Report on Air Leakage Testing, in compliance with ATTMA TSL1 (2010)

Result: Satisfactory

Site address: Cropthorne Autonomous House, WL10 3LZ

Test Reference No.:		**GALDAS12/01/0002**
Test Date:		**13th January 2012**
Testing carried out for:	**Clients:**	**Mike & Lizzie Coe**
	Address:	**Cropthorne Autonomous House, Evesham**
	Postcode:	**WL10 3LZ**
Testing carried out by:	**Test Engineer:**	**Paul Jennings**
	Company:	**GAIA Aldas**
	Contact Tel:	**07866 948200**
	Contact E-mail:	**Paul@Gaiagroup.org**
Design Air Changes:		**< 0.6 ACH^{-1} @ 50 Pa**
Achieved Air Changes:		**0.36 ACH^{-1} @ 50 Pa**

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Introduction & Set-Up:

Air leakage testing of the Cropthorne Autonomous House at Cropthorne near Evesham was carried out on the13th January 2012 to determine the Air Permeability of the dwelling for Building Regulations compliance and the achieved Air Change Rate for PassivHaus certification. Testing was carried out using a Retrotec 3300HP Blower Unit, mounted in the front door of the house.

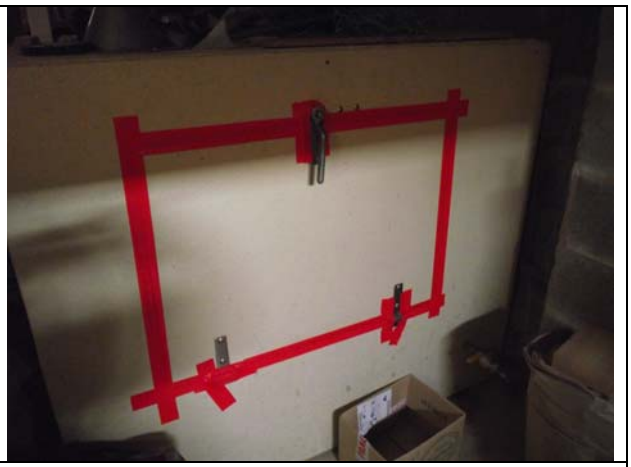
Testing was carried out in accordance with the requirements of BS EN 13829 and the BINDT Quality Procedure, in conformance with the ATTMA TSL1 standard (2010), Method B. any queries or complaints about this test should be addressed in the first instance to the test engineer and in the second instance to BINDT.

BINDT contact details: Newton Building, St. George's Avenue, Northampton NN2 6JB
Tel: 01604 893860 www.bindt.org

All external doors and windows, other than that where the test equipment was mounted, were shut for the duration of testing, and internal doors were kept open to ensure the building acted as a single volume. No trickle vents were fitted in the dwelling. Other test preparations included checking that plumbing and waste traps were charged with water and temporarily sealing of the heat recovery ventilation was undertaken on the warm side of the heat exchanger. A preliminary depressurisation test identified significant leakage occurring through the two compost toilets via the lid and the openable hatch of the composting tank in the basement of the property, outside the conditioned environment. Hence the gap around the lid of the tank was mastic sealed and the hatch was temporarily sealed with tape awaiting the fitting of effective draughtseals.

The photographs below illustrate some of the key features of the test preparation and equipment set-up:

Supply and return ducts disconnected from warm side of heat exchanger and temporally joined for the duration of testing



Hatch to composting chamber temporarily sealed with tape awaiting the fitting of effective & robust draughtseals

Measurement Procedures:

Test procedures in accordance with the following standards: ATTMA TSL1, 2010, Method B. After a preliminary single-point depressurisation test and leakage check, full multi-point depressurisation testing was carried out, followed by multi-point pressurisation testing.

The Envelope Area of the building was calculated according to TSL1 whilst the effective internal volume, for Air Change Rate purposes, was calculated according to guidance provided by the PassivHaus Institute and Warm Associates, PassivHaus Certifiers. The envelope area and volume was calculated from measurements taken on site by the test engineer in consultation with the builder and the clients (occupants).

Based upon: BS EN 13829:2001

Dwelling	Nett Volume m^3, V_{N50}	Envelope area m^2
Cropthorne Autonomous House	**363.3**	**340.9**

Measurements Recorded:

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

Depressurisation Test

After an initial single-point depressurisation test and leakage check, a full multi-point depressurisation test was undertaken, suitable for certification of the completed dwelling for Building Regulation purposes.

Date: **13th January 2012** Time: **12.08 pm** to **12.31 pm**

Environmental Conditions:

Barometric Pressure:			**103.7**	KPa	Wind speed:	**0.8 m/s**
Temperature:	Initial:	indoors	**20°C**		outdoors	**10°C**.
	Final:	indoors	**20°C**		outdoors	**12°C**.

Test Data:

At least **3** static pressures taken for **10** sec each.
A minimum of **10** induced pressures taken for ≥**20** sec each.

Existing Pressure Differentials (Static pressure):

Baseline, initial [Pa]	-1.5	-1.5	-1.5			
Baseline, final[Pa]	-0.5	-1.0	-0.5			

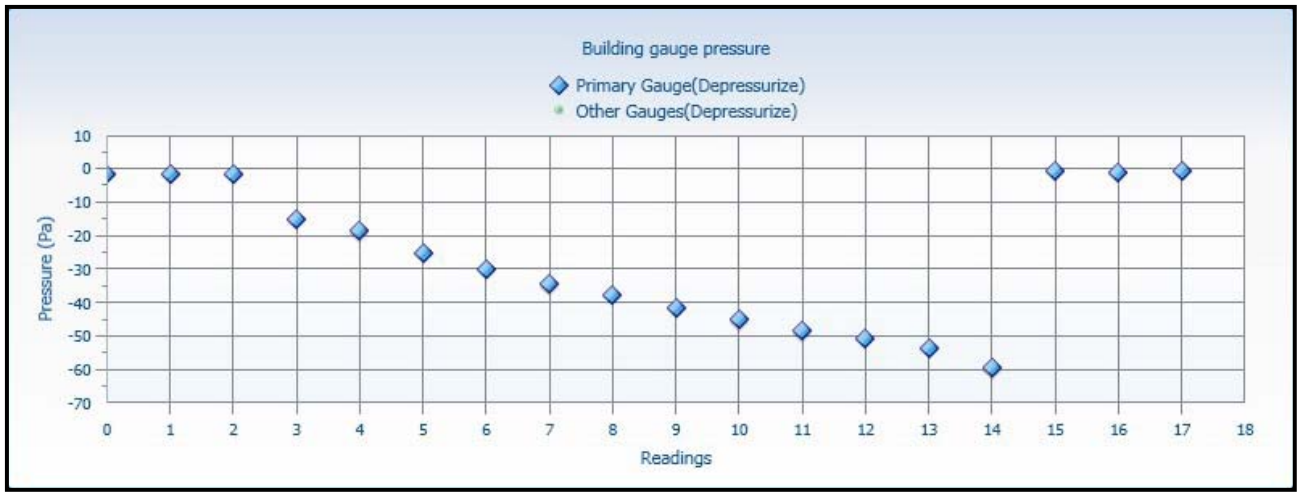
Static Pressure Averages:	initial [Pa]	ΔP_{01}	**-1.50**	ΔP_{01-}	**-1.50**	ΔP_{01+}	**0.00**
	final [Pa]	ΔP_{02}	**-0.67**	ΔP_{02-}	**-0.67**	ΔP_{02+}	**0.00**

Results:

