Technical Report
C/24074/T01

Project

The Laboratory Measurement of Sound Absorption of Panels

Prepared for

Ocee Design

By

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Quality Assurance

Project Title	The Laboratory Measurement of Sound Absorption of Panels
Client	Ocee Design
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Report Number	C/24074/T01

0444

Summary

Tests have been done in SRL's Laboratory at Holbrook House, Sudbury, Suffolk, to determine the sound absorption of panels in accordance with BS EN ISO 354:2003.

From these measurements the required results have been derived and are presented in both tabular and graphic form in Data Sheets 1 to 4.

The results are given in 1/3rd octave bands over the frequency range 50Hz to 10kHz, which is beyond that required by the test standard. Measurements outside the standard frequency range are not UKAS accredited.

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Contents

1.0 Details of Measurements

1.1 Location

Sound Research Laboratories

Holbrook House

Little Waldingfield

Sudbury

Suffolk

CO10 0TF

1.2 Test Date

29/06/2018

1.3 Tester

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1.4 Instrumentation and Apparatus Used

Make	Description	Type
E D I	Microphone Multiplexer	
	Microphone Power Supply Unit	
Norwegian Electronics	Real Time Analyser	830
Brüel & Kjaer	Windshields	UA0237
	Pre Amplifiers	2669C
	Microphone Calibrator	4231

	Omnipower Sound Source	4296
Larson Davis	12mm Condenser Microphone	2560, 377A60
Oregon Scientific	Temperature & Humidity & Probe	THGR810
TOA	Graphic Equalizer	E-1231
QSC Audio	Power Amplifier	RMX 1450
G.R.A.S	Pre Amplifier	26AK

1.5 References

BS EN ISO 11654:1997	Sound absorbers for use in buildings. Rating of sound absorption.
ATSM C423-01	Sound Absorption and sound Absorption Coefficients by the Reverberation Room Method
BS EN ISO 354:2003	Measurement of sound absorption in a reverberation room

2.0 Description of Test

2.1 Description of Sample

Various panels tested, see section 3 and Data Sheets for more information.

Sampling plan:	Enough for test only
Sample condition:	New
Details supplied by:	Ocee
Sample installed by:	SRL & Ocee

2.2 Sample Delivery date

28/06/2018

2.3 Test Procedures

The sample was mounted/located and tested in accordance with the relevant standard. The method and procedure is described in Appendix A. The measurement uncertainty is given in Appendix B. The mounting method used is described in Appendix C.

3.0 Results

The results of the measurements and subsequent analysis are given in Data Sheets 1 to 4 and summarised below.

Results relate only to the items tested.

SRL Test No.	Description in Brief	α_w
2	Ocee 100mm Acoustic panel in Cara	1.00
3	Ocee 65mm Acoustic panel in Kvadrat	1.00
4	Ocee 65mm Acoustic panel in Cara	1.00
5	Ocee 100mm Acoustic panel in Blazer Lite	1.00

0444

Data Sheet 1

See SRL report C/24074/T01 for full details

The Laboratory Measurement of Random Incidence Sound Absorption to BS EN ISO 354:2003

Client: Ocee Design

Test Date: 29/06/2018

Empty Room:	**Temperature:**	20.7	°C	**Humidity:**	58	%RH	**Pressure:**	1016 mbar
Room with Sample:	**Temperature:**	20.7	°C	**Humidity:**	57	%RH	**Pressure:**	1016 mbar

Sample Description: Ocee 100mm Acoustic panel in Cara

Mounting Method: A

Sample Area: 13.1 m^2

Chamber Volume: 300 m^3

	Test 2			
Freq Hz	T1 sec	T2 sec	Absorp Coeff α_s	Practical Absorp Coeff #
*50**	*5.69*	*4.99*	*0.09*	
*63**	*6.32*	*5.49*	*0.09*	*n/a*
*80**	*10.21*	*7.88*	*0.11*	
100	7.18	5.42	0.17	
125	7.94	5.11	0.26	0.25
160	7.27	4.12	0.39	
200	7.46	3.56	0.54	
250	8.07	2.90	0.81	0.80
315	7.83	2.51	1.00	
400	7.21	2.21	1.16	
500	6.62	2.09	1.21	1.00
630	5.68	2.15	1.07	
800	5.73	2.08	1.13	
1000	6.40	2.17	1.12	1.00
1250	6.18	2.11	1.15	
1600	5.63	2.16	1.05	
2000	5.13	2.07	1.06	1.00
2500	4.59	1.97	1.07	
3150	3.87	1.85	1.04	
4000	3.16	1.64	1.07	1.00
5000	2.53	1.46	1.06	
*6300**	*1.78*	*1.17*	*1.06*	
*8000**	*1.50*	*1.03*	*1.09*	*n/a*
*10000**	*1.05*	*0.80*	*1.05*	

α_w 1.00

Class A

Calculated to EN ISO 11654:1997

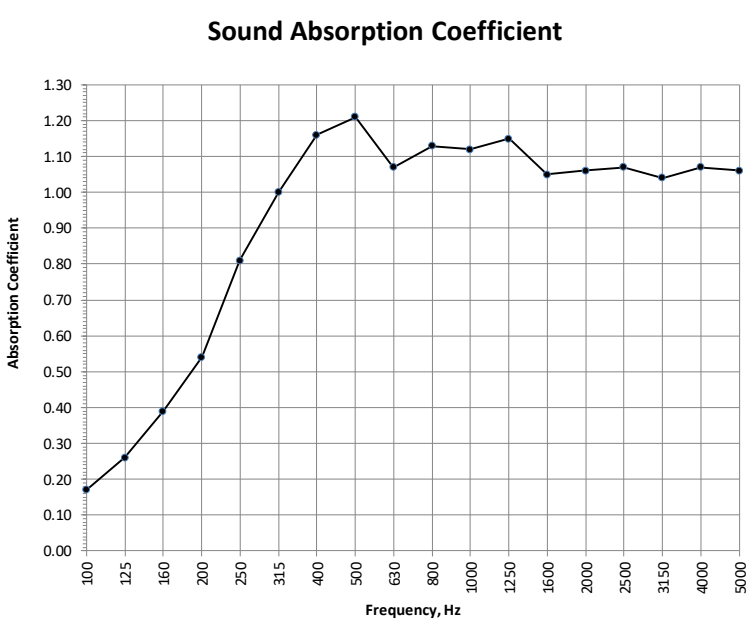
NRC 1.05

Calculated to ASTM C 423-01

** Denotes frequencies outside the range covered by BS EN ISO 354:2003*

T1, empty room reverberation time

T2, room reverberation time with sample



Practical absorption coefficient, BS EN ISO 11654:1997

v5

0444

Data Sheet 2

See SRL report C/24074/T01 for full details

The Laboratory Measurement of Random Incidence Sound Absorption to BS EN ISO 354:2003

Client:	Ocee Design								
Test Date:	29/06/2018								
Empty Room:		**Temperature:**	20.7	°C	**Humidity:**	58	%RH	**Pressure:**	1016 mbar
Room with Sample:		**Temperature:**	20.8	°C	**Humidity:**	57	%RH	**Pressure:**	1015 mbar
Sample Description:	Ocee 65mm Acoustic Panel in Kvadrat								

Mounting Method: A

Sample Area: 13.1 m^2

Chamber Volume: 300 m^3

	Test 3			
Freq Hz	**T1 sec**	**T2 sec**	**Absorp Coeff α_s**	**Practical Absorp Coeff #**
*50**	*5.69*	*5.08*	*0.08*	
*63**	*6.32*	*5.72*	*0.06*	*n/a*
*80**	*10.21*	*8.11*	*0.09*	
100	7.18	5.67	0.14	
125	7.94	5.23	0.24	0.25
160	7.27	4.18	0.37	
200	7.46	3.28	0.63	
250	8.07	2.65	0.93	0.85
315	7.83	2.48	1.02	
400	7.21	2.22	1.15	
500	6.62	2.12	1.18	1.00
630	5.68	2.25	0.99	
800	5.73	2.21	1.02	
1000	6.40	2.31	1.02	1.00
1250	6.18	2.29	1.01	
1600	5.63	2.22	1.01	
2000	5.13	2.17	0.98	1.00
2500	4.59	2.09	0.96	
3150	3.87	1.94	0.94	
4000	3.16	1.71	0.98	0.95
5000	2.53	1.52	0.96	
*6300**	*1.78*	*1.22*	*0.94*	
*8000**	*1.50*	*1.06*	*1.00*	*n/a*
*10000**	*1.05*	*0.82*	*0.95*	

α_w 1.00

Class A

Calculated to EN ISO 11654:1997

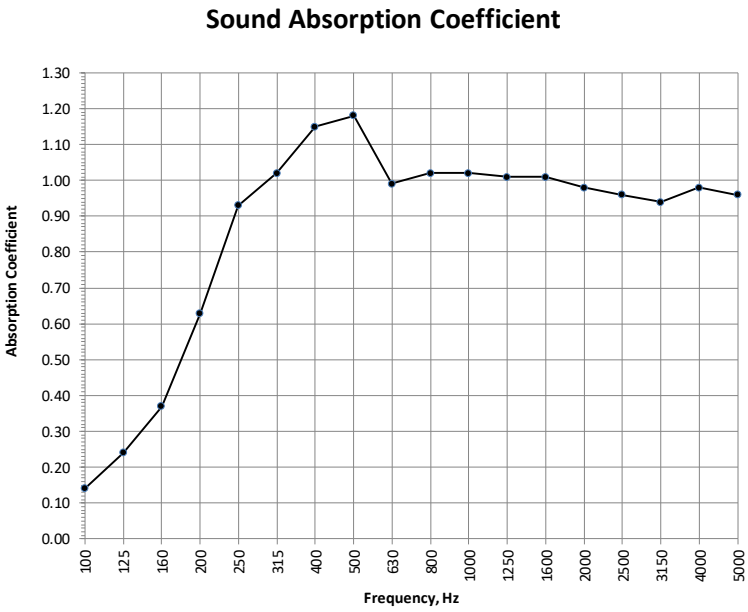
NRC 1.05

Calculated to ASTM C 423-01

** Denotes frequencies outside the range covered by BS EN ISO 354:2003*

T1, empty room reverberation time

T2, room reverberation time with sample



Practical absorption coefficient, BS EN ISO 11654:1997

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Data Sheet 3

See SRL report C/24074/T01 for full details

The Laboratory Measurement of Random Incidence Sound Absorption to BS EN ISO 354:2003

Client: Ocee Design

Test Date: 29/06/2018

Empty Room:	**Temperature:**	20.7	°C	**Humidity:**	58	%RH	**Pressure:**	1016	mbar
Room with Sample:	**Temperature:**	20.8	°C	**Humidity:**	57	%RH	**Pressure:**	1015	mbar

Sample Description: Ocee 65mm Acoustic Panel in Cara

Mounting Method: A

Sample Area: 13.1 m²

Chamber Volume: 300 m³

	Test 4			
Freq Hz	T1 sec	T2 sec	Absorp Coeff α_s	Practical Absorp Coeff #
*50**	*5.69*	*5.16*	*0.07*	
*63**	*6.32*	*5.64*	*0.07*	*n/a*
*80**	*10.21*	*8.26*	*0.09*	
100	7.18	5.80	0.12	
125	7.94	5.55	0.20	0.20
160	7.27	4.48	0.32	
200	7.46	3.81	0.47	
250	8.07	3.06	0.75	0.70
315	7.83	2.71	0.89	
400	7.21	2.32	1.08	
500	6.62	2.11	1.19	1.00
630	5.68	2.15	1.07	
800	5.73	2.17	1.06	
1000	6.40	2.20	1.10	1.00
1250	6.18	2.21	1.07	
1600	5.63	2.15	1.06	
2000	5.13	2.13	1.01	1.00
2500	4.59	2.02	1.02	
3150	3.87	1.79	1.10	
4000	3.16	1.62	1.10	1.00
5000	2.53	1.43	1.11	
*6300**	*1.78*	*1.18*	*1.04*	
*8000**	*1.50*	*1.01*	*1.17*	*n/a*
*10000**	*1.05*	*0.80*	*1.06*	

