</b>	<b>0.0266</b>	<b>0.65</b>	<b>100.183</b>	<b>NA</b>	<b>NA</b>	<b>0.0637</b>

Technician: **Paul Jennings** Certified to Level: **3 - Multiple blower tests**  
 Yes Level 1 – Understanding the technicalities of airtightness in buildings  
 Yes Level 2 – Single blower door-fan testing of buildings  
 Yes Level 3 – Multiple blower door-fan testing of buildings

# DOOR FAN TEST -- Graph

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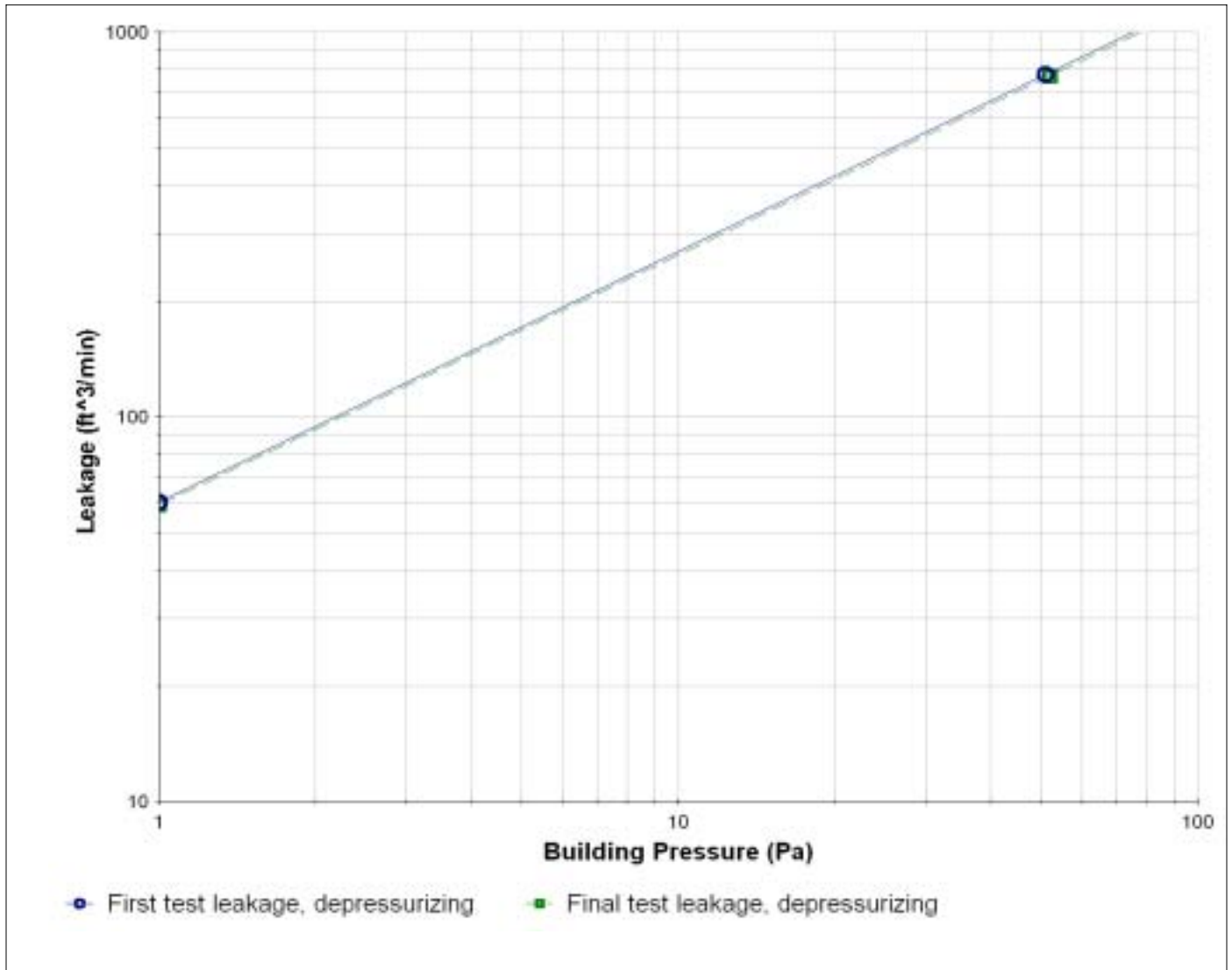
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# Air Leakage Report

