



## **Laboratory for Acoustics**



*Determination of the sound absorption  
(reverberation room method) of vinyl  
wallcovering, manufacturer Vescom*



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*Determination of the sound absorption (reverberation room method) of vinyl wallcovering, manufacturer Vescom*

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Report number	A 3233-1E-RA-001
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Reference	TS/TS/KS/A 3233-1E-RA-001
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All orders are accepted and executed according to 'De Nieuwe Regeling 2011' (The New Rules)

BTW NL004933837B01 KvK: 12028033

mook – zoetermeer – groningen – düsseldorf – dortmund – berlijn – leuven – parijs – lyon – sevilla

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## 1 Introduction

At the request of Vescom bv based in Deurne (The Netherlands), laboratory measurements of the sound absorption (reverberation room method) were carried out on:

**vinyl wallcovering, manufacturer Vescom**

in the Laboratory for Acoustics of Peutz bv, at Mook, the Netherlands (see figure 1).



For these type of measurements the Laboratory for Acoustics has been accredited by the Dutch Accreditation Council (RvA).

The RvA is member of the EA MLA (**EA MLA: European Accreditation Organisation MultiLateral Agreement**: <http://www.european-accreditation.org>).

*EA: "Certificates and reports issued by bodies accredited by MLA and MRA members are considered to have the same degree of credibility, and are accepted in MLA and MRA countries."*

## 2 Standards and guidelines

The measurements have been carried out according to the Quality Manual of the Laboratory for Acoustics as well as:

ISO 354:2003<sup>1</sup> Acoustics Measurement of sound absorption in a reverberation room  
NOTE: this international standard has been accepted within all EU-countries as European standard EN ISO 354:2003

Various other related norms:

EN ISO 11654:1997 Acoustics Sound absorbers for use in buildings Rating of sound absorption

ASTM C423-09a Standard Test Method for Sound Absorption and Sound Absorption Coefficients by the Reverberation Room Method

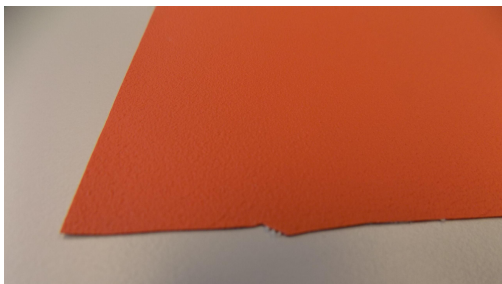

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<sup>1</sup> According to this norm, the report should include for each measurement the mean reverberation times  $T_1$  and  $T_2$  at each frequency. Because these figures are not relevant for judging the quality of the product being tested, but merely for judging the accuracy of the calculations, they have been omitted in this report. It is possible of course to reproduce those figures at any time if the principal requests this.

### 3 Tested construction

The data presented here have been received from the principal or obtained by own observations.

The measurements have been carried out on the following materials.

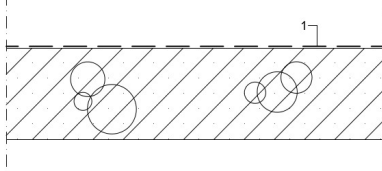
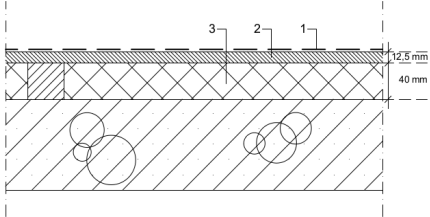
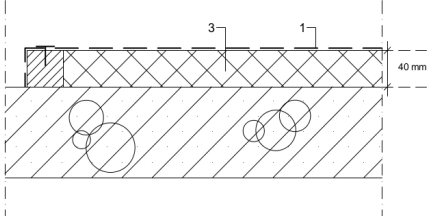
<b>Wallcovering 001</b>	
manufacturer:	Vescom
type:	Nero
view side:	Vinyl
	weight 354 gr/m <sup>2</sup>
	thickness 0,5 mm
backing:	none
	
<b>Wallcovering 002</b>	
manufacturer:	Vescom
type:	Color Choice
view side:	Vinyl
	weight 419 gr/m <sup>2</sup>
	thickness 0,5 mm
backing:	none
	

*The results as presented here relate only to the tested items and laboratory conditions as described in this report. The laboratory can make no judgement about the representativity of the tested samples. The test report ahead is valid as long as the tested constructions and/or materials are unchanged.*

## 4 Measurements

The wall coverings to be tested (see description in chapter 3) is measured at the following mounting conditions:

1. direct on the concrete floor of the reverberation room;
2. on a 12,5 mm thick (closed) gypsum board panel. The gypsum panels including the wall covering is mounted with a cavity of 40 mm behind it. The cavity is filled with mineral wool;
3. The test specimen is mounted with an air space of 40 mm behind it. he cavity is filled with mineral wool.