α_w 1.00

Class A

Calculated to EN ISO 11654:1997

NRC 1.00

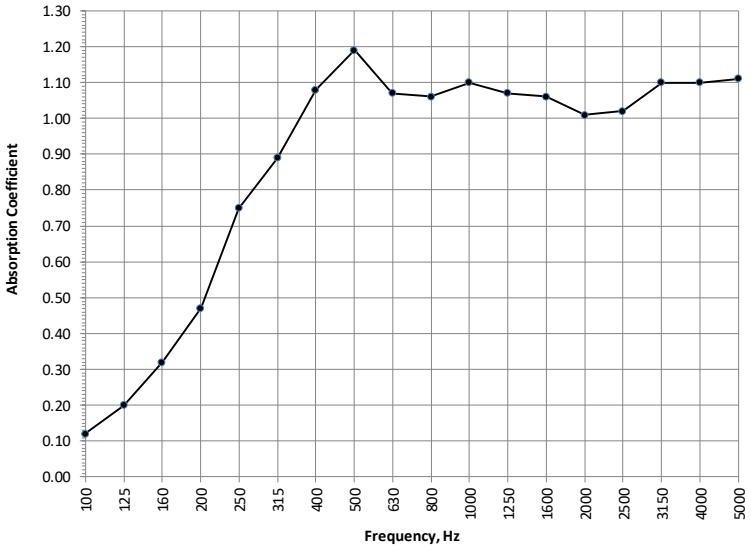
Calculated to ASTM C 423-01

** Denotes frequencies outside the range covered by BS EN ISO 354:2003*

T1, empty room reverberation time

T2, room reverberation time with sample

Sound Absorption Coefficient



Practical absorption coefficient, BS EN ISO 11654:1997

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Data Sheet 4

See SRL report C/24074/T01 for full details

The Laboratory Measurement of Random Incidence Sound Absorption to BS EN ISO 354:2003

Client: Ocee Design

Test Date: 29/06/2018

Empty Room:	**Temperature:**	20.7	°C	**Humidity:**	58	%RH	**Pressure:**	1016 mbar
Room with Sample:	**Temperature:**	20.9	°C	**Humidity:**	57	%RH	**Pressure:**	1015 mbar

Sample Description: Ocee 100mm Acoustic Panel in Blazer Lite

Mounting Method: A

Sample Area: 13.1 m²

Chamber Volume: 300 m³

	Test 5			
Freq Hz	T1 sec	T2 sec	Absorp Coeff α_s	Practical Absorp Coeff #
*50**	*5.69*	*5.11*	*0.07*	
*63**	*6.32*	*5.25*	*0.12*	*n/a*
*80**	*10.21*	*7.32*	*0.14*	
100	7.18	5.34	0.18	
125	7.94	4.87	0.29	0.30
160	7.27	3.84	0.45	
200	7.46	3.17	0.67	
250	8.07	2.68	0.92	0.85
315	7.83	2.49	1.01	
400	7.21	2.23	1.14	
500	6.62	2.04	1.25	1.00
630	5.68	2.09	1.11	
800	5.73	2.08	1.13	
1000	6.40	2.16	1.13	1.00
1250	6.18	2.17	1.10	
1600	5.63	2.09	1.11	
2000	5.13	2.07	1.06	1.00
2500	4.59	1.95	1.09	
3150	3.87	1.79	1.10	
4000	3.16	1.62	1.10	1.00
5000	2.53	1.45	1.08	
*6300**	*1.78*	*1.19*	*1.02*	
*8000**	*1.50*	*1.01*	*1.18*	*n/a*
*10000**	*1.05*	*0.79*	*1.13*	

α_w 1.00

Class A

Calculated to EN ISO 11654:1997

NRC 1.10

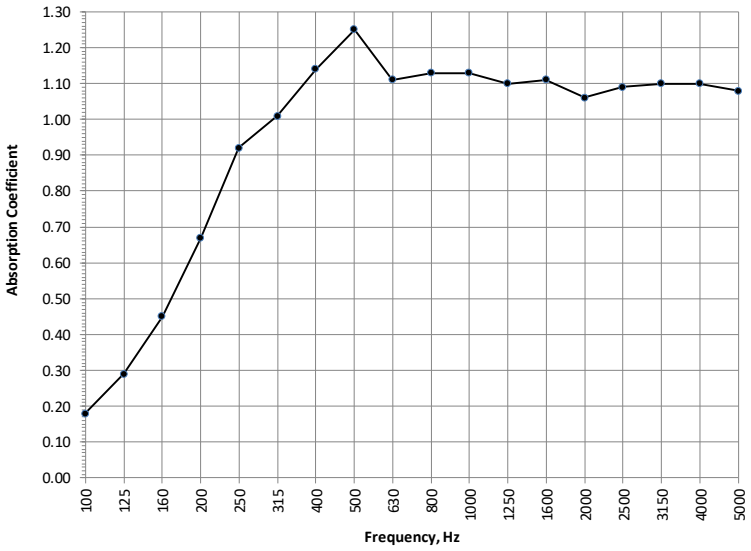
Calculated to ASTM C 423-01

** Denotes frequencies outside the range covered by BS EN ISO 354:2003*

T1, empty room reverberation time

T2, room reverberation time with sample

Sound Absorption Coefficient



Practical absorption coefficient, BS EN ISO 11654:1997

v5

Appendix A - Test Procedure

Measurements of Random Incidence Sound Absorption Coefficients to BS EN ISO 354:2003 - TP14 (Plane Absorbers)

In the laboratory, random incidence sound absorption coefficients are determined from the rate of decay of a sound field in a reverberation room, with and without a test sample installed. The rate of decay is described by the time a sound field takes to decay by 60dB, known as the reverberation time.

The reverberation room is constructed from 215mm brick, which is internally plastered with a reinforced concrete roof and floor. The reverberation room is rectangular, measuring 8.3 metres long, 6.7 metres wide and 5.4 metres high. The volume is 300m^3, the total surface area, 275m^2. From the ceiling hang 10 randomly positioned diffusers, with a total surface area (for one side) of 20m^2. The room is isolated from the surrounding structure by the use of resilient mountings and seals, ensuring good acoustic isolation.

Using at least two omnidirectional loudspeaker positions, broad band random noise is produced in the room using an electronic generator and power amplifier. When the amplification system is switched off, the decay of sound is filtered into one-third octave band widths and the reverberation times measured. This process is repeated for each of six microphone positions and the values arithmetically averaged to obtain a final value for each frequency.

The sample, which has an area between 10m^2 and 15.7m^2, is then laid over a pre-assembled laboratory test rig positioned on the floor of the reverberation room so that no part of it is closer than one metre from any edge of the boundaries. The test rig provides a space beneath the sample, the depth of which can be varied to simulate specific requirements such as the void above a suspended ceiling system. The procedure of measuring the reverberation times then repeated.

The sound absorption coefficients are calculated from the difference in decay rates for each frequency according to the formula:

$$\alpha_s = \frac{A_T}{S}$$

where

α_s is the random incidence absorption coefficient
A_T is the increase in equivalent sound absorption area of the test specimen (m^2)
S is the area covered by the test specimen (m^2)

The equivalent absorption area of the test specimen is further defined as:

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

where

V	is the volume of the empty reverberation room (m^3)
c_1	is the speed of sound in the empty room (m/sec)
T_1	is the reverberation time in the empty room (sec)
m_1	is the power attenuation coefficient calculated according to ISO 9613-1 using the climatic conditions that have been present in the empty room during the measurement.

c_2, T_2 and m_2 have the same meanings as c_1, T_1 and m_1 but with the test specimen in the room.

It is occasionally found that the absorption coefficient derived in this manner reaches a value greater than unity. This is impossible, by definition, and investigation has shown that this anomaly is due to diffraction of the impinging sound waves at the edges of the sample. In practical terms this is insignificant.

Appendix B - Measurement Uncertainty

BS EN ISO 354:2003 - TP14

1. Introduction

The estimated values of uncertainty are based on a standard uncertainty multiplied by a coverage factor of K = 2, which provides a level of confidence of approximately 95%.

Table 1: Uncertainty For Equivalent Absorption Area Measurement

Frequency, Hz	Expanded uncertainty K = 2, 95% % of A_1 or A_2
100	9.0
125	8.1
160	5.6
200	6.7
250	4.3
315	8.1
400	4.6
500	5.0
630	5.3
800	3.2
1000	3.5
1250	3.1
1600	2.8
2000	2.7
2500	2.2
3150	1.8
4000	1.6
5000	1.6

2. Estimation of Expanded Uncertainty For Sample Equivalent Sound Absorption Area

The expanded uncertainty, U_A, m^2 is estimated by using the following formulae:-

$$U_A = \sqrt{\left(\frac{uA_1}{100}\right)^2 + \left(\frac{uA_2}{100}\right)^2}$$

where

U_A is the expanded uncertainty for the sample equivalent sound absorption area, for K = 2, 95%, m^2

u is the estimated expanded uncertainty for the equivalent sound absorption area, taken from Table 1 above, K = 2, 95%, % of A_1 or A_2

A_1 is the equivalent sound absorption area of the empty room, m^2

A_2 is the equivalent sound absorption area of the room with the sample, m^2

3. Estimation of expanded Uncertainty For Sound Absorption Coefficients

The expanded uncertainty for sound absorption coefficients, U_{α_s} , is estimated using the following formulae:-

$$U_{\alpha_s} = \frac{\alpha_s U_A}{A}$$

where

U_{α_s} is the expanded uncertainty for sound absorption coefficients, K=2, 95%

α_s is the sound absorption coefficient

U_A is the expanded uncertainty for the sample equivalent sound absorption area, K=2, 95%, m^2

A is the sample equivalent sound absorption area, m^2

Appendix C – Mounting Method

Descriptions of Test Specimen Mountings for Sound Absorption Tests

BS EN ISO 354:2003 describes various test specimen mountings. The methods of mounting used for these tests are briefly described as follows:

Type A Mounting

Test specimen placed directly against a room surface. The specimen may be held in place with adhesive or mechanical fasteners providing there is no resulting air space between the specimen and room surface.

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