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Airtightness Testing Report

Prepared for:

Unit 1 Wellington Lane
Bristol, BS6 5PY

On behalf of:

Ben East, Earthwise Construction

Author:

Paul Jennings

Date:

20th December 2016

Reference:

P3382-02

DOCUMENT HISTORY

Role	Name	Date
Author	Paul Jennings	20th December 2016
Checked	Alex Baines	21st December 2016
Authorised	Linda Forbes	21st December 2016

Design recommendations and specifications provided in this report are based on the best professional endeavours of the authors. All calculations are based on the best information available to us at the time of report production. Where third party equipment is referred to we rely on manufacturer performance statements, guarantees and warranties. We are not liable for any errors in calculations or omissions resulting from data provided by the customer or third parties.

Encraft works to all relevant professional standards and holds professional indemnity insurance as consulting engineers.

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EXECUTIVE SUMMARY

The results achieved in the acceptance Airtightness Testing of the newbuild infill house at Unit 1 Wellington Lane in Bristol, carried out on 6th December 2016, are detailed in the table below:

Testing carried out by:	**Test Engineer: Paul Jennings**
Target Air Changes, ACH^{-1} @ 50 Pa:	**< 0.6 ACH^{-1} @ 50 Pa (Passivhaus)**
Achieved Air Changes, ACH^{-1} @ 50 Pa:	**0.66**
Achieved Air Permeability, $m^3/hr/m^2$ @ 50 Pa:	**0.57**
Data consistency, r^2 (requirement, $r^2 > 0.98$):	**1.000**
Slope, n (requirement, $0.5 < n < 1.0$):	**0.69**

This is an unsatisfactory result as the house fails to meet the newbuild Passivhaus airtightness target, although by a very small margin. The key area of air leakage appears to be:

- Associated with the centre pillars of the two rear doors on the ground floor;

Full information on the test set-up and procedure is detailed in Appendix I and the test data for the depressurisation and pressurisation tests carried out is provided in the subsequent appendices. An Air Leakage Certificate is included as the final Appendix.

1.0 INTRODUCTION

This report documents the air leakage testing and leakage investigations undertaken by Encraft for Ben East of Earthwise Construction at the newbuild Passivhaus at Unit 1, Wellington Lane in Bristol, carried out on 6th December 2016. We present direct observations from what was noted during our attendance on site, together with recommendations for what to do next, in terms of both investigative and/or remedial work, if required.

The purpose of this report is to:

- Detail the measurements recorded and the test procedures followed
- Provide a photographic record of the test configuration, including any temporary sealing undertaken, and pictures of any significant leakage issues identified
- Confirm the air tightness result achieved
- Identify typical and atypical airtightness faults that did or may impede successful delivery of the required airtightness standard
- Provide air leakage certificates for buildings where conforming airtightness tests were completed.

2.0 TEST SET-UP AND PROCEDURES

2.1 Set-up

Acceptance air leakage testing of the newbuild infill Passivhaus at Unit 1, Wellington Lane in Bristol, BS6 5PY, was carried out on 6th December 2016. Testing was carried out using a Retrotec 300 DucTester fan mounted internally in a window board mounted in a first floor living room window. Testing was carried out in accordance with the requirements of BS EN 13829 and the ATTMA Quality Procedure, in conformance with the ATTMA TSL1 standard (2016), Method B. The additional requirements of the Passivhaus Institute when testing building aiming for Passivhaus certification were also complied with. Any queries or complaints about this test should be addressed in the first instance to the test engineer and in the second instance to the scheme manager at ATTMA.

ATTMA contact details: Scheme Manager, ATTMA, Airport House, Purley Way, Croydon CR0 0XZ
e-mail: manager@attma.org www.attma.org

All external doors and windows, other than that where the test equipment was mounted, were shut for the duration of testing, whilst internal doors were kept open for the duration of testing so free movement of air within the property was assured.

2.2 Measurement procedures

Test procedures in accordance with the following standards: ATTMA TSL1, 2016, Method B. After a preliminary single-point depressurisation test and initial leakage check of the dwelling, full multi-point depressurisation testing was carried out. As required by the PHI for Passivhaus certification a full multi-point pressurisation test was then undertaken.