<p><b>Measurement set-up 1</b> 1: Vinyl wall covering</p>	
<p><b>Measurement set-up 2</b> 1: Vinyl wall covering 2: Gypsum plasterboard, t = 12,5 mm 3: Mineral wool</p>	
<p><b>Measurement set-up 3</b> 1: Vinyl wall covering 3: Mineral wool</p>	

The perimeter edges of the test specimen are covered with an acoustical reflective frame, the facing side of the panels was up. The measurement setups are according to type B and E mounting, as described in annex B of the ISO 354:2003 (Test specimen mountings for sound absorption tests).

## 4.1 Method

The tests were conducted in accordance with the provisions of the test method ISO 354 in the reverberation room of "Peutz bv" in Mook (the Netherlands) (see figure 1). The relevant data regarding the reverberation room are given in figure 2 of this report.

By means of reverberation measurements the reverberation time of the room is measured under two conditions:

- when the reverberation room is empty
- when the construction under test is inside the reverberation room

In general, once material is placed into the reverberation room a lower reverberation time will result.

The difference in reverberation times is a measure of the amount of absorption brought into the room.

Measurements and calculations were carried out in 1/3-octave bandwidth from 100 to 5000 Hz, according to the norms. Where applicable the octave values have been calculated from these 1/3-octave values.

From the reverberation measurements in the empty reverberation room the equivalent sound absorption  $A_1$  is calculated (per frequency band) according to formula 1 and expressed in  $m^2$

$$A_1 = \frac{55,3 V}{c T_1} - 4 V m_1 \quad (1)$$

in which:

- $V$  = the volume of the reverberation room [m<sup>3</sup>]  
 $T_1$  = the reverberation time in the empty reverberation room [sec.]  
 $m_1$  = "power attenuation coefficient" in the empty room, calculated according to formula [m<sup>-1</sup>]  
 $c$  = the speed of sound in the air, in m/s, calculated according to [m/s]

$$c = 331 + 0,6 t \quad (2)$$

in which:

- $t$  = the temperature; this formula is valid for temperatures between 15 and 30 °C [°C]

$$m = \frac{\alpha}{10 \log(e)} \quad (3)$$

in which:

- $\alpha$  = "attenuation coefficient" according to ISO 9613-1



In the same manner the equivalent sound absorption  $A_2$  for the room with the test specimen is calculated according to formula 4, also expressed in  $m^2$

$$A_2 = \frac{55,3V}{cT_2} - 4Vm_2 \quad (4)$$

in which:

$c$  and  $V$  have the same definition as in formula 1 and

$T_2$  = the reverberation time of the reverberation room with the test specimen placed inside [sec]

$m_2$  = "power attenuation coefficient" in the room with the test specimen placed inside, calculated according to formula 3 [m<sup>-1</sup>]

The equivalent sound absorption  $A$  of the test specimen has been calculated according to formula 5 and is expressed in  $m^2$

$$A = A_2 - A_1 \quad (5)$$

When the test specimen consists of one plane with an area between 10 and 12  $m^2$  the sound absorption coefficient  $\alpha_s$  has to be calculated according to formula 6:

$$\alpha = \frac{A}{S} \quad (6)$$

in which:

$S$  = the area of the test specimen [m<sup>2</sup>]

## 4.2 Accuracy

The accuracy of the sound absorption as calculated can be expressed in terms of repeatability (tests within one laboratory) and reproducibility (between various laboratories).

When:

- two tests are performed on identical test material
- within a short period of time
- by the same person or team
- using the same instrumentation
- under unchanged environmental conditions

the probability will be 95% that the difference between the two test results will be less than or equal to  $r$ .

In order to evaluate the repeatability  $r$  for the sound absorption measurements performed in the reverberation room of "Peutz bv" in Mook (the Netherlands) eight series of measurements have been carried out according to ISO 354:1985 annex C. From the results of those measurements the repeatability  $r$  has been calculated. It was found that for the frequency range from 100 to 200 Hz and at 5000 Hz the repeatability  $r$  is 0,21 as a maximum. For the frequency range 250 to 4000 Hz the repeatability  $r$  is 0,09 as a maximum.

### 4.3 Environmental conditions during the measurements

#### t4.1 *Environmental conditions during the measurements at December 12th, 2016*

<b>reverberation room</b>	<b>temperature</b> [°C]	<b>barometric pressure</b> [kPa]	<b>relative humidity</b> [%]
empty	17,1	102,8	53
occupied	17,2-17,6	102,7-102,8	51-53

### 4.4 Results

The results of the measurements are given in table 4.2, 4.3 and in figure 3 to 8. The measurements were made in 1/3-octave bands. The results presented in octave-bands are the arithmetic average of the results of the three 1/3-octave bands belonging to that octaveband. From those values the following one-figure ratings have been calculated and stated :

- the "weighted sound absorption coefficient  $a_w$ " according to ISO 11654;
- the "Noise Reduction Coefficient NRC" according to ASTM-C423, being the average of the absorption coefficients (1/3 octave values) at the frequencies of 250, 500, 1000 and 2000 Hz, rounded to the nearest 0,05;
- the "Sound Absorption Average SAA" according to ASTM-C423, being the average of the absorption coefficients (1/3 octave values) at the frequencies of 200 Hz up to 2500 Hz, rounded to the nearest 0,01.

t4.2 measurement results Vinyl Wall covering

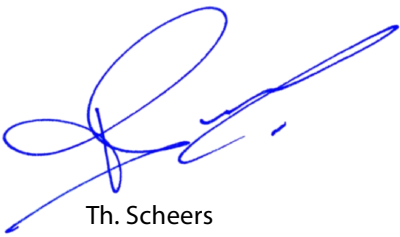
sound absorption coefficient $\alpha_s$				
prod nr.	001		002	
	direct at the concrete floor		direct at the concrete floor	
mounting				
cavity	none		none	
total height	1 mm		1 mm	
record nr.	#110		#111	
figure	3		4	
frequency [Hz]	1/3 oct.	1/1 oct.	1/3 oct.	1/1 oct.
100	-0,01		-0,01	
125	0,00	0,00	0,00	0,00
160	0,00		0,01	
200	0,00		0,01	
250	-0,01	0,00	0,00	0,00
315	0,00		0,00	
400	0,01		0,01	
500	0,01	0,01	0,01	0,01
630	0,01		0,01	
800	0,01		0,01	
1000	0,01	0,01	0,02	0,02
1250	0,02		0,04	
1600	0,03		0,06	
2000	0,04	0,05	0,09	0,08
2500	0,07		0,10	
3150	0,11		0,12	
4000	0,13	0,13	0,14	0,14
5000	0,15		0,17	
$\alpha_w$	0,05		0,05	
NRC	0,00		0,05	
SAA	0,02		0,03	

t4.3 measurement results Vinyl Wall covering

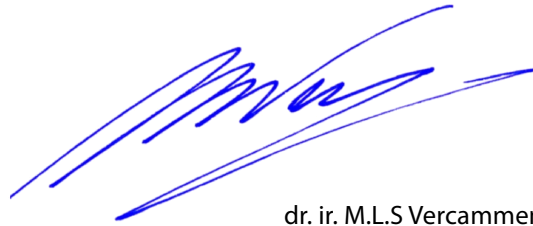
sound absorption coefficient $\alpha_s$									
prod nr.	001		002		001		002		figure
	at gypsum board + cavity filled with mineral wool		at gypsum board + cavity cavity filled with mineral wool		at 40 mm cavity filled with mineral wool		at 40 mm cavity filled with mineral wool		
mounting									
cavity	40 mm		40 mm		40 mm		40 mm		
total height	53 mm		53 mm		40 mm		40 mm		
record nr.	#222		#185		#259		#296		
figure	5		6		7		8		
frequency [Hz]	1/3 oct.	1/1 oct.	1/3 oct.	1/1 oct.	1/3 oct.	1/1 oct.	1/3 oct.	1/1 oct.	
100	0,44		0,50		0,06		0,04		
125	0,29	0,30	0,32	0,33	0,13	0,16	0,13	0,16	
160	0,16		0,16		0,29		0,32		
200	0,11		0,12		0,42		0,42		
250	0,09	0,09	0,09	0,09	0,68	0,66	0,70	0,68	
315	0,07		0,07		0,87		0,91		
400	0,07		0,06		0,99		0,99		
500	0,05	0,05	0,05	0,05	0,83	0,80	0,74	0,75	
630	0,04		0,04		0,59		0,51		
800	0,04		0,05		0,43		0,38		
1000	0,04	0,04	0,05	0,05	0,31	0,32	0,28	0,29	
1250	0,05		0,06		0,22		0,21		
1600	0,09		0,10		0,17		0,18		
2000	0,12	0,12	0,14	0,14	0,14	0,15	0,16	0,16	
2500	0,16		0,17		0,13		0,14		
3150	0,19		0,20		0,11		0,14		
4000	0,19	0,20	0,22	0,22	0,09	0,10	0,12	0,12	
5000	0,23		0,25		0,11		0,11		
$\alpha_w$	0,10		0,10		0,20(LM)		0,20(LM)		
NRC	0,10		0,10		0,50		0,45		
SAA	0,08		0,08		0,48		0,47		

The sound absorption coefficient of a material is not a material property. It should be taken into account that the sound absorption of a construction depends on the dimensions, the way of mounting of the material and its position in the room.

Mook,



Th. Scheers  
Laboratory Supervisor



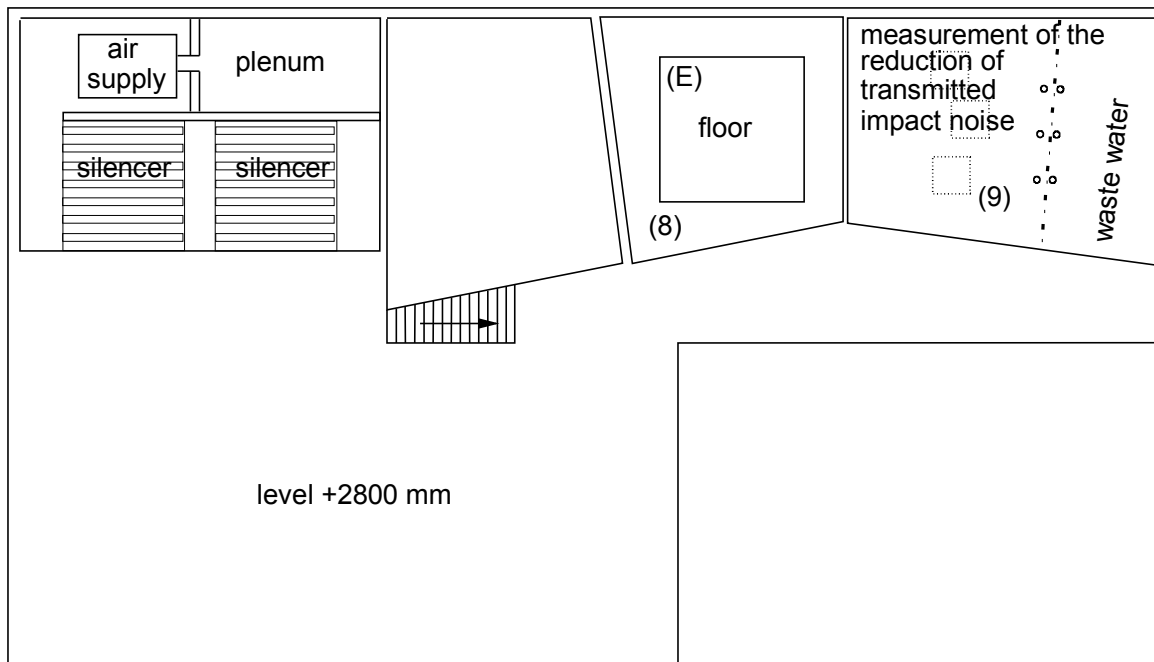
dr. ir. M.L.S Vercammen  
Manager

This report contains 13 pages and 8 figures.

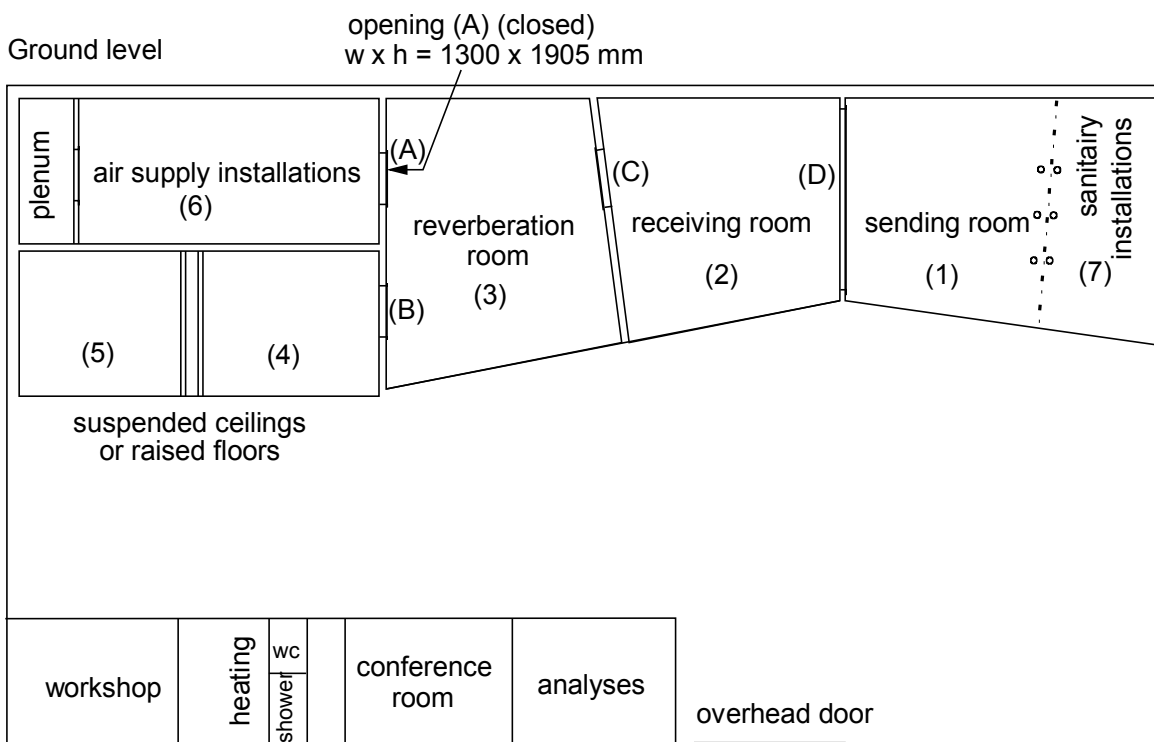
PEUTZ bv  
Lindenlaan 41, NL-6584 AC MOLENHOEK (LB), THE NETHERLANDS

OVERVIEW

Story

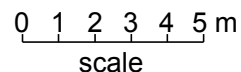


Ground level



TEST OPENINGS (w x h in mm)

- (B) 1000 x 2200
- (C) 1500 x 1250
- (D) 4300 x 2800
- (E) 4000 x 4000



PEUTZ bv  
Lindenlaan 41, 6584 AC MOLENHOEK (LB)

**REVERBERATION ROOM**

The reverberation room meets the requirements of ISO 354:2003.

additional data:

volume : 214 m<sup>3</sup>

total area S<sub>t</sub> (walls, floor and ceiling) : 219 m<sup>2</sup>

diffusion: by the shape of the room and by adding 6 curved and 2 flat reflecting elements with a total area of approx. 13 m<sup>2</sup> a sufficient diffusion has been gained.

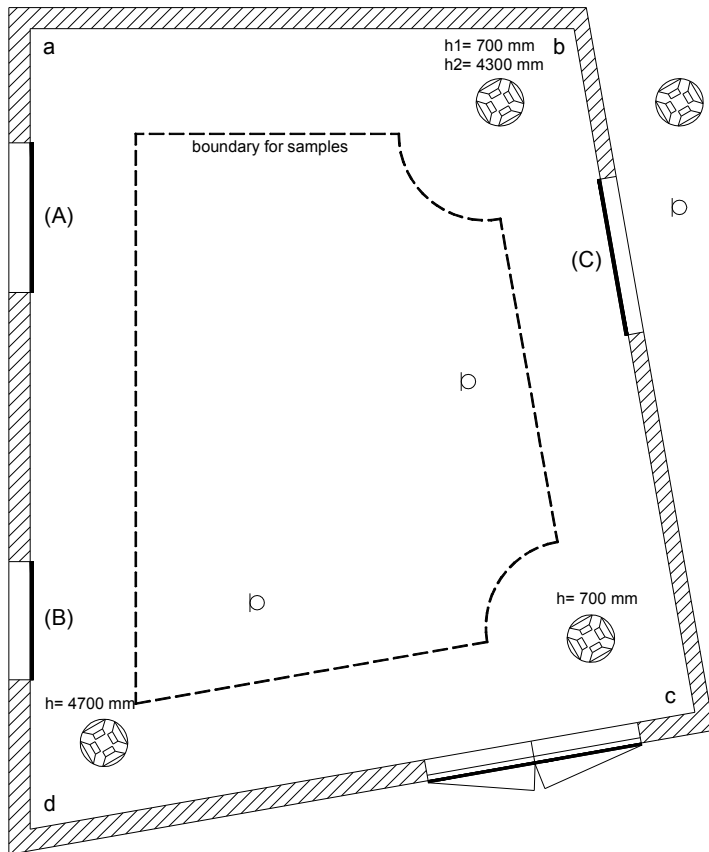
reverberation time of the empty reverberation room during measurements of 12-12-2016

frequency (1/1 oct.)	125	250	500	1000	2000	4000	Hz
reverberationtime	7,98	6,23	6,05	5,43	4,13	2,65	sec.

repeatability r (1/1 oct.) c.f. ISO 354:1985 annex C (see chapter 4.2 of this report).

r at high α	0,13	0,04	0,04	0,02	0,02	0,08	-
r at low α	0,09	0,02	0,01	0,02	0,02	0,04	-

plan

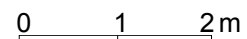


loudspeaker (4x)

microphone (3x)

(closed) testopenings  
(width x height in mm)  
(A): 1300 x 1800  
(B): 1000 x 2200  
(C): 1500 x 1250

height at:  
a: 5573 mm  
b: 5102 mm  
c: 5000 mm  
d: 5580 mm



Absorb, versie 5.8.4 mode 7, PM: JK, file: a3233 E#:1-36 T<sub>1</sub> = 17,1 °C p<sub>1</sub> = 102,8 kPa h<sub>1</sub> = 53,1 %

MEASUREMENT OF SOUND ABSORPTION IN A REVERBERATION ROOM  
ACCORDING TO ISO 354:2003

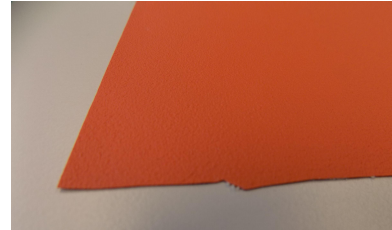


principal: Vescom B.V.

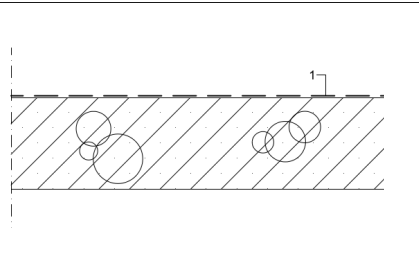
Variant 1

**Wallcovering 001**

manufacturer: Vescom  
 type: Nero  
 view side: Vinyl  
 weight 354 gr/m<sup>2</sup>  
 thickness 0,5 mm  
 backing: none



**Measurement set-up 1**  
1: Vinyl wallcovering



volume reverberation room: 214 m<sup>3</sup>

surface area sample: 11,7 m<sup>2</sup>

height of the construction: 0,001 m

measured at: Peutz Laboratory for Acoustics

signal: broad-band noise

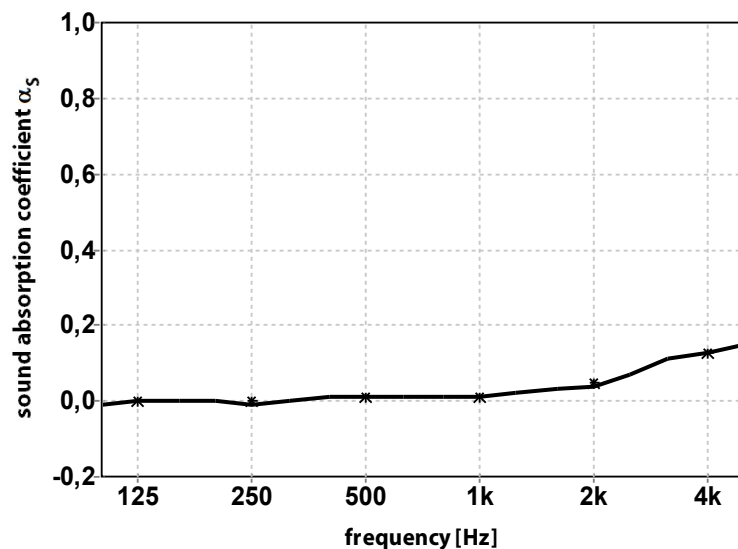
bandwidth: 1/3 octave

$\alpha_w$  (ISO 11654) = 0,05

NRC (ASTM - C423) = 0,00

SAA (ASTM - C423) = 0,02

— 1/3 oct.  
\* 1/1 oct.



	125	250	500	1k	2k	4k
1/3 oct.	-0,01	0,00	0,01	0,01	0,03	0,11
	0,00	-0,01	0,01	0,01	0,04	0,13
	0,00	0,00	0,01	0,02	0,07	0,15
1/1 oct.	<b>0,00</b>	<b>0,00</b>	<b>0,01</b>	<b>0,01</b>	<b>0,05</b>	<b>0,13</b>

publication is permitted for the entire page only

Mook, measured at  
12-12-2016

Absorb, versie 5.8.4 mode 7, PM: JK, file: a3233 E#:1-36 F#:37-72 A#:110 T<sub>1</sub> = 17,1 °C T<sub>2</sub> = 17,2 °C p<sub>1</sub> = 102,8 kPa p<sub>2</sub> = 102,8 kPa h<sub>1</sub> = 53,1 % h<sub>2</sub> = 52,7 %



**MEASUREMENT OF SOUND ABSORPTION IN A REVERBERATION ROOM  
ACCORDING TO ISO 354:2003**

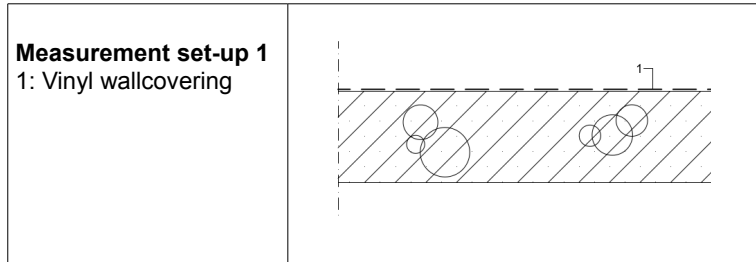


principal: Vescom B.V.

Variant 2

**Wallcovering 002**

manufacturer: Vescom  
 type: Color Choice  
 view side: Vinyl  
 weight 419 gr/m<sup>2</sup>  
 thickness 0,5 mm  
 backing: none



volume reverberation room: 214 m<sup>3</sup>

surface area sample: 11,7 m<sup>2</sup>

height of the construction: 0,001 m

measured at: Peutz Laboratory for Acoustics

signal: broad-band noise

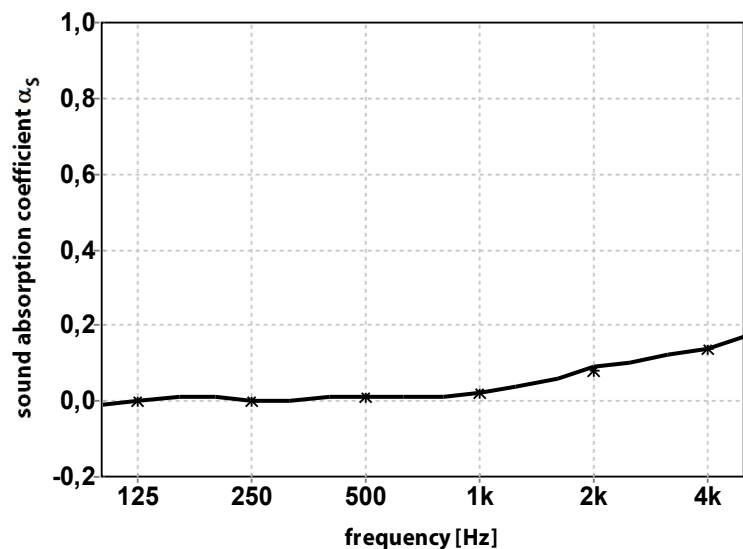
bandwidth: 1/3 octave

$\alpha_w$  (ISO 11654) = 0,05

NRC (ASTM - C423) = 0,05

SAA (ASTM - C423) = 0,03

— 1/3 oct.  
\* 1/1 oct.



	125	250	500	1k	2k	4k
1/3 oct.	-0,01 0,00 0,01	0,01 0,00 0,00	0,01 0,01 0,01	0,01 0,02 0,04	0,06 0,09 0,10	0,12 0,14 0,17
1/1 oct.	<b>0,00</b>	<b>0,00</b>	<b>0,01</b>	<b>0,02</b>	<b>0,08</b>	<b>0,14</b>

publication is permitted for the entire page only

Mook, measured at  
12-12-2016

Absorb, versie 5.8.4 mode 7, PM: JK, file: a3233 E#:1-36 F#:74-109 A#:111 T<sub>1</sub> = 17,1 °C T<sub>2</sub> = 17,3 °C p<sub>1</sub> = 102,8 kPa p<sub>2</sub> = 102,8 kPa h<sub>1</sub> = 53,1 % h<sub>2</sub> = 52,8 %

**MEASUREMENT OF SOUND ABSORPTION IN A REVERBERATION ROOM  
ACCORDING TO ISO 354:2003**

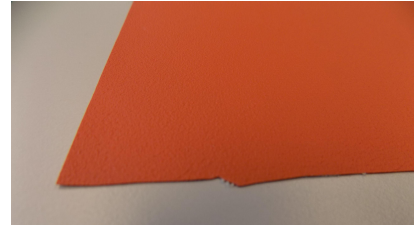


principal: Vescom B.V.

Variant 3

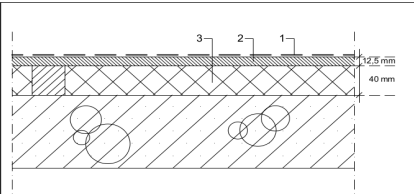
**Wallcovering 001**

manufacturer: Vescom  
 type: Nero  
 view side: Vinyl  
 weight 354 gr/m<sup>2</sup>  
 thickness 0,5 mm  
 backing: none



**Measurement set-up 2**

- 1: Vinyl wallcovering
- 2: Gypsum plasterboard, t = 12,5 mm
- 3: Mineral wool



volume reverberation room: 214 m<sup>3</sup>

surface area sample: 11,7 m<sup>2</sup>

height of the construction: 0,053 m

measured at: Peutz Laboratory for Acoustics

signal: broad-band noise

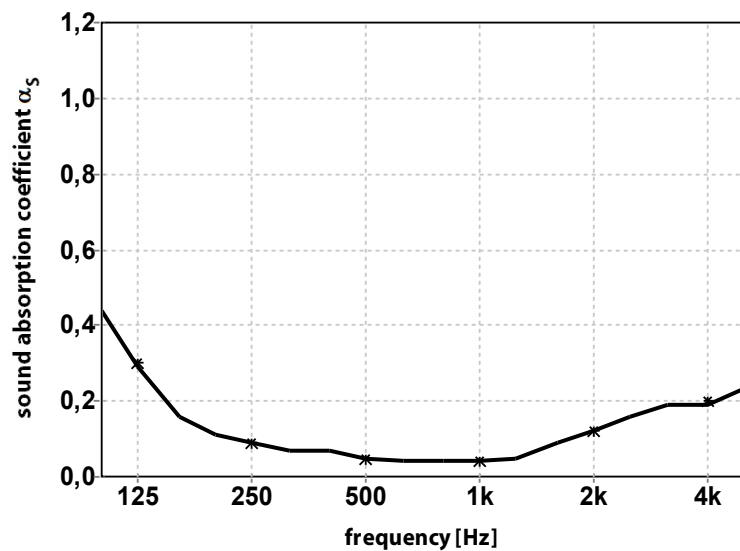
bandwidth: 1/3 octave

$\alpha_w$  (ISO 11654) = 0,10

NRC (ASTM - C423) = 0,10

SAA (ASTM - C423) = 0,08

— 1/3 oct.  
 \* 1/1 oct.



	0,44	0,11	0,07	0,04	0,09	0,19
1/3 oct.	0,29	0,09	0,05	0,04	0,12	0,19
	0,16	0,07	0,04	0,05	0,16	0,23
1/1 oct.	<b>0,30</b>	<b>0,09</b>	<b>0,05</b>	<b>0,04</b>	<b>0,12</b>	<b>0,20</b>

publication is permitted for the entire page only

Mook, measured at  
12-12-2016

Absorb, versie 5.8.4 mode 7, PM: JK, file: a3233 E#:1-36 F#:186-221 A#:222 T<sub>1</sub> = 17,1 °C T<sub>2</sub> = 17,2 °C p<sub>1</sub> = 102,8 kPa p<sub>2</sub> = 102,7 kPa h<sub>1</sub> = 53,1 % h<sub>2</sub> = 53,0 %

**MEASUREMENT OF SOUND ABSORPTION IN A REVERBERATION ROOM ACCORDING TO ISO 354:2003**



principal: Vescom B.V.

