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UKAS TESTING
1262

TEST REPORT No : AT/03/16

DATE OF ISSUE : 29 April 2003

BRITISH STANDARD METHOD FOR MEASUREMENT OF SOUND ABSORPTION IN A REVERBERATION ROOM

BS EN 20354 : 1993

ISO 354 : 1985

CLIENT:

Armacell UK Limited
Mars Street
Oldham
OL9 6LY

JOB NUMBER:	A03/21
MANUFACTURER:	Armacell UK Limited
MODEL:	Foam absorber - various
DATE RECEIVED:	28 April 2003
DATE OF TEST:	28 April 2003

Signed: .....
E Shanks
Assistant Laboratory Manager

Approved: .....
G Kerry
Technical Manager

School of Acoustics and Electronic Engineering
Head of School: D J Saunders BSc PhD CEng FIOA

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1 DESCRIPTION OF TEST PROCEDURE

1.1 Description of Test Facility

The tests were carried out in the large ($225m^3$) reverberation chamber 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. In addition 11 plywood panels 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 and the sound was monitored at each of 6 microphone positions.

1.2 Test Procedure

The procedure followed that detailed in BS EN 20354: 1993 "Measurement of sound absorption in a reverberation room". 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 5 decays at each of 6 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 30dB is measured and doubled 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 ensemble 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.

1.3 Calculation

The random incidence sound absorption coefficients were determined from the measured data by means of the Sabine equation, in the form:

$$\alpha_s = \frac{0.16V}{Ss}\left(\frac{1}{T_{absorb}} - \frac{1}{T_{empty}}\right)$$

where α_s is the absorption coefficient of the sample

V is the room volume (m^3)

S_s is the area of the sample (m^2)

T_{absorb} is the measured reverberation time of the room with the sample in (secs)

T_{empty} is the measured empty room reverberation time (secs)

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

2 EQUIPMENT

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

3 TEST SAMPLES

Test ref. no.: AC/03/04/06

Single layer of 5mm thick Arma_sound (5mm thickness specified, 6mm thickness measured).

Test ref. no.: AC/03/04/07

First layer of 5mm thick Arma_sound (5mm thickness specified, 6mm thickness measured).

Second layer of 10mm thick Arma_sound (10mm thickness specified, 10.5mm thickness measured).

Test ref. no.: AC/03/04/08

First layer of 5mm thick Arma_sound (5mm thickness specified, 6mm thickness measured).

Second layer of 10mm thick Arma_sound (10mm thickness specified, 10.5mm thickness measured).

Third layer of 10mm thick Arma_sound (10mm thickness specified, 10.5mm thickness measured).

3 RESULTS

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

Reverberant Room Volume	225 m^3
Sample Size	See individual results sheets for details
Sample thickness	See individual results sheets for details
Temperature	See individual results sheets for details
Relative humidity	See individual results sheets for details

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

ISO 354:1985 / BS EN 20354:1993, Acoustics -

Measurement of absorption in a reverberation room

Client: Armacell UK Limited
Mars Street
Oldham
OL9 6LY

Object: Armacell UK Limited
5mm Arma_sound (6mm measured)

Size: 11.6 m²

Receiving room
Volume V = 225 m³
Condition: good
Type: Large reverberation room
Location: Acoustics transmission suite

Temperature [°C]: 20.5 Humidity [%]: 43.4

Sound absorption coefficient α_s

Frequency [Hz]	α_s	T1 [s]	T2 [s]				
100	0.00	7.51	7.54				
125	0.01	6.27	6.17				
160	0.01	6.04	5.94				
200	0.03	6.24	5.90				
250	0.02	5.97	5.72				
315	0.03	5.26	4.97				
400	0.06	5.53	5.04				
500	0.07	6.32	5.54				
630	0.09	6.54	5.47				
800	0.13	6.28	4.96				
1000	0.17	6.17	4.61				
1250	0.23	5.71	4.00				
1600	0.31	4.94	3.33				
2000	0.38	4.38	2.85				
2500	0.49	3.74	2.36				
3150	0.61	3.06	1.92				
4000	0.74	2.44	1.54				
5000	0.88	1.87	1.22				

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No. of test reference: AC/03/04/06 Salford, 28.04.2003

ISO 354:1985 / BS EN 20354:1993, Acoustics - Measurement of absorption in a reverberation room

Object:

Armacell UK Limited

5mm Arma_sound (6mm measured)

Description of the specimen:

5mm Arma_sound (6mm measured)