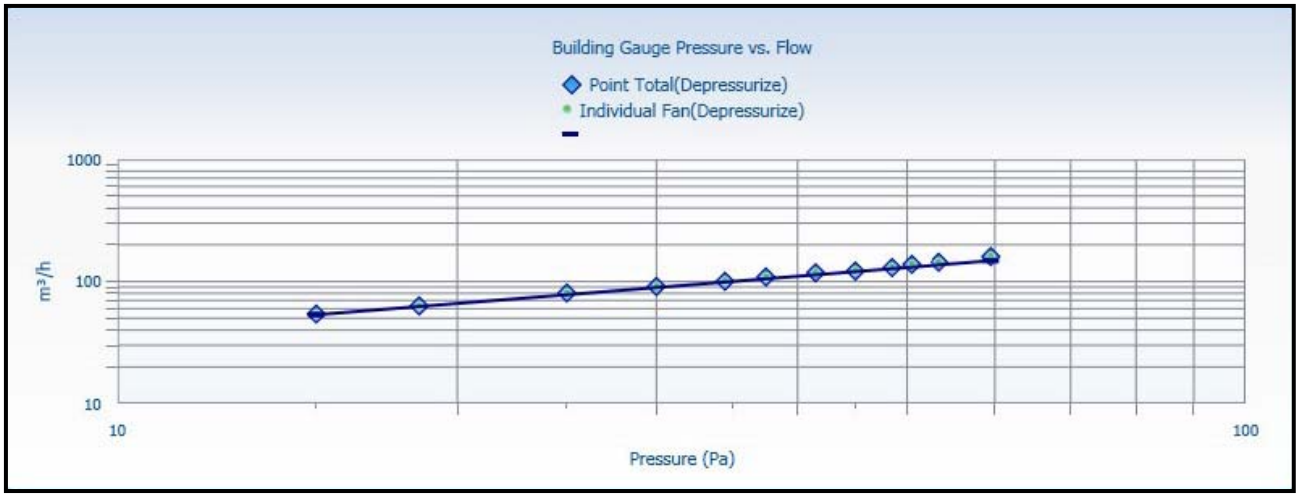
All results are compared to the standards set in Building Regulations 'Approved Document L1A – Conservation of fuel and power in new dwellings (2010)', and to the requirements of the PassivHaus Institute for buildings meeting the PassivHaus standard. Results are calculated using the formula set out in ATTMA TSL1 (section 3.2). Readings collected are detailed below:

Reading:	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**
Induced Pressure [Pa]	-15.0	-18.5	-25.0	-30.0	-34.5	-37.5	-41.5	-45.0	-48.5	-50.5	-53.5	-59.5
Total flow, Q_r [m^3/h]	54.3	63.2	80.6	91.2	100.6	109.0	117.9	121.7	130.0	138.3	143.9	160.3
Corrected flow, Q_{env} [m^3/h]	51.3	59.7	76.2	86.2	95.1	103.0	111.5	115.1	122.9	130.7	136.0	151.5
Error [%]	1.3%	0.0%	0.9%	-0.7%	-1.6%	-0.3%	0.0%	-2.9%	-2.0%	1.2%	0.8%	3.7%

Graph of imposed pressure differentials:



Graph of imposed pressure differential against airflow:



Depressurisation Test Results

	Results		
Correlation, r^2	**0.9986**	95% confidence limits	
Intercept, C_{env} [$m^3/h.Pa^n$]	**7.255**	**6.585**	**7.255**
Slope, n	**0.7379**	**0.7107**	**0.7379**

	Results	Uncertainty
Air flow at 50 Pa, Q_{50} [m^3/h]	**132.0**	**±0.0156**
Permeability at 50 Pa, AP_{50} [$m^3/h.m^2$]	**0.387**	**±0.0163**
Equivalent leakage area at 50 Pa [m^2]	**0.006585**	**±0.0156**
Air changes, n_{50}	**0.3630**	**±0.0164**

Pressurisation Test

A multi-point pressurisation test was then undertaken, as required for PassivHaus certification.

Date: **13th January 2012** Time: **12.34 pm** to **12.58 pm**

Environmental Conditions:

Barometric Pressure:		**103.7** KPa	Wind speed:	**0.8 m/s**
Temperature:	Initial: indoors	**20°C**	outdoors	**12°C**.
	Final: indoors	**20°C**	outdoors	**12°C**.

Test Data:

At least **3** static pressures taken for **10** sec each.
A minimum of **10** induced pressures taken for ≥**20** sec each.

Existing Pressure Differentials (Static pressure):