Measurements recorded

Averages of zero flow pressure differentials were recorded before and after the test, as were internal and external temperatures, windspeed and the barometric pressure.

2.3 Dwelling air volume

The ATTMA volume and envelope areas were calculated by the previous test engineer from plans and sections provided, supplemented by measurements made directly on site as necessary. The best available estimates of the thicknesses of plasterboard and other finishes were utilized for preliminary testing and a revised SketchUp model of the house prepared after the acceptance testing to determine the final as-built calculated volume and envelope area for use in generating the final airtightness results.

Volume under test	Volume (m^3)	Envelope area (m^2)
	PHI conventions	ATTMA conventions
Unit 1, Wellington Lane, Bristol, BS6 5PY	250.3	288.5

2.4 Equipment calibration

All test equipment and accessories are calibrated. The table below provides details of the equipment and the calibration validity for each:

Equipment	Serial No.	Calibration expiry date
Retrotec 300 DucTester	Serial No: 3LFT00000383	Expires 10th March 2017
Retrotec DM-2A Digital Gauge	Serial No: 208847	Expires 6th March 2017
Testo 511 Digital Barometer	Serial No: 39109073/311	Expires 11th January 2017
Testo 110 Digital Thermometer	Serial No: 33955502/310	Expires 11th January 2017

3.0 LEAKAGE OBSERVATIONS

Leakage sites identified in the building tested are grouped into categories and described in detail below. Photographs, including thermographic images where applicable, are provided for key leakage sites where possible.

3.1 Leakage associated with openings: windows, doors & rooflights

Substantial leakage was identified occurring on the two rear ground floor doors, particularly at the top and bottom of the centre posts and also on the handles.

	
3.1.1 Leakage at top of centre post, rear ground floor door	3.1.2 Temporary sealing to top of centre post, rear ground floor door
	
3.1.3 Leakage at bottom of centre post, rear ground floor door	3.1.4 Temporary sealing to bottom of centre post, rear ground floor door
	
3.1.5 Leakage on handle of centre post, rear ground floor door	3.1.6 Temporary sealing on handle of centre post, rear ground floor door

Comparative airtightness testing was carried out after minimising the leakage associated with the two pairs of rear doors on the ground floor by temporary sealing at three locations, as shown above. These were (a) the top of the centre columns, (b) the bottom of the centre columns and (c) the door handles. This made a measurable difference in a comparative pair of depressurisation tests, undertaken at approximately 50 Pa, with an air change rate with the temporary sealing in place of 0.64 AC/hr @ 50 Pa.

3.2 Leakage associated with service penetrations: ducts, pipes & cables

Considerable leakage was identified around a DIRGO in one of the downstairs bathrooms, which was poorly fitted, possibly due to the very limited space available within the timber framing of the boxing. This was removed and the end of the waste pipe temporarily sealed for the duration of testing. The installation of this DIRGO needs to be improved to achieve a satisfactory level of airtightness in the final house.

3.2.1 End of waste temporarily sealed after DIRGO removed

No other significant areas of leakage were identified in the house.

APPENDIX I – Set-up images

Site Address: Unit 1, Wellington Lane, Bristol, BS6 5PY

A1.1) External view of test equipment mounted in window board fitted in open window off lounge on first floor

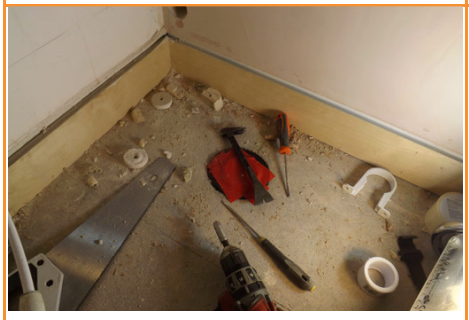
A1.2) Internal view of test equipment mounted in window board fitted in open window off lounge on first floor