Date of test: 28/04/03

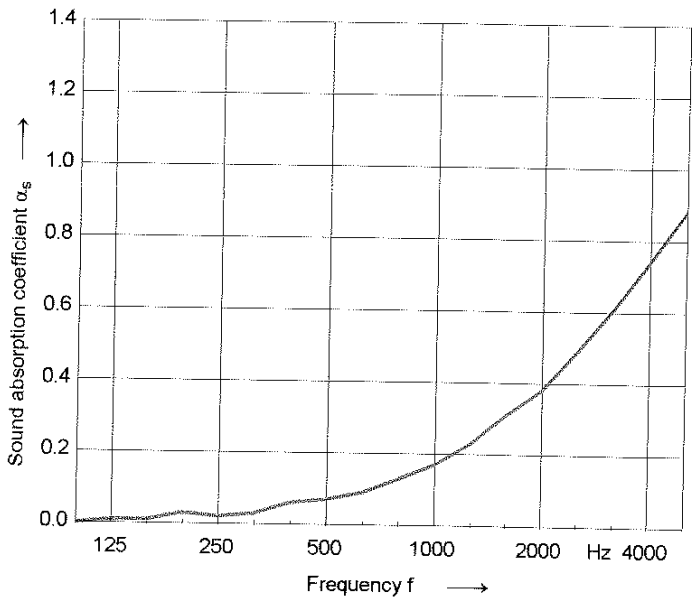
Size: 11.6 m²

Reverberation Room Volume: 225 m³

Temperature [°C]: 20.5

Humidity [%]: 43.4

Frequency [Hz]	α_s
100	0.00
125	0.01
160	0.01
200	0.03
250	0.02
315	0.03
400	0.06
500	0.07
630	0.09
800	0.13
1000	0.17
1250	0.23
1600	0.31
2000	0.38
2500	0.49
3150	0.61
4000	0.74
5000	0.88



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No. of test reference: AC/03/04/06

Client: Armacell UK Limited, Mars Street

Salford, 28.04.2003

Signature:

ISO 354:1985 / BS EN 20354:1993, Acoustics -

Measurement of absorption in a reverberation room

Client: Armacell UK Limited
Mars Street
Oldham
OL9 6LY

Object: Armacell UK Limited
10mm + 5mm (specified) Arma_sound

Size: 11.6 m²

Receiving room
Volume V = 225 m³
Condition: good
Type: Large reverberation room
Location: Acoustics transmission suite

Temperature [°C]: 20.7 Humidity [%]: 44

Sound absorption coefficient α_s

Frequency [Hz]	α_s	T1 [s]	T2 [s]				
100	0.02	7.51	7.15				
125	0.04	6.27	5.83				
160	0.04	6.04	5.59				
200	0.08	6.24	5.39				
250	0.10	5.97	5.00				
315	0.16	5.26	4.16				
400	0.26	5.53	3.77				
500	0.36	6.32	3.64				
630	0.51	6.54	3.15				
800	0.67	6.28	2.68				
1000	0.79	6.17	2.41				
1250	0.93	5.71	2.11				
1600	1.03	4.94	1.88				
2000	1.06	4.38	1.77				
2500	1.00	3.74	1.70				
3150	0.94	3.06	1.59				
4000	0.88	2.44	1.45				
5000	0.84	1.87	1.25				

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No. of test reference: AC/03/04/07 Salford, 28.04.2003

ISO 354:1985 / BS EN 20354:1993, Acoustics - Measurement of absorption in a reverberation room

Object:

Armacell UK Limited

10mm + 5mm (specified) Arma_sound

Description of the specimen:

5mm + 10mm (specified) Arma_sound.

(6mm & 10.5mm measured)

