University of Salford MANCHESTER

UKAS
TESTING

1262

TEST REPORT No : 2099-1

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DATE OF ISSUE : 5 January 2015

BS EN ISO 354:2003

ACOUSTICS – MEASUREMENT OF SOUND ABSORPTION IN A REVERBERATION ROOM

CLIENT:	OCEE Design
	Design House,
	Caswell Road,
	Brackmills,
	Northampton,
	NN4 7PW
JOB NUMBER:	ACOUS/02099
MANUFACTURER:	OCEE Design
MODEL:	"Lucia", "Blazer" & "Blazer Quilt"
TYPE:	Discrete Panel Absorbers
DATE RECEIVED:	3 December 2014
DATE OF TEST:	16 September 2014

Signed:

I G Rattigan

Laboratory Manager

Approved:

D J McCaul

Technical Manager

1   TEST SAMPLES

1.1   Description of Test Samples

Three modular / back panels of the models described on the following pages were installed by the client into randomly marked locations in the centre of the floor of the reverberation room. The panels were positioned at positions greater than 2m away from each other and greater than 1m from any room surface and microphone position.

Test Reference: **1884-1542**

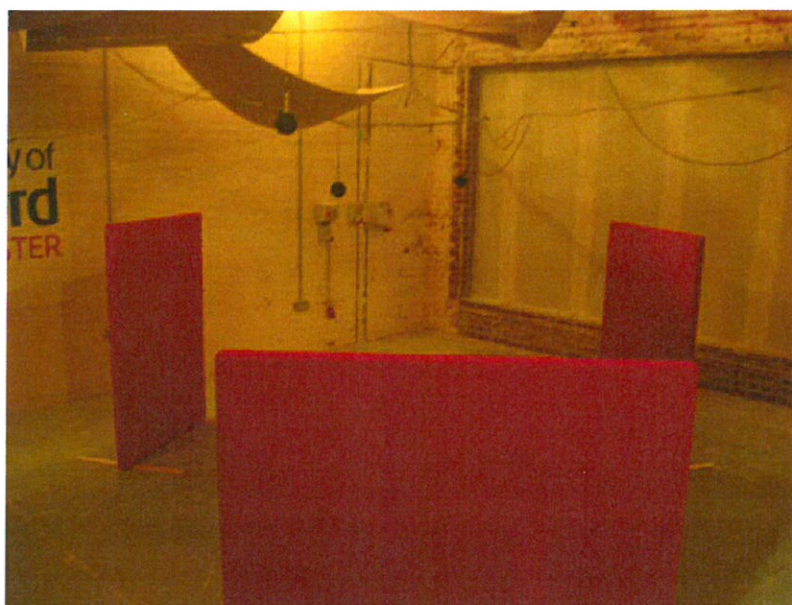**Sample Reference:**   "Lucia" – fabric covered modular / back panel

Sample Dimensions: 1480mm high × 1050mm wide × 50mm thick (measured)
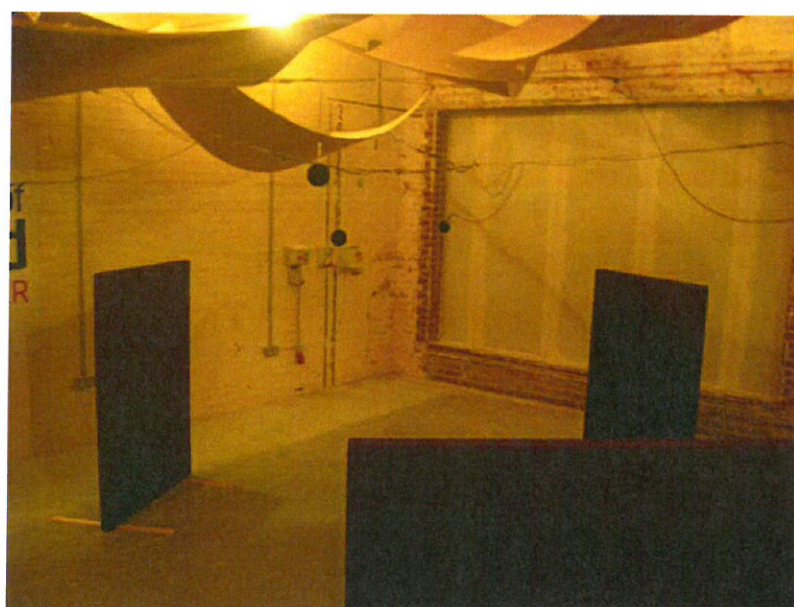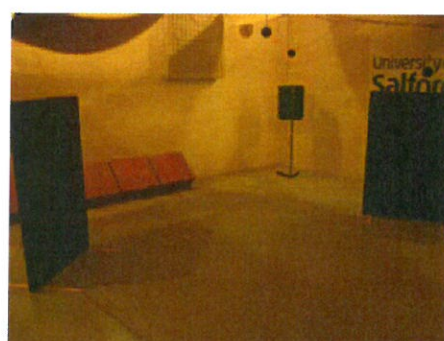
Test Reference: **1884-1543**

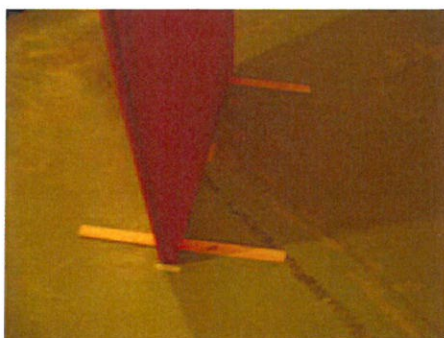**Sample Reference:**   "Blazer" – fabric covered modular / back panel

Sample Dimensions: 1483mm high × 1054mm wide × 52mm thick (measured)

Test Reference: **1884-1544**

Sample Reference: "Blazer Quilt" – fabric covered modular / back panel

Sample Dimensions: 1480mm high × 1045mm wide × 55mm thick (measured)

2   DESCRIPTION OF TEST PROCEDURE

2.1   Description of Test Facility

The tests were carried out in the large reverberation room at the University of Salford. The room has been designed with hard surfaces and non-parallel walls to give long empty room reverberation times with uniform decays. It has the shape of a truncated wedge. In addition 11 plywood panels, each panel 1.22m × 2.44m, were hung in the room to improve the diffusivity of the sound field. The test sample was placed in the centre of the floor. The excitation signal comprised wide band random noise played into the room via a loudspeaker system mounted in a cabinet facing a corner. The sound was monitored at each of 6 microphone positions. The room is 7.4m long × ~6.6m wide × 4.5m high with a volume of 220m^3 and a total surface area of 224m^2. The volume of the room permits a maximum sample size of 12.79m^2 to be tested, in accordance with Clause 6.2.1.1 in BS EN ISO 354: 2003, "Acoustics - Measurement of sound absorption in a reverberation room".

2.2   Test Procedure

The procedure followed that detailed in BS EN ISO 354. Measurements were made on the rate of decay of sound in the test chamber with and without the sample in place. The frequency range from 100Hz to 5000Hz was covered in one-third octave bands. An average reverberation time was taken from five decays at each of six microphone positions for each of two loudspeaker positions (i.e. 60 decays per third octave band). The decays were produced by exciting the room with amplified wide band random noise and stopping the excitation once the chamber became saturated. The time taken for the sound to decay by 20dB is measured and tripled to give the reverberation time. In practice this was determined by sampling the decaying sound field on a one-third octave band frequency analyser and storing the spectrum in a computer every 32 milliseconds. The reverberation time was obtained from the arithmetically averaged decays at each frequency. The measurements with and without the sample in the room were carried out consecutively to avoid significant changes in relative humidity and temperature that influence air absorption at higher frequencies.

2.3   Calculation

The equivalent sound absorption area of the test specimen in m² was determined at each frequency from the measured data by means of the equations below:

$$A_T = A_2 - A_1 = 55.3V\left(\frac{1}{c_2 T_2} - \frac{1}{c_1 T_1}\right) - 4V(m_2 - m_1)$$

Where

A_1 is the equivalent sound absorption area of the empty reverberation room (m^2).

A_2 is the equivalent sound absorption area of the room reverberation containing the test specimen (m^2).

V is the volume, in cubic metres, of the empty reverberation room:

c_1 is the propagation speed of sound at air temperature t_1;

c_2 is the propagation speed of sound at air temperature t_2;

T_1 is the mean reverberation times of the empty reverberation room in each frequency band (sec).

T_2 is the mean reverberation times of the reverberation room containing the test specimen in each frequency band (sec)

m_1 is the power attenuation, in reciprocal metres, using the climatic conditions that have been presented in the empty reverberation room.

m_2 is the power attenuation, in reciprocal metres, using the climatic conditions that have been presented in the reverberation room containing the test specimen.

(No correction is applied for the absorption of the surface covered by the test sample)

3   EQUIPMENT

	Departmental Record No
Norwegian Electronics 1/3 octave band real time analyser type 840 with in-built random noise generator	RTA2
Quad 510 power amplifier	PA7
2 of broadband loudspeakers (receiving room)	LS3-LS4
5 of Bruel &Kjaer random incidence condenser microphone type 4166 in the receiving room	M7-M9 M18, M19
1 of G.R.A.S. random incidence condenser microphones type 40AP in the receiving room	M20
1 of Norsonic Multiplexers type 834A	MP2
HP Brio Pentium personal computer and related peripheral equipment (printer, plotter, monitor etc.)	COM6
Yamaha GQ1031BII graphic equalizer	GEQ1

<u>4</u>   <u>RESULTS</u>

The random incidence sound absorption coefficients are given in the table(s) overleaf.

Reverberant room volume: 220 m³

Static Pressure: 101.5 kPa

Test Reference:		1884...	1542	1543	1544
Sample size:	[m²]		1480 × 1050	1483 × 1054	1480 × 1045
Sample thickness:	[mm]		50	52	55
Sample out temperature:	[°C]		21.6	21.6	21.6
Sample out relative humidity:	[%]		53.5	53.5	53.5
Sample in temperature:	[°C]		21.7	21.6	21.8
Sample in relative humidity:	[%]		55.7	57.0	56.4

The results here presented relate only to the items tested and described in this report.

BS EN ISO 354:2003

Acoustics - Measurement of absorption in a reverberation room

Client:	OCEE Design
	Design House
	Caswell Road, Brackmills
	Northampton, NN4 7PW
Object:	"Lucia"

Size:	Three panels 1480mm high x 1050mm wide x 50mm thick

Receiving room:

Volume:	220 m^3
Condition:	clean
Type:	large reverberation room
Location:	acoustic transmission suite

Sample out:	Temperature [^{o}C]:	21.6	Humidity [%]:	53.5
Sample in:	Temperature [^{o}C]:	21.7	Humidity [%]:	55.7

Equivalent absorption Area A$_T$

Frequency	A$_T$	T$_1$	T$_2$			
Hz	m^2	s	s			
100	1.7	5.30	4.22			
125	2.3	4.57	3.50			
160	2.8	3.57	2.77			
200	4.4	3.71	2.55			
250	4.4	3.98	2.67			
315	4.2	4.34	2.87			
400	4.8	4.36	2.75			
500	4.4	4.68	2.95			
630	4.2	4.62	2.98			
800	4.3	4.67	2.99			
1000	4.3	4.52	2.92			
1250	4.1	4.35	2.89			
1600	4.2	4.13	2.79			
2000	4.4	3.76	2.56			
2500	4.9	3.34	2.29			
3150	6.0	2.98	1.99			
4000	6.9	2.47	1.68			
5000	8.2	1.98	1.37			

Test reference number: 1884-1542	Date: 16/09/2014

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Acoustics - Measurement of absorption in a reverberation room

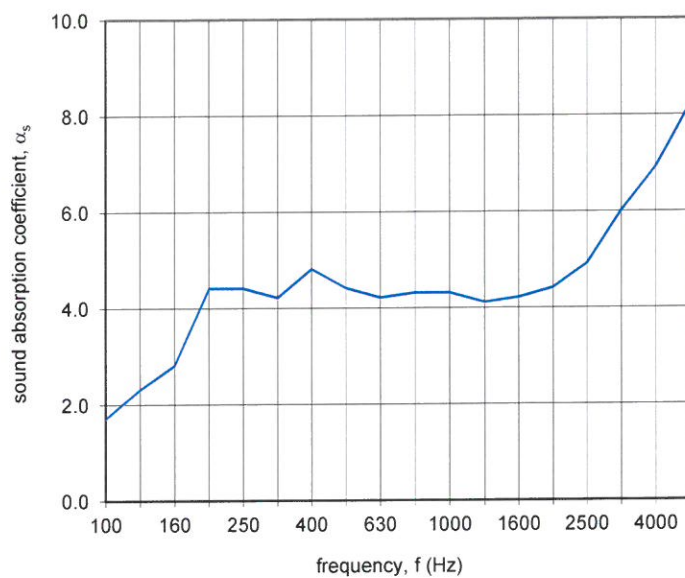|	
Client:	OCEE Design Design House Caswell Road, Brackmills Northampton, NN4 7PW
Object:	"Lucia"
Size:	Three panels 1480mm high x 1050mm wide x 50mm thick

Receiving room:

Volume:	220 m^3	
Condition:	clean	
Type:	large reverberation room	
Location:	acoustic transmission suite	

Sample out:	Temperature [^{o}C]:	21.6	Humidity [%]:	53.5
Sample in:	Temperature [^{o}C]:	21.7	Humidity [%]:	55.7

Equivalent absorption Area A$_T$

Frequency	A$_T$
Hz	m^2
100	1.7
125	2.3
160	2.8
200	4.4
250	4.4
315	4.2
400	4.8
500	4.4
630	4.2
800	4.3
1000	4.3
1250	4.1
1600	4.2
2000	4.4
2500	4.9
3150	6.0
4000	6.9
5000	8.2

Test reference number: 1884-1542

Date: 16/09/2014

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BS EN ISO 354:2003

Acoustics - Measurement of absorption in a reverberation room

Client:	OCEE Design
	Design House
	Caswell Road, Brackmills
	Northampton, NN4 7PW

Object:	"Blazer"

Size:	Three panels 1483mm high x 1054mm wide x 52mm thick

Receiving room:

Volume:	220 m^3
Condition:	clean
Type:	large reverberation room
Location:	acoustic transmission suite

Sample out:	Temperature [$^\circ$C]:	21.6	Humidity [%]:	53.5
Sample in:	Temperature [$^\circ$C]:	21.6	Humidity [%]:	57.0

Equivalent absorption Area A_T

Frequency	A_T	T_1	T_2			
Hz	m^2	s	s			
100	1.8	5.30	4.17			
125	2.2	4.57	3.55			
160	2.5	3.57	2.84			
200	4.3	3.71	2.56			
250	4.3	3.98	2.68			
315	4.3	4.34	2.85			
400	4.7	4.36	2.77			
500	4.5	4.68	2.93			
630	4.4	4.62	2.95			
800	4.5	4.67	2.94			
1000	4.3	4.52	2.92			
1250	4.3	4.35	2.85			
1600	4.3	4.13	2.76			
2000	4.9	3.76	2.47			
2500	5.5	3.34	2.20			
3150	6.5	2.98	1.94			
4000	7.1	2.47	1.67			
5000	7.9	1.98	1.39			

Test reference number: 1884-1543		Date: 16/09/2014

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BS EN ISO 354:2003

Acoustics - Measurement of absorption in a reverberation room

Client:	OCEE Design
	Design House
	Caswell Road, Brackmills
	Northampton, NN4 7PW

Object:	"Blazer"

Size:	Three panels 1483mm high x 1054mm wide x 52mm thick

Receiving room:

Volume:	220 m^3
Condition:	clean
Type:	large reverberation room
Location:	acoustic transmission suite

Sample out:	Temperature [^{o}C]:	21.6	Humidity [%]:	53.5
Sample in:	Temperature [^{o}C]:	21.6	Humidity [%]:	57.0

Equivalent absorption Area A$_T$

Frequency	A$_T$
Hz	m^2
100	1.8
125	2.2
160	2.5
200	4.3
250	4.3
315	4.3
400	4.7
500	4.5
630	4.4
800	4.5
1000	4.3
1250	4.3
1600	4.3
2000	4.9
2500	5.5
3150	6.5
4000	7.1
5000	7.9

Test reference number: 1884-1543   Date: 16/09/2014

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Acoustics - Measurement of absorption in a reverberation room

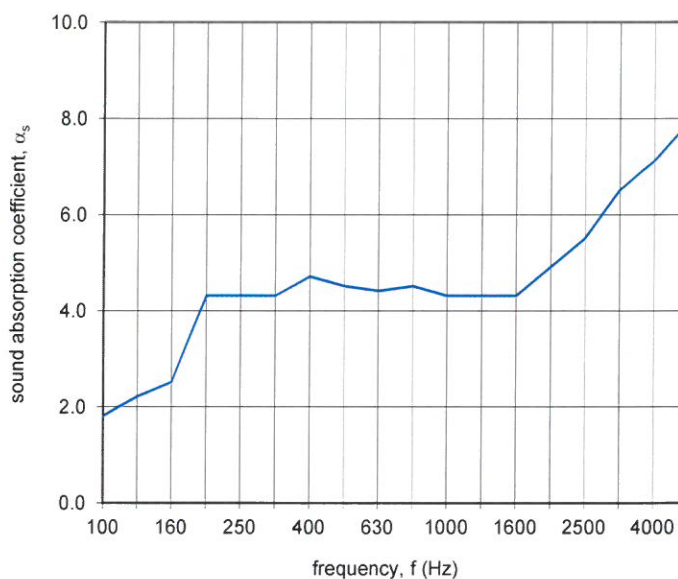|	
Client:	OCEE Design Design House Caswell Road, Brackmills Northampton, NN4 7PW
Object:	"Blazer Quilt"
Size:	Three panels 1480mm high x 1045mm wide x 55mm thick

Receiving room:

Volume:	220 m^3
Condition:	clean
Type:	large reverberation room
Location:	acoustic transmission suite

Sample out:	Temperature [$^\circ$C]:	21.6	Humidity [%]:	53.5
Sample in:	Temperature [$^\circ$C]:	21.8	Humidity [%]:	56.4

Equivalent absorption Area A$_T$

Frequency	A$_T$	T$_1$	T$_2$			
Hz	m^2	s	s			
100	2.1	5.30	4.04			
125	2.1	4.57	3.59			
160	2.9	3.57	2.76			
200	4.6	3.71	2.52			
250	4.4	3.98	2.66			
315	4.6	4.34	2.78			
400	5.6	4.36	2.59			
500	5.2	4.68	2.77			
630	5.0	4.62	2.80			
800	5.2	4.67	2.76			
1000	5.7	4.52	2.62			
1250	5.9	4.35	2.53			
1600	6.6	4.13	2.34			
2000	7.2	3.76	2.13			
2500	7.9	3.34	1.92			
3150	8.8	2.98	1.72			
4000	9.2	2.47	1.52			
5000	9.3	1.98	1.32			

Test reference number: 1884-1544   Date: 16/09/2014

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BS EN ISO 354:2003

Acoustics - Measurement of absorption in a reverberation room

Client:	OCEE Design
	Design House
	Caswell Road, Brackmills
	Northampton, NN4 7PW

Object:	"Blazer Quilt"

Size:	Three panels 1480mm high x 1045mm wide x 55mm thick

Receiving room:

Volume:	220 m^3
Condition:	clean
Type:	large reverberation room
Location:	acoustic transmission suite

Sample out:	Temperature [^{o}C]:	21.6	Humidity [%]:	53.5
Sample in:	Temperature [^{o}C]:	21.8	Humidity [%]:	56.4

Equivalent absorption Area A_T

Frequency	A_T
Hz	m^2
100	2.1
125	2.1
160	2.9
200	4.6
250	4.4
315	4.6
400	5.6
500	5.2
630	5.0
800	5.2
1000	5.7
1250	5.9
1600	6.6
2000	7.2
2500	7.9
3150	8.8
4000	9.2
5000	9.3

Test reference number: 1884-1544

Date: 16/09/2014

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