



Tel: 08456 808048  
 Mob: 07866 948200  
[www.aldas.co.uk](http://www.aldas.co.uk)  
[Info@aldas.co.uk](mailto:Info@aldas.co.uk)

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Report on the Repeat Air Permeability Testing of the  
 Passivhaus Refurbishment of:

# 57 Portfield Street, Hereford

16<sup>th</sup> July 2010



|  |   |                       |
|--|---|-----------------------|
| Address:   | 57 Portfield St                         | Target:               |
| Air Change Rate (ACH @ 50 Pa):                               | 0.79                                    | 1.0                   |
| Airflow @ 50 Pa (m <sup>3</sup> /hr):                        | 392.3                                   | n/a                   |
| Air Permeability (m <sup>3</sup> /hr/m <sup>2</sup> @ 50 Pa) | 0.82                                    | 1.0                   |
| Air flow exponent, n-value:                                  | 0.77                                    | 0.5 ≤ n ≤ 1.0         |
| Correlation coefficient, r <sup>2</sup> -value:              | 1.000                                   | r <sup>2</sup> ≥ 0.98 |
| Customer:  | <i>Toby Balson, Energy Saving Trust</i> |                       |
| Test Engineer:   | <i>Paul Jennings, ALDAS Limited</i>     |                       |

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## Air Leakage Detailing & Awareness Services

Company Directors

Jackie Carpenter & Paul Jennings

Co. Registration No:

06578439

VAT No:

932 9067 12

Registered Address:

Air Leakage Detailing and Awareness Services Limited, Trelay Farm, Bude, Cornwall EX23 0NJ



**Test Engineer: Paul Jennings**

**Objectives:**

1. To ascertain the air permeability ( $\text{m}^3/\text{hr}/\text{m}^2$  @ 50 Pa) and air change rate (ACH @ 50 Pa) of the refurbished house at 57 Portfield Street, Hereford, approximately one year after the completion of remedial works.
2. To complete a full air change rate test in conformance with the draft Enerphit standard from the PassivHaus Institute, including a detailed inspection for residual leakage sites.

**Measurement Procedures:**

Test procedures in accordance with the following standards: ATTMA TS1, Method B.

**Based upon: BS EN 13829:2001**

**Site Layout & Description of Testing:**

The site comprised a two storey semi-detached house, with a newbuild rear extension and an unheated basement (which, other than the access stairs, was outside the test volume). The test equipment was mounted in the rear single doorway, part of the original construction. The building was inspected; external doors and windows were closed, internal doors opened. The supply and return ducts from the heat recovery ventilation system were temporarily sealed for the duration of testing.

**Building Measurements:**

The building envelope area and volume measurements used were calculated by the owner & architect, Andy Simmonds, and checked on site during the previous acceptance air permeability test by the test engineer, having regard to the ATTMA measuring conventions detailed in TS1.

| Volume $\text{m}^3$ | Envelope area $\text{m}^2$ | Exposed envelope area $\text{m}^2$ |
|---------------------|----------------------------|------------------------------------|
| 498                 | 480                        | 438                                |

**TEST METHOD AND PROCEDURE**

**Method**

Prior to testing the average of positive and negative values of the existing pressure differential, with the fan unit not operating, were recorded over six periods of 30 seconds each to ensure that the pressure difference between the external and internal environments did not exceed +/- 5Pa, as required by TS1.

The existing pressure differential, the barometric pressure, the external wind speed and the internal and external temperatures were recorded at the beginning of the test, and the wind speed and internal and external temperatures, as well as any existing pressure differential, were also recorded at the completion of the test.

During the test, measurements of airflow and the corresponding imposed pressure differential were taken and recorded at a series of fan speeds. This was by depressurising 57 Portfield Street, using a calibrated fan. The test was conducted in accordance with ATTMA TS1 adopting Method B of BS EN 13829:2001.

The air leakage rate  $V_L$ , for the depressurisation test, was calculated using equation (8) of BS EN 13829:2001.

$$V_L = C_L$$

$C_L$  is the air leakage coefficient, in  $\text{m}^3 / (\text{h} \cdot \text{Pa})$

$$C_L = C_{\text{env}} (\rho_e / \rho_0)^{(1-n)} \text{ from BS EN 13829:2001 (Page 12)}$$

**Procedure:**

Prior to switching on the fan(s), the test engineer was satisfied with the weather conditions and the wind speed, and established that the static pressure readings between the building and the external environment did not exceed +/- 5Pa.

An initial leakage investigation was undertaken with the dwelling depressurised to approximately 25 Pa, where those attending the test undertook visual inspections and used our hands to check for draughts at interfaces and joints between sections of the building envelope, as well as around penetrations through the envelope.



Some minor leakage was identified beneath doors and at the corners of window frames, also in the basement stairwell and above the front door where the foam sealing has not yet been finished off. No leakage could be found along the party wall, nor around the service penetrations associated with the heat recovery ventilation. A slight concentration of leakage was identified around the cable hole to the ceiling rose in the upstairs bedroom in the newbuild extension. Some leakage was also identified in the rear upstairs bathroom wall, where there had been some residual leakage at the time of the acceptance testing.

Following the leakage inspection, measurements of flow and pressure were recorded for 10 different pressures, using Magnahelic gauges, for the full depressurisation test. The fan was then turned around and a second series of readings recorded for the pressurisation test. The test report was subsequently generated offsite by the testing organization.

#### Measurements Recorded:

##### Pre-Test Site Data:

| Date and Time                  | External Temp °C | Internal Temp °C | Wind Speed m/s | Barometric Pressure Pa | Zero Flow Pressure Differential Pa |      |         |
|--------------------------------|------------------|------------------|----------------|------------------------|------------------------------------|------|---------|
|                                |                  |                  |                |                        | +ve                                | -ve  | average |
| 10.30am, 13 <sup>th</sup> July | 15.0             | 21.0             | 1.0            | 99,350                 | 0.0                                | -1.5 | -1.5    |

##### Full Acceptance Test:

A full multi-point depressurisation test was carried out, followed by a pressurisation test. The readings collected are detailed below:

##### Depressurisation

| Reading:                           | 1     | 2     | 3     | 4     | 5     | 6     | 7     | 8     | 9     | 10    |
|------------------------------------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|
| Building Pressure, Pa:             | -59.5 | -51   | -58.5 | -47.5 | -41.5 | -48.5 | -16   | -18.5 | -20.5 | -24.5 |
| Corrected Flow m <sup>3</sup> /hr: | 427.8 | 370.4 | 416.1 | 347.7 | 313.3 | 356.9 | 142.1 | 160.7 | 177.2 | 207.7 |

##### Pressurisation

| Reading:                           | 1     | 2     | 3     | 4     | 5     | 6     | 7     | 8     | 9     | 10    |
|------------------------------------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|
| Building Pressure, Pa:             | 36    | 44    | 49.5  | 53.5  | 57.5  | 60    | 19.5  | 18    | 16.5  | 11.5  |
| Corrected Flow m <sup>3</sup> /hr: | 309.2 | 349.6 | 382.8 | 405.1 | 425.3 | 446.5 | 200.6 | 185.2 | 173.5 | 134.9 |

##### Post-Test Site Data:

| Time     | External Temp °C | Internal Temp °C | Wind Speed m/s | Barometric Pressure Pa | Zero Flow Pressure Differential Pa |      |         |
|----------|------------------|------------------|----------------|------------------------|------------------------------------|------|---------|
|          |                  |                  |                |                        | +ve                                | -ve  | average |
| 12.30 pm | 15.0             | 21.0             | 1.0            | 99,350                 | 0.0                                | -1.5 | -1.5    |

##### Results:

All results are compared to the standards set in Building Regulations 'Approved Document L1A – Conservation of fuel and power in new dwellings (2006)'. Results are calculated using the formula set out in ATTMA TS1 (section 3.2).



| RESULT                          | UNITS           | DEPRESSURISE |
|---------------------------------|-----------------|--------------|
| Air Leakage Coefficient, $C_L$  | ( $m^3/h$ )     | <b>19.37</b> |
| Air Flow Coefficient, $C_{env}$ | ( $m^3/h$ )     | <b>19.61</b> |
| Air Flow Exponent               | -               | <b>0.77</b>  |
| Correlation Coefficient         | -               | <b>1.00</b>  |
| Air Changes / Hour @ 50Pa       | (/hr)           | <b>0.79</b>  |
| Air Permeability @ 50 Pa        | ( $m^3/h/m^2$ ) | <b>0.82</b>  |
| Airflow @ 50 Pa                 | ( $m^3/hr$ )    | <b>392.3</b> |

### Conclusion:

With an Air Permeability of 0.82 and an Air Change Rate of 0.79 ACH @ 50 Pa, the refurbished house at 57 Portfield Street, Hereford, has improved since the previous acceptance test in June 2009. Some of this is will be the result of easing and adjusting the four doors to the property, particularly the double doors to the rear kitchen, which was carried out subsequent to that test. However such a significant improvement suggests that there was also some substantial unidentified leakage at the time of the test. This might have been through the area where sealing works were incomplete – the party wall to the adjacent house – or perhaps some temporary sealing, most likely in the basement, had come partially away during the testing. The similarity of the results between the pressurisation and depressurisation tests suggests that there are no significant problems with the membranes in the walls or roof, since this would tend to be substantially worse under one or other of the two different pressure regimes.

Overall the property at 57 Portfield Street is substantially better than is required to be in **COMPLIANCE** with the Building Regulations 'Approved Document L1B – Conservation of fuel and power in existing dwellings (2006)'. It also meets the draft airtightness target (1.0 ACH @ 50 Pa) set by the Passivhaus Institute in the forthcoming Enerphit standard for refurbished Passivhaus dwellings.



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[Info@aldas.co.uk](mailto:Info@aldas.co.uk)

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# Air Permeability Certificate

In accordance with BS EN 13829  
 & CIBSE Technical Memorandum 23 / ATTMA Technical Standard 1

Building tested: 57 Portfield Street, Hereford  
 Repeat Test Date: 13<sup>th</sup> July 2010  
 Test Engineer: Paul Jennings  
 Site Contact & Company: Andy Simmonds, Simmonds Mills Architects/ Toby Balson,  
 Energy Saving Trust  
 Certificate No: ALD10-06-0251

This is to certify that the above named structure has been tested for air tightness in accordance with the BS EN 13829:2001 methodology.

The Key Leakage Characteristics of the building were recorded as follows:

|  |   |
|--|---|
| Air Permeability Rate @ 50 Pa:           | 0.82 m <sup>3</sup> /(hr.m <sup>2</sup> )             |
| Air Change Rate @ 50 Pa:                 | 0.79 ACH  |
| Airflow @ 50 Pa:                         | 392.3 m <sup>3</sup> /hr                              |
| Correlation of results, R <sup>2</sup> : | 1.00 (average)  |
| Slope, n:                                | 0.77 (average)  |
| Air Flow Coefficient, C <sub>env</sub> : | 19.61 m <sup>3</sup> /(hr.Pa <sup>n</sup> ) (average) |
| Intercept, C <sub>L</sub> :              | 19.37 m <sup>3</sup> /(hr.Pa <sup>n</sup> ) (average) |

Test Parameters:

|                                 |                                |
|---------------------------------|--------------------------------|
| Envelope Area, A <sub>E</sub> : | 480 m <sup>2</sup>             |
| Volume:                         | 498 m <sup>3</sup>             |
| Env. Calc Prepared by:          | Andy Simmonds                  |
| Env. Calc Verified by:          | Paul Jennings of ALDAS Limited |

|                              |         |                           |           |
|------------------------------|---------|---------------------------|-----------|
| Initial Offset Pressure:     | -1.5 Pa | Final Offset Pressure:    | -1.5      |
| Initial Inside Temperature:  | 21 °C   | Final Inside Temperature: | 21 °C     |
| Average Outside Temperature: | 15 °C   | Barometric Pressure:      | 99,350 Pa |

This test certificate should be read in conjunction with the report ALD10-06-0251 and associated test method statement.

*Paul Jennings*

Signed: \_\_\_\_\_ Name: Paul Jennings Date Issued: 16<sup>th</sup> July 2010

## Air Leakage Detailing & Awareness Services

|                      |  |         |             |
|----------------------|--|---------|-------------|
| Company Directors    | Jackie Carpenter & Paul Jennings   |         |             |
| Co. Registration No: | 06578439   | VAT No: | 932 9067 12 |
| Registered Address:  | Air Leakage Detailing and Awareness Services Limited, Trelay Farm, Bude, Cornwall EX23 0NJ |         |             |
| Scottish Office:     | 23 Forth Street, Edinburgh, Scotland EH1 3LE   |         |             |



## Appendix One

## Software Printout

## Retrotec Door Fan Test Report

|                            |  |  |
|----------------------------|--|--|
| <b>Tester Information</b>  |  |  |
|                            |  | Air Leakage Detailing & Awareness Services Limited     |
|                            |  | Trelay Farm  |
|                            |  | St. Gennys, Bude, Cornwall                             |
|                            |  | UK, EX23 0NJ   |
|                            |  | Telephone: +44 (0)8456 808048                          |
|                            |  | <a href="mailto:info@aldas.co.uk">info@aldas.co.uk</a> |
| <b>Customer</b>            |  |  |
| Group Name                 |  | Energy Saving Trust                                    |
| Contact Person             |  | Toby Balson / Andy Simmonds                            |
| <b>Building Under Test</b> |  |  |
| Details                    |  | Refurbishment  |
| Address                    |  | 57 Portfield Street                                    |
| City                       |  | Hereford HR1 2SE                                       |
| ATTMA Building Type        |  | Dwelling – mechanically ventilated                     |
| Air Permeability Targets   |  | Best Practice : 3 , Normal : 5                         |
| Temporary Air Sealing      |  | HRV ducts – inlet & exhaust                            |
| <b>Test</b>                |  |  |
| Test #:                    |  | 1  |
| Performed On               |  | 2010/07/13   |
| Operator                   |  | In the Room  |
| Direction(s)               |  | Test both directions                                   |
| Standard                   |  | ATTMA: TS-1  |

### Environmental Conditions

|                     |      | <u>Before</u> |  |      | <u>After</u> |
|---------------------|------|---------------|--|------|--------------|
| Barometric Pressure |      | 99350 Pa      |  |      | 99350 Pa     |
| Wind Speed          |      | 1m/s          |  |      | 1m/s         |
| Inside Temperature  |      | 21 °C         |  |      | 21 °C        |
| Outside Temperature |      | 15 °C         |  |      | 15 °C        |
| Static Pressure     | P01+ | 0.0 Pa        |  | P02+ | 0.0 Pa       |
|                     | P01- | -1.5 Pa       |  | P02- | -1.5 Pa      |
|                     | P01  | -1.5 Pa       |  | P02  | -1.5 Pa      |

### Baseline static pressure measured before test.

|      |      |      |      |      |      |  |  |
|------|------|------|------|------|------|--|--|
| -1.5 | -1.0 | -2.0 | -1.5 | -1.0 | -2.0 |  |  |
|------|------|------|------|------|------|--|--|

### Depressurize

|                                    |       |       |       |       |       |       |       |       |       |       |
|------------------------------------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|
| Room Pressure (Pa):                | -59.5 | -51   | -58.5 | -47.5 | -41.5 | -48.5 | -16   | -18.5 | -20.5 | -24.5 |
| Corrected Room Pr (Pa):            | 58    | 49.5  | 57    | 46    | 40    | 47    | 14.5  | 17    | 19    | 23    |
| Corrected Flow Pr (Pa):            | 427.8 | 370.4 | 416.1 | 347.7 | 313.3 | 356.9 | 142.1 | 160.7 | 177.2 | 207.7 |
| Measured Flow (m <sup>3</sup> /h): | 439.5 | 380.6 | 427.5 | 357.2 | 321.9 | 366.7 | 146.0 | 165.1 | 182.1 | 213.4 |
| Best Fit Flow (m <sup>3</sup> /h): | 435.1 | 384.5 | 429.3 | 363.1 | 325.5 | 369.2 | 147.4 | 166.8 | 182.0 | 211.3 |
| Error (%):                         | 1.    | -1.   | -4    | -1.6  | -1.1  | -7    | -9    | -1.1  | 0     | 1.    |