Energy 2001 airtightness test program version 1.0(build 1.0.7)

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 Name, Phone **Gavin Cook, 07985 117342**

Test number **5**

Calibration Certificate # **870** Certificate created **2004/05/05**

Test date/time	<b>2005/07/02 16:28</b>	Building Volume	<b>313.0 m<sup>3</sup></b>
Standard used	<b>TM23: 2000</b>	Exposed envelope area	<b>416.0 m<sup>2</sup></b>
Tester	<b>Paul Jennings</b>	Envelope area	<b>416.0 m<sup>2</sup></b>
Certified to Level:	<b>3 - Multiple blower tests</b>	Fireplace	<b>No fireplace</b>
Signature	.....	External doors & windows	<b>Closed</b>
Barometric pressure	<b>101,500.0 Pa.</b>	Exhaust Fans	<b>Sealed</b>
Windspeed Average	<b>1.0 m/sec</b>	Window air-conditioners	<b>No window A/C</b>
Combustion appliances	<b>Off</b>		
Internal doors & hatches	<b>Open</b>		
Ventilation openings	<b>Open</b>		
Dryer	<b>None</b>		

RESULT	UNITS	First Test, Depressurize
Flow @ 50 Pa	m <sup>3</sup> /hr	<b>1,820.11</b>
Airchanges, ACH @ 50 Pa	m <sup>3</sup> /hr/m <sup>3</sup>	<b>5.82</b>
Air Leakage Index @ 50 Pa	m <sup>3</sup> /hr/m <sup>2</sup>	<b>4.38</b>
Permeability @ 50 Pa	m <sup>3</sup> /hr/m <sup>2</sup>	<b>4.38</b>
Effective Leakage Area @ 4 Pa, EflA	m <sup>2</sup>	<b>0.0381</b>
Equivalent Leakage Area @ 50 Pa	m <sup>2</sup>	<b>0.0910</b>

Notes **Final single-point test after opening eight slot vents across the tops of Velux rooflights.**

Witnesses

# DOOR FAN TEST -- First Test Leakage Data

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 Name, Phone **Gavin Cook, 07985 117342**

Test number **5**

Calibration Certificate # **870** Certificate created **2004/05/05**

## First test of building leakage

Operator In the room Smoke doesn't move Temperature during test (F)  
 Static pressure 0 Pa 72 inside 68 outside

### Depressurization

Take 10 readings at 60, 55, 50, 45, 40, 35, 30, 25, 20 & 15.

Blower range	Building pressure	-44.5
	Auto corrected BP	-45.1
Ring C4	Flow pressure	460
	Auto corrected FP	462
	Corrected flow (m <sup>3</sup> /hr)	-1,687

### Depressurization

Q m <sup>3</sup> /hr	@ pa	EfLA m <sup>2</sup>	Slope, n	Intercept, C m <sup>3</sup> /hr/Pa <sup>n</sup>	Correlation %	Standard Error, %	EqLA @ 50Pa m <sup>2</sup>
<b>1,820.11</b>	<b>50</b>	<b>0.0381</b>	<b>0.65</b>	<b>143.142</b>	<b>NA</b>	<b>NA</b>	<b>0.0910</b>

Technician: **Paul Jennings** Certified to Level: **3 - Multiple blower tests**  
 Yes Level 1 – Understanding the technicalities of airtightness in buildings  
 Yes Level 2 – Single blower door-fan testing of buildings  
 Yes Level 3 – Multiple blower door-fan testing of buildings

# DOOR FAN TEST -- Graph

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