Date of test: 28/04/03

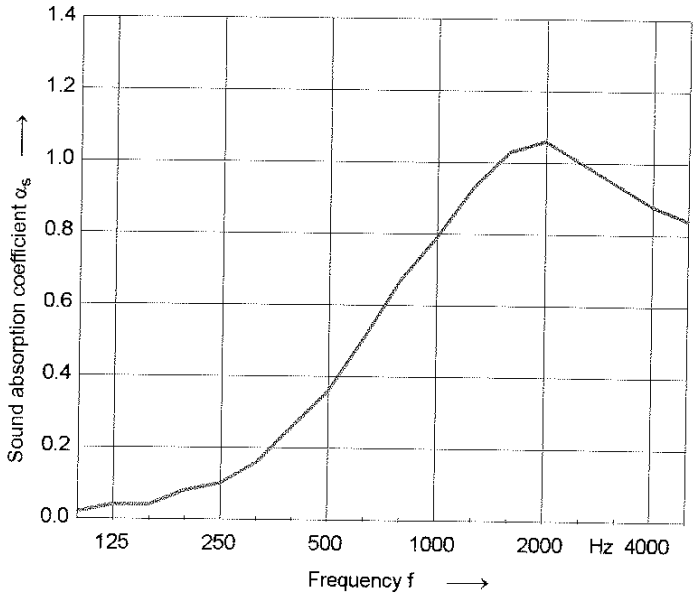
Size: 11.6 m²

Reverberation Room Volume: 225 m³

Temperature [°C]: 20.7

Humidity [%]: 44

Frequency [Hz]	α_s
100	0.02
125	0.04
160	0.04
200	0.08
250	0.10
315	0.16
400	0.26
500	0.36
630	0.51
800	0.67
1000	0.79
1250	0.93
1600	1.03
2000	1.06
2500	1.00
3150	0.94
4000	0.88
5000	0.84



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No. of test reference: AC/03/04/07

Client: Armacell UK Limited, Mars Street

Salford, 28.04.2003

Signature:

ISO 354:1985 / BS EN 20354:1993, Acoustics -

Measurement of absorption in a reverberation room

Client: Armacell UK Limited
Mars Street
Oldham
OL9 6LY

Object: Armacell UK Limited
10mm + 10mm + 5mm (specified) Arma_sound

Size: 12 m²

Receiving room
Volume V = 225 m³
Condition: good
Type: Large reverberation room
Location: Acoustics transmission suite

Temperature [°C]: 23.2 Humidity [%]: 42.6

Sound absorption coefficient α_s

Frequency [Hz]	α_s	T1 [s]	T2 [s]				
100	0.05	7.51	6.67				
125	0.10	6.27	5.21				
160	0.12	6.04	4.90				
200	0.19	6.24	4.45				
250	0.26	5.97	3.94				
315	0.39	5.26	3.11				
400	0.60	5.53	2.62				
500	0.77	6.32	2.41				
630	0.95	6.54	2.14				
800	1.04	6.28	1.98				
1000	1.04	6.17	1.97				
1250	1.00	5.71	1.97				
1600	0.96	4.94	1.92				
2000	0.95	4.38	1.84				
2500	0.91	3.74	1.75				
3150	0.93	3.06	1.57				
4000	0.94	2.44	1.39				
5000	0.84	1.87	1.23				

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No. of test reference: AC/03/04/08 Salford, 28.04.2003

ISO 354:1985 / BS EN 20354:1993, Acoustics - Measurement of absorption in a reverberation room

Object:

Armacell UK Limited

10mm + 10mm + 5mm (specified) Arma_sound

Description of the specimen:

5mm + 10mm + 10mm (specified) Arma_sound.

(6mm + 10.5mm +10.5mm measured)

Date of test: 28/04/03

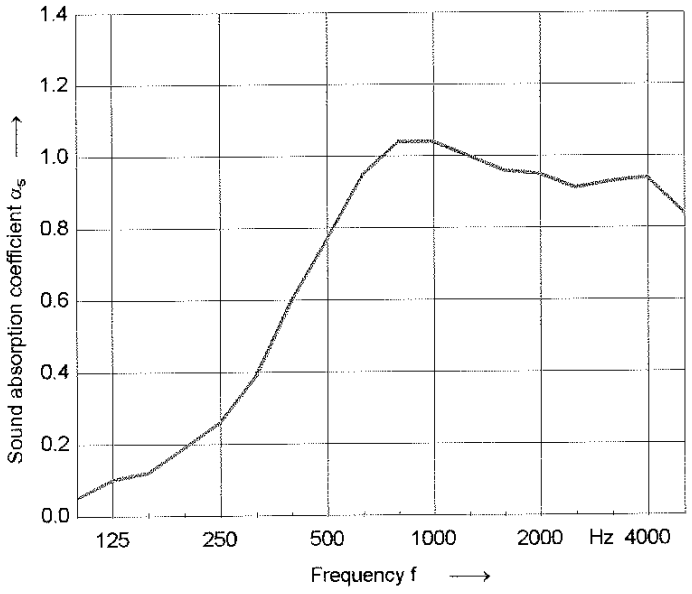
Size: 12 m²

Reverberation Room Volume: 225 m³

Temperature [°C]: 23.2

Humidity [%]: 42.6

Frequency [Hz]	α_s
100	0.05
125	0.10
160	0.12
200	0.19
250	0.26
315	0.39
400	0.60
500	0.77
630	0.95
800	1.04
1000	1.04
1250	1.00
1600	0.96
2000	0.95
2500	0.91
3150	0.93
4000	0.94
5000	0.84



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No. of test reference: AC/03/04/08

Client: Armacell UK Limited, Mars Street

Salford, 28.04.2003

Signature: