BUILDING ANALYSIS & TESTING LIMITED

ENVELOPE INTEGRITY TEST

BALEHAUS
BATH UNIVERSITY CAMPUS
BATH

Photo supplied by Modcell

15th DECEMBER 2009

MODCELL

PROJECT REF:	**B1248-ALTRDF-P-151209**
REPORT DATE:	**23rd December 2009**
AUTHORISED BY:	**Andrew Lane**
FUNCTION:	**Director**
SIGNED:	

Andrew Lane

UKAS TESTING
2612

UKAS accredited air leakage testing to ATTMA TS1 and BSEN 13829 undertaken by:

Building Analysis & Testing Ltd

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1.0 EXECUTIVE SUMMARY

1.1 The building air leakage test of the Balehaus, Bath University Campus, Bath was undertaken early in the morning of the 15th December 2009. Weather conditions for the test were acceptable to allow readings of sufficient accuracy to be taken.

1.2 The building air leakage test undertaken to ATTMA TS1 and BS EN 13829 determined that the building met the current UK Building Regulations standards and produced a measured Air Permeability of below 1 $m^3/hr.m^2$ envelope.

2.0 INTRODUCTION

2.1 BAT were employed by Modcell to undertake the building air leakage testing. The building is due for completion in December 2009. The building is a naturally ventilated research building constructed on rendered timber panels insulated with straw bales.

2.2 The building air permeability and air leakage index were measured using the procedures detailed in ATTMA TS1 and BS EN 13829: 2000 with a view to establishing the performance for Building Regulations 2000 Part L2 Compliance. The test Method B as defined in BS EN 13829 was employed to test the building envelope thus allowing the designed ventilation openings to be sealed.

2.3 The building had no mechanical ventilation.

3.0 DESCRIPTION OF TEST

3.1 The air permeability testing was started at 10:00 hrs and was completed by 11:00 hrs.

3.2 Conditions for the duration of the test were dry with broken cloud with virtually no wind. No unexpected pressure fluctuations occurred during the testing and the barometric pressure remained constant.

3.3 The fan was located in front door as shown in photograph 1. The internal pressure sensing tube was positioned inside the building out of the influence of the fan unit.

3.4 The building envelope surface area was calculated by BAT from an onsite survey.

Photograph 1

4.0 TEST PROCEDURE

4.1 The Building Pressure test follows the procedures set out in ATTMA TS1 using an air pressurisation technique. Air is removed from the building at varying rates and the resultant building static pressure differential measured using calibrated differential pressure devices.

4.2 The pressure differential generated by the air supplied is related by the equation:

$$Q = C(\Delta p)^n$$

Where:

Q	Air flow rate supplied to the building	m³/s
Δp	Differential pressure across the building	Pa
C	Air Leakage coefficient	
n	A derived power coefficient	

4.3 The air flow rate is measured using purpose designed calibrated Retrotec door fans located inside a hard panel door frame unit which can be expanded to the door frame size.

4.4 The fan units incorporate pressure tappings and orifice plates of known size and configuration. The differential pressure across the fan and orifice plates is measured with a Retrotec differential pressure meter which is calibrated to UKAS requirements.

4.5 The building pressure is measured using Retrotec differential pressure DM2 Micromanometer which is calibrated to UKAS requirements with internal and external sensing tubes with tee terminations located appropriately out of the airstream generated by the fan unit.

4.6 In order to achieve meaningful results in accordance with ATTMA TS1, the fan pressurisation equipment needed to generate a minimum pressure in the building of 35Pa. The zero flow pressures before and after the test need to be in the range ±5Pa for a period of around 30 seconds. The calculated parameters n and R^2 need to be between 0.5-1.0 and better than 0.98 respectively.

5.0 DATA COLLECTION AND ANALYSIS

5.1 The measurements required to complete the data analysis were taken on site before, during and after the test as appropriate. Results were recorded on site on Retrotec Airtightness software run on a laptop computer. A single point test run was undertaken at 50Pa test pressure initially to roughly assess whether the building air leakage was above or below the test standard prior to running the accurate multi-point test.

5.2 For the multi-point test the flow pressure and the building differential pressure were recorded at a minimum of ten different fan speeds generating building pressures between 60 and 10Pa and entered in the software on the laptop computer.

5.3 Internal temperature data for the buildings was recorded and used in the data analysis to correct the building air leakage volume flow rate and to normalise the results to STP.

5.4 The results of site measurements were checked at site to determine whether any incidents had occurred during the measurement process that caused anomalous results to be recorded. This could be an occurrence such as a door or window being pushed open by the air as the building pressure was increased.

5.5 The building pressure and the measured volume were plotted on a chart using log-log scales and the slope determined using a regression analysis. The constants C and n are determined

and used in the equation in 4.2 above to generate the Q_{50} flow rate which is the air flow associated with a pressure of 50Pa.

5.6 Further data analysis is undertaken to correct the results for the actual environmental conditions encountered at site. The first step accounts for differences in density that affects the supplied air volume between the test day and the day on which the equipment was calibrated. The second step adjusts the leakage air volume to account for temperature changes between that supplied by the fan and the internal air temperature. If the indoor air temperature is higher than that supplied, then the volume of the air increases as it is mixed and the amount of air expelled through the building façade is slightly higher than the measured volume.

5.7 Once the data has been corrected a third step generates Q_{50}, which is standardised to STP and is used to establish the final Building Air Permeability. The building air permeability Q_{50}/S ($m^3/hr.m^2$) which is the air flow associated with a pressure of 50Pa normalised with respect the envelope area S can be widely compared with other buildings.

6.0 CONCLUSIONS

6.1 The Building Air Permeability test undertaken to ATTMA TS1 and BS EN 13829 determined that the building performed well and has an air permeability that is within current UK Building Regulations 2000 Part L2 with a measured Air Permeability of **0.86 $m^3/hr.m^2$ envelope which is exceptionally low.**

6.2 Any opinions and interpretations expressed herein are outside the scope of UKAS accreditation for Building Air Permeability Testing.

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APPENDIX 1 - AIR PERMEABILITY TEST DATA SHEET & RESULTS SHEET

Tester Information

Jonathan Dickson
Building Analysis & Testing Limited
School House, Bristol Road, Wraxall

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Customer

Group Name	Modcell
Contact Person	
Customer Phone	

Building Under Test

Details	Balehaus Bath
Address	Bath University Campus
City	Bath
State	North Somerset
ATTMA Building Type	General
Air Permeability Targets	Best Practice : , Normal :
Temporary Air Sealing	

Test

Test #:	1
Performed On	2009/12/15
Operator	In the Room
Direction(s)	Test both directions
Standard	ATTMA: TS-1
Notes:	

Equipment Used

System	Certificate # 3596		
Fan Serial #	H01737	expires	2010-09-30
Room Gauge Serial #	101427A	expires	2010-09-29
Flow Gauge Serial #	101427B	expires	2010-09-29

Environmental Conditions

		Before		After
Barometric Pressure		99580 Pa		99580 Pa
Wind Speed		2m/s		2m/s
Inside Temperature		14 °C		14 °C
Outside Temperature		12 °C		12 °C
Static Pressure	P01+	0.0 Pa	P02+	0.0 Pa
	P01-	-1.65 Pa	P02-	-0.84 Pa
	P01	-1.65 Pa	P02	-0.84 Pa

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Baseline static pressure measured before test.

-2.3	-.9	-1.1	-1.3	-1.6	-2.1	-2.3	-2.1	-1.5	-1.3

Depressurize

Fan Range - C1

Room Pressure (Pa):	-59.60	-56.40	-51.40	-48.30	-46.80	-42.10	-40.20	-36.70	-31.70	-27.40
Corrected Room Pr (Pa):	58.23	55.03	50.03	46.93	45.43	40.73	38.83	35.33	30.33	26.03
Flow Pressure (Pa):	157	143	135	119	107	93.90	88.50	74	65.90	45.40
Corrected Flow Pr (Pa):	156.0	142.2	134.2	118.4	106.5	93.6	88.2	73.7	65.6	45.1
Measured Flow (m³/h):	239.8	239.7	232.2	217.3	205.6	191.7	185.8	169.0	158.5	130.3
Best Fit Flow (m³/h):	251.0	240.4	223.5	212.8	207.6	191.0	184.1	171.3	152.4	135.5
Error (%):	-4.7	-.3	3.7	2.	-1.	.4	.9	-1.3	3.8	-4.

Pressurize

Fan Range - C1

Room Pressure (Pa):	59	54.20	51.40	45.40	42.30	39	36.50	35.10	29.10	21.60
Corrected Room Pr (Pa):	60.37	55.57	52.77	46.77	43.67	40.37	37.87	36.47	30.47	22.97
Flow Pressure (Pa):	211	190	175	154	137	123	111	97	87.10	65.90
Corrected Flow Pr (Pa):	210.0	189.0	174.0	153.0	136.2	122.4	110.5	96.6	86.8	65.6
Measured Flow (m³/h):	235.2	220.9	209.5	195.0	180.5	168.8	157.8	141.6	137.4	118.1
Best Fit Flow (m³/h):	230.1	216.2	207.9	189.9	180.3	169.9	161.9	157.4	137.5	111.1
Error (%):	2.2	2.1	.7	2.6	.1	-.7	-2.6	-11.1	-.1	5.9

Baseline static pressure measured after test.

-1.1	-1.1	-1.1	-.9	-1.0	-.9	-.4	-.7	-1.1	-.1

Data Analysis

	Slope (n)	Intercept (C) (m³/h)	Correlation (r²)
Best Fit: Least Squares			
Depressurize	0.7654	11.1869	98.95
Pressurize	0.7537	10.4656	98.08
Average	0.7596	10.82625	98.52

Zone Dimensions

Net Floor Area	46	m²
Envelope Area	247	m²
Internal Volume	262	m³

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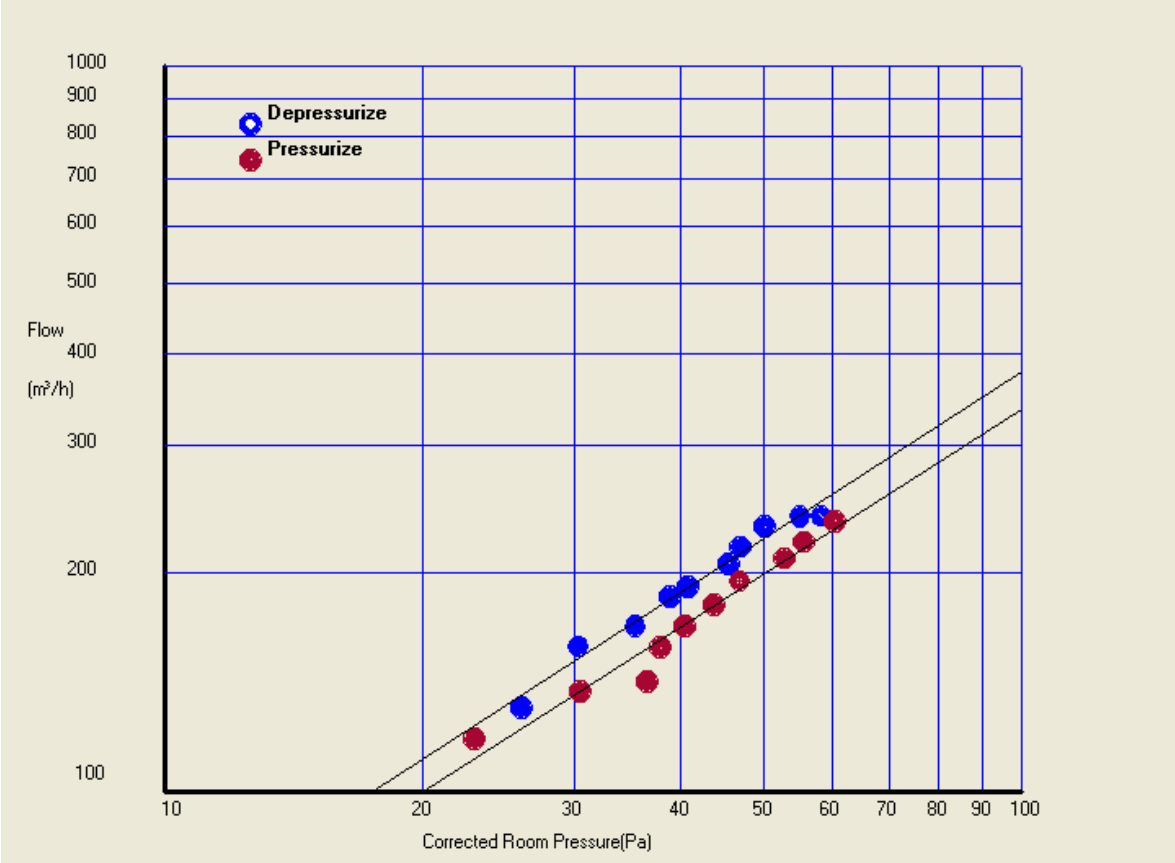
Results

		Units	Depressurize	Pressurize	Average
Air Flow Coefficient	(CL)	(m^3/h)	11.187	10.466	
Air Flow Coefficient	(Cenv)	(m^3/h)	11.167	10.465	
Air flow Exponent	(n)		0.7654	0.7537	
Correlation Coefficient	r^2	(%)	98.95	98.08	
Flow@ 50 Pa		(m^3/h)	223.42	199.66	211.5
Air Changes/Hour @ 50 Pa	(ACH)	(/hr)	0.853	0.76	0.8074
Air Permeability@ 50 Pa		($m^3/h.m^2$)	0.9	0.81	0.86
Specific Leakage Rate @ 50 Pa	(SLR)	($m^3/h.m^2$)	4.86	4.34	4.6

Door Fan 3.0 Enclosure Leakage Analysis Software (Version 3.251)
By: Retrotec Energy Innovations Ltd (Canada).
Copyright 2006-2007, Retrotec Energy Innovations Ltd
This software conforms to the ATTMA: TS-1 testing standard



APPENDIX 2 – CERTIFICATE OF BUILDING AIR PERMEABILITY

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CERTIFICATE OF BUILDING AIR PERMEABILITY

This is to certify that

BALEHAUS
BATH UNIVERSITY CAMPUS
BATH
NORTH SOMERSET

Tested for Building Air Permeability on 15th December 2009
Measured in accordance with ATTMA TS1: 2007
Achieved a performance of

0.86 m³/hr.m²

Certificate Number: **B001248**

Awarded by: **Andrew Lane** BSc (hons) CEng MCIBSE
Director BAT Limited

Date: **23rd December 2009**

SIGNED: .....

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