### Pressurize

|                                    |       |       |       |       |       |       |       |       |       |       |
|------------------------------------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|
| Room Pressure (Pa):                | 36    | 44    | 49.5  | 53.5  | 57.5  | 60    | 19.5  | 18    | 16.5  | 11.5  |
| Corrected Room Pr (Pa):            | 37.5  | 45.5  | 51    | 55    | 59    | 61.5  | 21    | 19.5  | 18    | 13    |
| Corrected Flow Pr (Pa):            | 309.2 | 349.6 | 382.8 | 405.1 | 425.3 | 446.5 | 200.6 | 185.2 | 173.5 | 134.9 |
| Measured Flow (m <sup>3</sup> /h): | 324.3 | 366.7 | 401.5 | 424.9 | 446.1 | 468.3 | 210.4 | 194.2 | 182.0 | 141.5 |
| Best Fit Flow (m <sup>3</sup> /h): | 319.3 | 369.7 | 403.1 | 426.9 | 450.2 | 464.6 | 205.8 | 194.6 | 183.1 | 143.1 |
| Error (%):                         | 1.5   | -8    | -4    | -5    | -9    | .8    | 2.2   | -2    | -6    | -1.1  |



**Baseline static pressure measured after test.**

|      |      |      |      |      |      |  |  |
|------|------|------|------|------|------|--|--|
| -1.0 | -2.0 | -1.5 | -2.0 | -1.0 | -1.5 |  |  |
|------|------|------|------|------|------|--|--|

**Data Analysis**

|                         | Slope (n) | Intercept (C)<br>(m³/h) | Correlation (r²) |
|-------------------------|-----------|-------------------------|------------------|
| Best Fit: Least Squares |           |                         |                  |
| Depressurize            | 0.7811    | 18.2479                 | 99.98            |
| Pressurize              | 0.7578    | 20.4858                 | 99.97            |
| Average                 | 0.7694    | 19.36685                | 99.98            |

**Zone Dimensions**

|                 |     |    |
|-----------------|-----|----|
| Net Floor Area  | 50  | m² |
| Envelope Area   | 480 | m² |
| Internal Volume | 498 | m³ |

**Results**

|                               |                  | Units     | Depressurise | Pressurise | Average |
|-------------------------------|------------------|-----------|--------------|------------|---------|
| Air Flow Coefficient          | C <sub>L</sub>   | (m³/h)    | 18.248       | 20.486     | 19.367  |
| Air Flow Coefficient          | C <sub>env</sub> | (m³/h)    | 18.412       | 20.800     | 19.606  |
| Air flow Exponent             | n                |           | 0.7811       | 0.7578     | 0.7694  |
| Correlation Coefficient       | r²               | (%)       | 99.98        | 99.97      | 99.98   |
| Flow@ 50 Pa                   |                  | (m³/h)    | 387.52       | 397.13     | 392.3   |
| Air Changes/Hour @ 50 Pa      | ACH              | (/hr)     | 0.778        | 0.8        | 0.7878  |
| Air Permeability@ 50 Pa       |                  | (m³/h.m²) | 0.81         | 0.83       | 0.82    |
| Specific Leakage Rate @ 50 Pa | SLR              | (m³/h.m²) | 7.75         | 7.94       | 7.85    |

Door Fan 3.0 Enclosure Leakage Analysis Software (Version 3.260)

By: Retrotec Energy Innovations Ltd (Canada).

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This software conforms to the ATTMA: TS-1 testing standard