A1.3) Temporary seal to external terminal of MVHR duct through rear side wall

A1.4) Temporary seal to external terminal of MVHR duct through rear wall

A1.5) Temporary seal to toilet waste

A1.6) Temporary seal to basin waste



A1.7) Temporary seal to waste through floor for connection from washing machine

A1.8) Temporary seal to incomplete waste from bath, ground floor

APPENDIX II – Negative Pressure Differential vs Airflow Data Set

Site address: Unit 1, Wellington Lane, Bristol, BS6 5PY

Date:	**6th December 2016**	Time:		**15:48**	to	**16:30**	
Environmental Conditions:							
Barometric Pressure:		**102.4**	**KPa**	Wind speed:		**0.2**	**m/s**
Temperatures, initial:	Indoors:	**11.7**	**°C**	Outdoors:		**8.8**	**°C**
Temperatures, final:	Indoors:	**12.6**	**°C**	Outdoors:		**8.0**	**°C**

Test Data:

At least **10** static pressures taken for **10** seconds each.

A minimum of **10** induced pressures taken for >**20** seconds each.

Existing Pressure Differentials (Static pressure):

Baseline, initial [Pa]	0.4	0.4	0.3	0.4	0.4	0.3	0.4	0.5	0.4	0.2
Baseline, final [Pa]	0.5	0.3	0.3	0.0	0.2	0.3	0.2	0.1	0.2	0.3

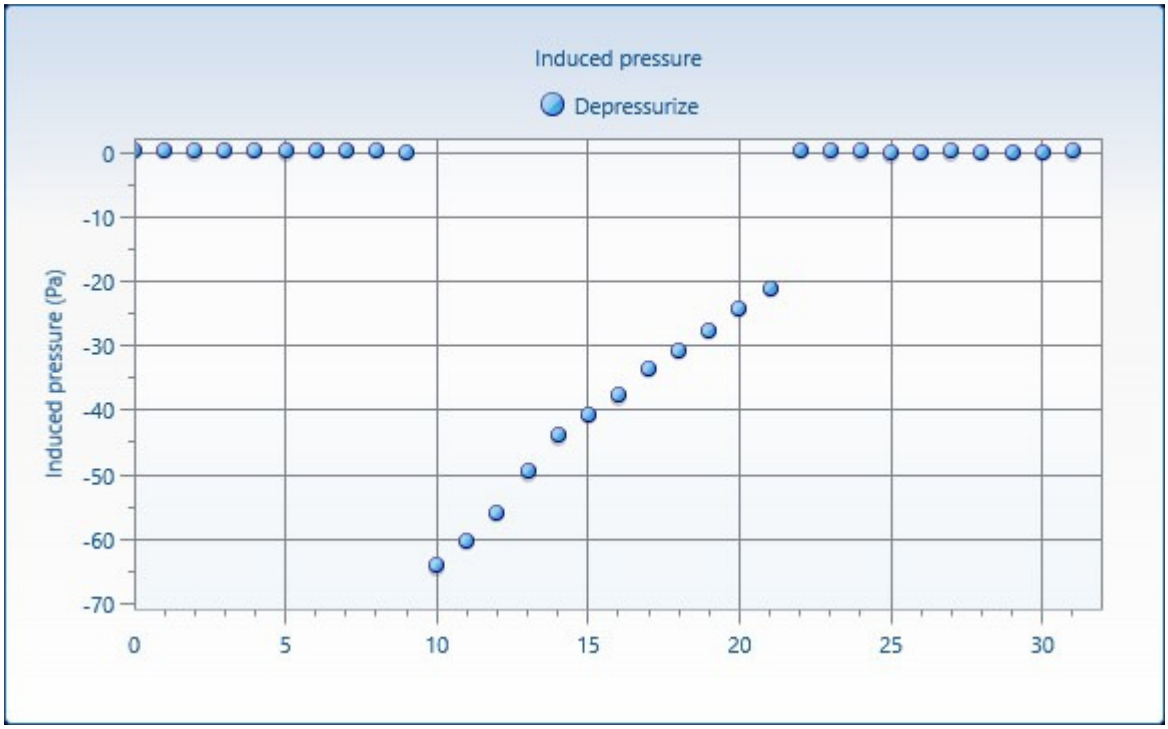
Static Pressure Averages:	**initial [Pa]**	**ΔP_{01}**	**0.37**	**$\Delta P_{01\text{-ve}}$**	**0.00**	**ΔP_{01+ve}**	**0.37**
	final [Pa]	**ΔP_{02}**	**0.24**	**$\Delta P_{02\text{-ve}}$**	**0.00**	**ΔP_{02+ve}**	**0.24**

Results:

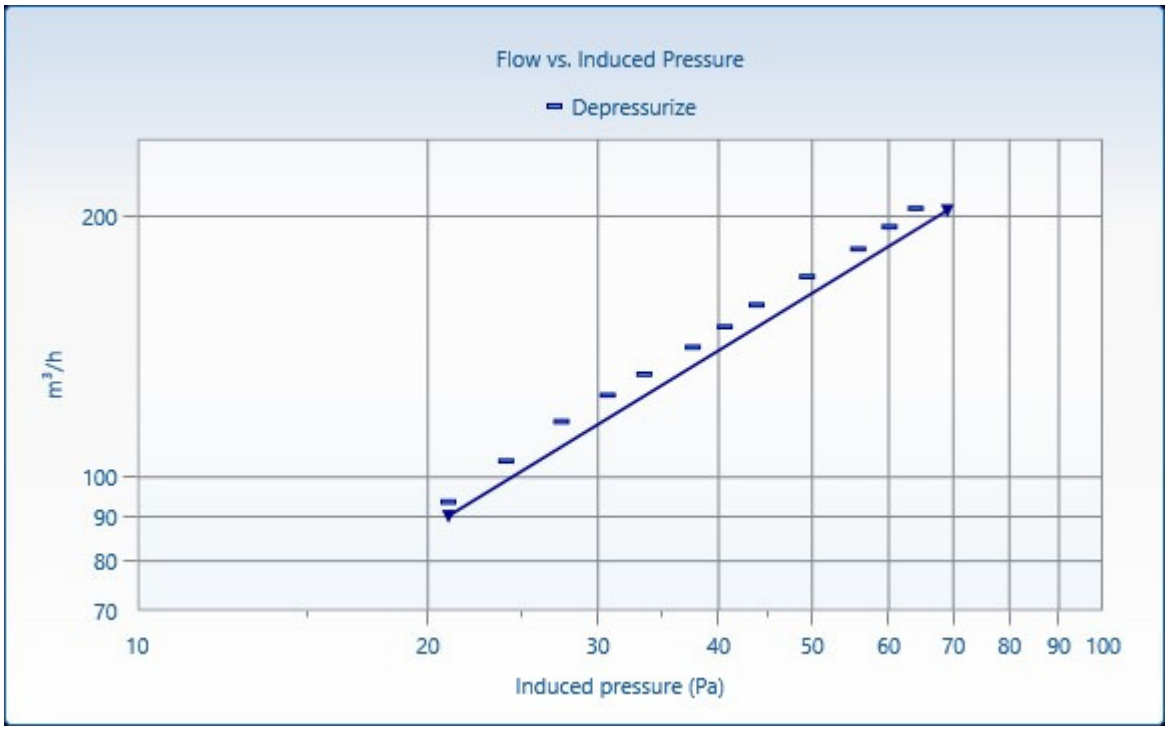
All results are compared to the standards set in Building Regulations 'Approved Document L1A – Conservation of fuel and power in new dwellings (2010)'. Results are calculated using the formulae set out in ATTMA TSL1 (Appendix A). Readings collected are detailed below:

Reading	1	2	3	4	5	6	7	8	9	10	11	12
Induced Pressure [Pa]	-63.7	-59.8	-55.5	-49.1	-43.5	-40.3	-37.3	-33.2	-30.4	-27.2	-23.8	-20.7
Total flow, Q_r [m^3/h]	204.3	194.5	183.4	170.4	158.0	149.1	141.2	131.4	124.3	115.9	104.4	93.6
Corrected flow, Q_{env} [m^3/h]	193.7	184.4	173.8	161.5	149.8	141.4	133.9	124.6	117.8	109.9	99.0	88.7
Error [%]	0.3%	-0.3%	-1.1%	-0.1%	0.6%	-0.1%	-0.3%	0.5%	0.8%	1.4%	-0.1%	-1.6%

G1: Graph of imposed pressure differentials, Depressurisation, Unit 1, Wellington Lane, Bristol, BS6 5PY:



G2: Graph of imposed pressure differential against airflow, Depressurisation, Unit 1, **Wellington Lane, Bristol, BS6 5PY:**



Depressurisation Test Results – Unit 1, Wellington Lane, Bristol, BS6 5PY						
	Results				Results	Uncertainty
Correlation, r^2	**1.000**	95% confidence limits		Air flow at 50 Pa, Q_{50} [m^3/h]	**163.1**	**+/-0.7%**
Intercept, C_{env} [$m^3/h.Pa^n$]	**11.3**	**10.6**	**11.9**	Permeability at 50 Pa, AP_{50} [$m^3/h.m^2$]	**0.57**	**+/-0.8%**
Slope, n	**0.68**	**0.67**	**0.70**	Equivalent leakage area at 50 Pa [cm^2]	**81.3**	**+/-0.7%**
				Air changes, n_{50}	**0.65**	**+/-0.8%**

APPENDIX III – Positive Pressure Differential vs Airflow Data Set

Site address: Unit 1, **Wellington Lane, Bristol, BS6 5PY**

Date:	**6th December 2016**	Time:	**16:45**	to	**17:02**		
Environmental Conditions:							
Barometric Pressure:		**102.4**	**KPa**	Wind speed:	**0.2**	**m/s**	
Temperatures, initial:	Indoors:	**12.6**	**°C**	Outdoors:	**8.0**	**°C**	
Temperatures, final:	Indoors:	**12.6**	**°C**	Outdoors:	**7.8**	**°C**	

Test Data:

At least **10** static pressures taken for **10** seconds each.

A minimum of **10** induced pressures taken for >**20** seconds each.

Existing Pressure Differentials (Static pressure):

Baseline, initial [Pa]	0.5	0.3	0.3	0.0	0.2	0.3	0.2	0.1	0.2	0.3
Baseline, final [Pa]	0.5	0.4	0.6	0.6	0.8	0.6	0.4	0.4	0.8	0.6

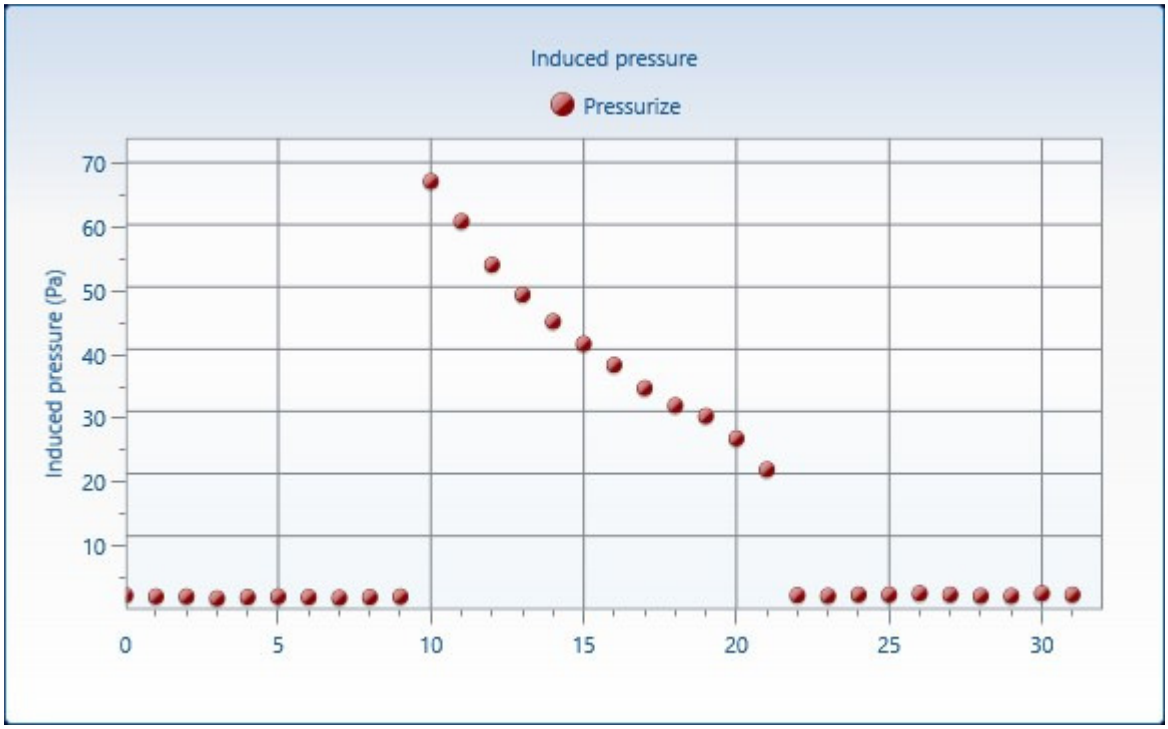
Static Pressure Averages:	**initial [Pa]**	ΔP_{01}	0.24	$\Delta P_{01\text{-ve}}$	0.00	ΔP_{01+ve}	0.24
	final[Pa]	ΔP_{02}	0.57	$\Delta P_{02\text{-ve}}$	0.00	ΔP_{02+ve}	0.57

Results:

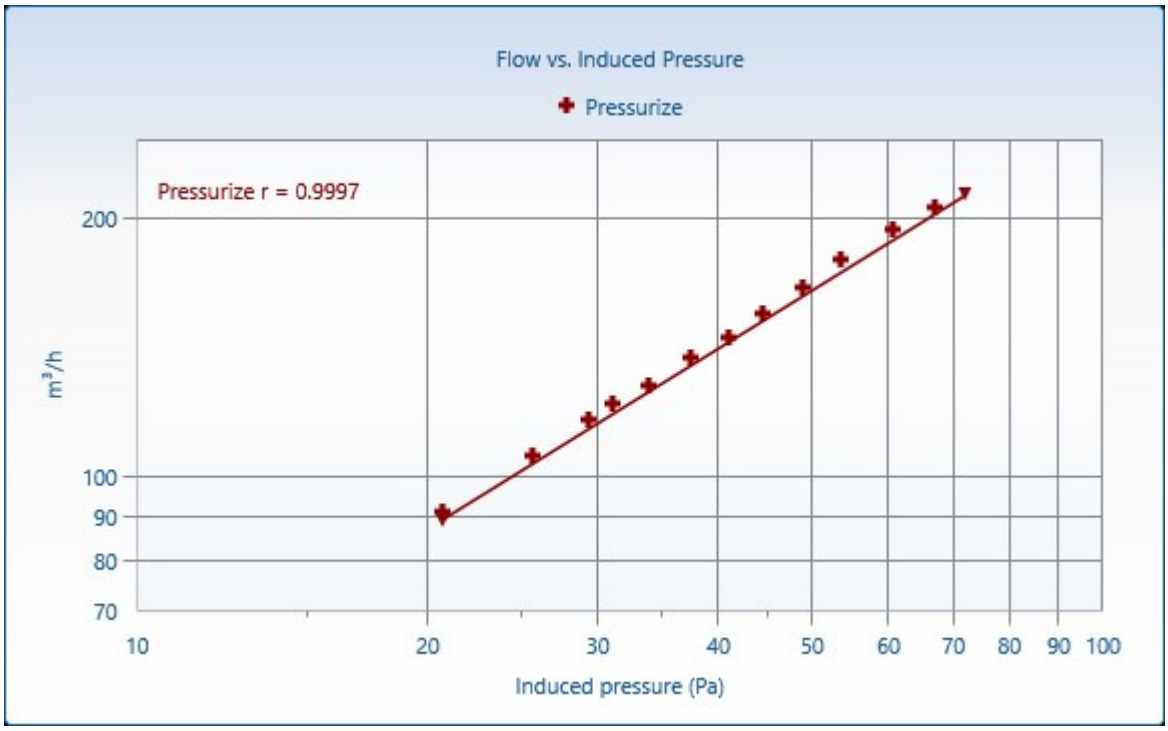
All results are compared to the standards set in Building Regulations 'Approved Document L1A – Conservation of fuel and power in new dwellings (2010)'. Results are calculated using the formulae set out in ATTMA TSL1 (Appendix A). Readings collected are detailed below:

Reading	1	2	3	4	5	6	7	8	9	10	11	12
Induced Pressure [Pa]	67.4	61.0	54.0	49.2	44.9	41.3	37.9	34.2	31.4	29.7	26.1	21.1
Total flow, Q_r [m^3/h]	205.2	193.3	178.9	166.3	154.9	145.5	137.4	127.9	121.8	116.5	106.0	91.1
Corrected flow, Q_{env} [m^3/h]	201.1	189.4	175.3	162.9	151.7	142.5	134.6	125.3	119.3	114.2	103.9	89.3
Error [%]	-0.7%	0.3%	1.1%	0.3%	-0.4%	-0.8%	-0.4%	-0.3%	0.7%	0.3%	0.0%	-0.1%

G3: Graph of imposed pressure differentials, Pressurisation, Unit 1, Wellington Lane, Bristol, BS6 5PY:



G4: Graph of imposed pressure differential against airflow, Pressurisation, Unit 1, Wellington Lane, Bristol, BS6 5PY:



Pressurisation Test Results – Unit 1, Wellington Lane, Bristol, BS6 5PY						
	Results				Results	Uncertainty
Correlation, r^2	**1.000**	95% confidence limits		Air flow at 50 Pa, Q_{50} [m^3/h]	**165.2**	**+/-0.5%**
Intercept, C_{env} [$m^3/h.Pa^n$]	**10.8**	**10.4**	**11.3**	Permeability at 50 Pa, AP_{50} [$m^3/h.m^2$]	**0.57**	**+/-0.7%**
Slope, n	**0.70**	**0.68**	**0.71**	Equivalent leakage area at 50 Pa [cm^2]	**82.4**	**+/-0.5%**
				Air changes, n_{50}	**0.66**	**+/-0.7%**

APPENDIX IV – Air Leakage Certificate

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Air Leakage Certificate

In accordance with BS EN 13829 and ATTMA TSL1 (2016)

Building Tested:		**Unit 1, Wellington Lane, Bristol, BS6 5PY**
Test Date:		**6th December 2016**
Test Engineer:		**Paul Jennings, Encraft**
Certificate No:		**P3382-C01**

This is to certify that the above named dwelling has been tested for air leakage in accordance with the BS EN 13829:2001 methodology and the requirements of ATTMA as specified in TSL1 (2016). The average Leakage Characteristics of the dwelling were recorded as follows:

Airflow @ 50 Pa:		**164.1 m^3/hr**
Air Permeability @ 50 Pa:		**0.57 m^3/ ($hr.m^2$)**
Air Change Rate @ 50 Pa:		**0.66 ACH^{-1}**
Data consistency, r^2 (requirement, $r^2 > 0.98$):		**1.000**
Slope, n (requirement, $0.5 < n < 1.0$):		**0.69**
Intercept, C_{env}:		**11.05 m^3/ ($hr.Pa^n$)**
Test Parameters		
Envelope, A_E:		**288.5 m^2**
Volume, V:		**250.2 m^3**
Env. Calc. prepared by:		**Adam Moring, Encraft**

Initial Offset Pressure	**0.37 Pa**	**Final Offset Pressure:**	**0.57 Pa**
Initial Inside Temperature:	**11.7°C**	**Final Inside Temperature:**	**12.6°C**
Average Outside Temperature:	**8.3°C**	**Barometric Pressure:**	**102.4 kPa**

This certificate should be read in conjunction with the full airtightness test report P3382-02 and associated test method statement.

Signed: Paul Jennings **Name:** Paul Jennings **Date Issued:** 21st December 2016

Position: Air Leakage Specialist

Encraft Ltd, Brandon House Courtyard, William Street, Leamington Spa CV32 4HJ
Telephone: +44 (0)1926 312 159 | Email: enquiries@encraft.co.uk | www.encraft.co.uk