Baseline, initial [Pa]	-0.5	-1.0	-0.5			
Baseline, final[Pa]	+0.8	+0.7	+0.5			

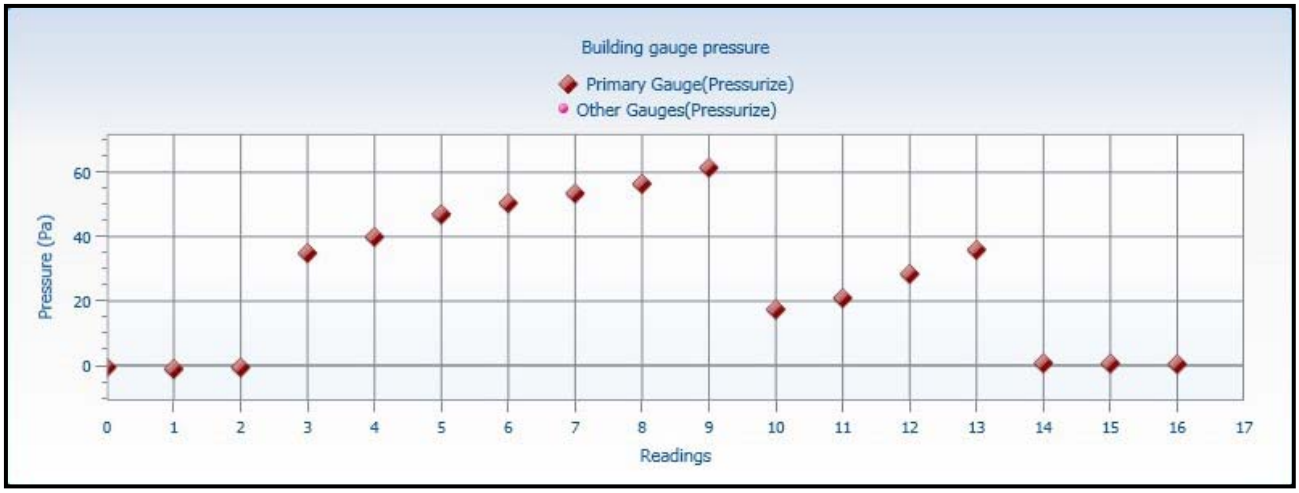
Static Pressure Averages:	initial [Pa]	ΔP_{01}	**-0.67**	ΔP_{01-}	**-0.67**	ΔP_{01+}	**0.00**
	final [Pa]	ΔP_{02}	**0.67**	ΔP_{02-}	**0.00**	ΔP_{02+}	**0.67**

Results:

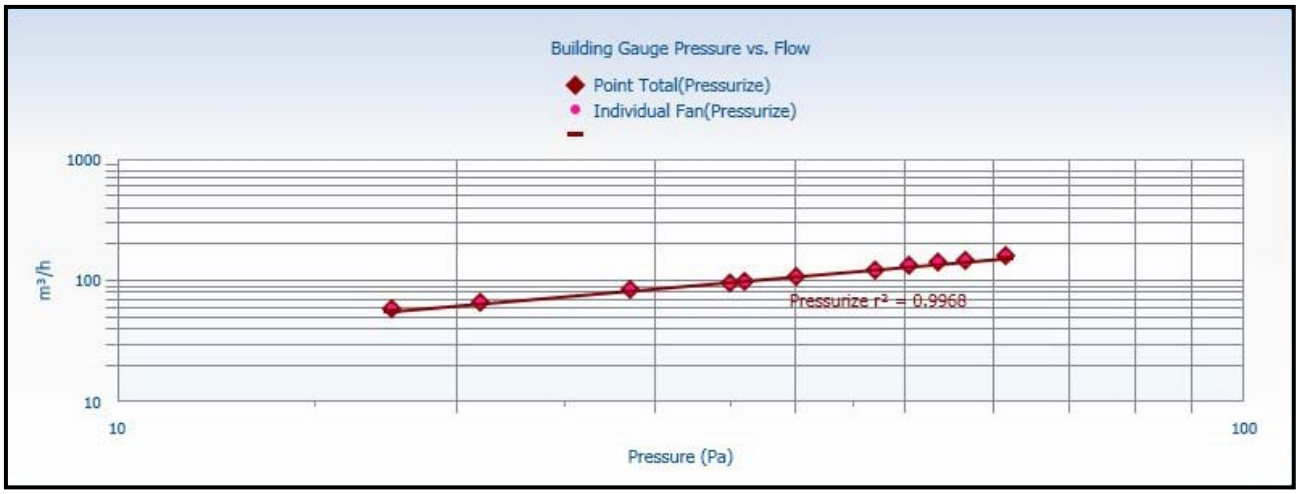
Once again, the readings collected are detailed below:

Reading:	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**
Induced Pressure [Pa]	35.0	40.0	47.0	50.5	53.5	56.5	61.5	17.5	21.0	28.5	36.0
Total flow, Q_r [m^3/h]	96.0	108.2	123.5	132.9	142.8	148.3	162.6	59.4	66.6	84.3	98.9
Corrected flow, Q_{env} [m^3/h]	93.8	105.7	120.7	129.8	139.6	144.8	158.9	58.0	65.1	82.3	96.7
Error [%]	-3.6%	-2.4%	-2.0%	-0.5%	2.2%	1.5%	4.1%	3.7%	0.5%	-0.3%	-2.9%

Graph of imposed pressure differentials:



Graph of imposed pressure differential against airflow:



Pressurisation Test Results

	Results		
Correlation, r^2	**0.9968**	95% confidence limits	
Intercept, C_{env} [$m^3/h.Pa^n$]	**5.690**	**4.765**	**5.690**
Slope, n	**0.7985**	**0.7502**	**0.7985**

	Results	Uncertainty
Air flow at 50 Pa, Q_{50} [m^3/h]	**130.0**	**±0.0232**
Permeability at 50 Pa, AP_{50} [$m^3/h.m^2$]	**0.381**	**±0.0236**
Equivalent leakage area at 50 Pa [m^2]	**0.006485**	**±0.0232**
Air changes, n_{50}	**0.3575**	**±0.0238**

Combined Test Data

	Results	Uncertainty
Air flow at 50 Pa, V_{50} [m^3/h]	**131.0**	**+/-0.0194**
Permeability at 50 Pa, Q_{50} [$m^3/h.m^2$]	**0.384**	**+/-0.0200**
Equivalent leakage area at 50 Pa [m^2]	**0.006535**	**+/-0.0194**
Air changes, n_{50}	**0.3605**	**+/-0.0201**

Conclusions:

The result achieved, an Air Permeability of 0.38 $m^3/hr/m^2$ @ 50 Pa, meets and exceeds by a very substantial margin the Building Regulations requirement to not exceed 10 $m^3/hr/m^2$ @ 50 Pa. The Air Change Rate achieved, 0.36 ACH^{-1} @ 50 Pa also meets and exceeds by a substantial margin the PassivHaus target for newbuild dwellings (a maximum Air Change Rate of 0.6 ACH^{-1} @ 50 Pa), indicating that this characteristic of the dwelling permits PassivHaus Certification to proceed. Hence we are happy to issue an air leakage certificate, a copy of which is attached.

Leakage Inspection:

Prior to the testing, and particularly whilst the building was depressurised during the preliminary testing, it was inspected for leakage. The photographs below show the key leakage sites that were identified and repaired prior to the acceptance test.

Substantial leakage through gap around top of composting chamber, despite compressive seals attached to the underside of the lid.

Gap around lid of composting chamber, mastic sealed prior to the acceptance air leakage test.

Leakage along section in roof void where adhesion between Intello$^+$ membrane and Contega sealing tape plastered into wall was ineffective. This was repaired prior to the acceptance test.

Air Leakage Certificate

In accordance with BS EN 13829
& ATTMA TSL1 (2010)

Dwelling tested:	Cropthorne Autonomous House, Cropthorne, Evesham,
Test Date:	13th January 2012
Test Engineer:	Paul Jennings
Site Contacts:	Mike & Lizzie Coe
Certificate No:	GALDAS12/01/0002C

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 average Leakage Characteristics of the building were recorded as follows:

Airflow @ 50 Pa:		**131.0 m^3/hr**
Air Permeability Rate @ 50 Pa:		**0.38 $m^3/(hr.m^2)$**
Air Change Rate @ 50 Pa:		**0.36 ACH^{-1}**
	Correlation of results, R^2:	**0.998**
	Slope, n:	**0.77**
	Intercept, C_{env}:	**6.47 $m^3/(hr.Pa^n)$**
Test Parameters:		
	Envelope Area, A_E:	**340.9 m^2**
	Volume, V:	**363.3 m^3**
	Env. Calc Prepared by:	**Paul Jennings, GAIA Aldas**

Initial Offset Pressure:	-1.50 Pa	Final Offset Pressure:	+ 0.67 Pa
Initial Inside Temperature:	20°C	Final Inside Temperature:	20°C
Average Outside Temperature:	11°C	Barometric Pressure:	103.7 KPa

This certificate should be read in conjunction with the report GALDAS12/01/0002 and associated test method statement.

Signed: Paul Jennings Name: Paul Jennings Date Issued: 7th February 2012

Position: Building Air Leakage Specialist

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