Variant 4

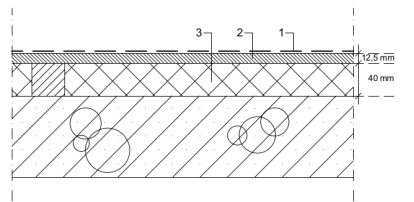
**Wallcovering 002**

manufacturer: Vescom  
 type: Color Choice  
 view side: Vinyl  
 weight 419 gr/m<sup>2</sup>  
 thickness 0,5 mm  
 backing: none



**Measurement set-up 2**

- 1: Vinyl wallcovering
- 2: Gypsum plasterboard, t=12,5 mm
- 3: Mineral wool



volume reverberation room: 214 m<sup>3</sup>

surface area sample: 11,7 m<sup>2</sup>

height of the construction: 0,053 m

measured at: Peutz Laboratory for Acoustics

signal: broad-band noise

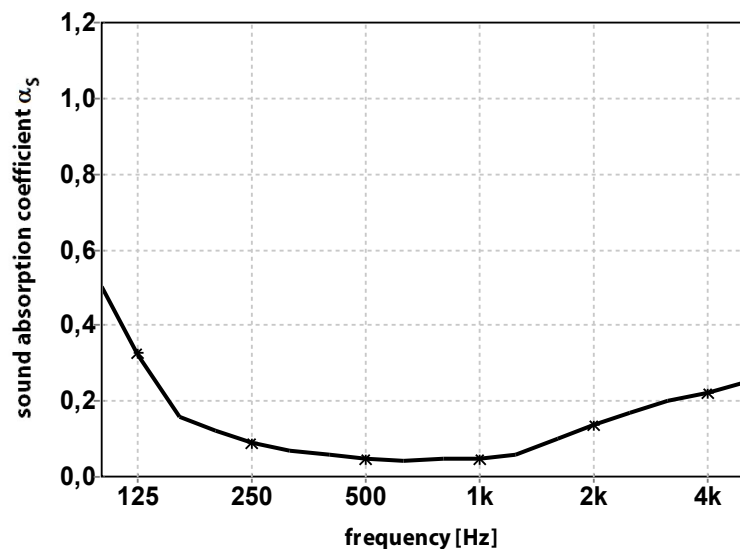
bandwidth: 1/3 octave

$\alpha_w$  (ISO 11654) = 0,10

NRC (ASTM - C423) = 0,10

SAA (ASTM - C423) = 0,08

— 1/3 oct.  
 \* 1/1 oct.



	0,50	0,12	0,06	0,05	0,10	0,20
1/3 oct.	0,32	0,09	0,05	0,05	0,14	0,22
	0,16	0,07	0,04	0,06	0,17	0,25
1/1 oct.	<b>0,33</b>	<b>0,09</b>	<b>0,05</b>	<b>0,05</b>	<b>0,14</b>	<b>0,22</b>

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Mook, measured at  
 12-12-2016

Absorb, versie 5.8.4 mode 7, PM: JK, file: a3233 E#:1-36 F#:149-184 A#:185 T<sub>1</sub> = 17,1 °C T<sub>2</sub> = 17,3 °C p<sub>1</sub> = 102,8 kPa p<sub>2</sub> = 102,8 kPa h<sub>1</sub> = 53,1 % h<sub>2</sub> = 52,3 %

**MEASUREMENT OF SOUND ABSORPTION IN A REVERBERATION ROOM  
ACCORDING TO ISO 354:2003**

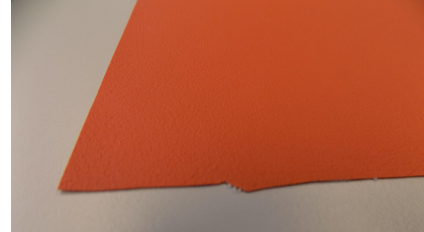


principal: Vescom B.V.

Variant 5

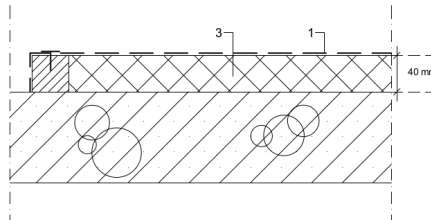
**Wallcovering 001**

manufacturer: Vescom  
 type: Nero  
 view side: Vinyl  
 weight 354 gr/m<sup>2</sup>  
 thickness 0,5 mm  
 backing: none



**Measurement set-up 3**

- 1: Vinyl wallcovering
- 3: Mineral wool



volume reverberation room: 214 m<sup>3</sup>

surface area sample: 11,7 m<sup>2</sup>

height of the construction: 0,040 m

measured at: Peutz Laboratory for Acoustics

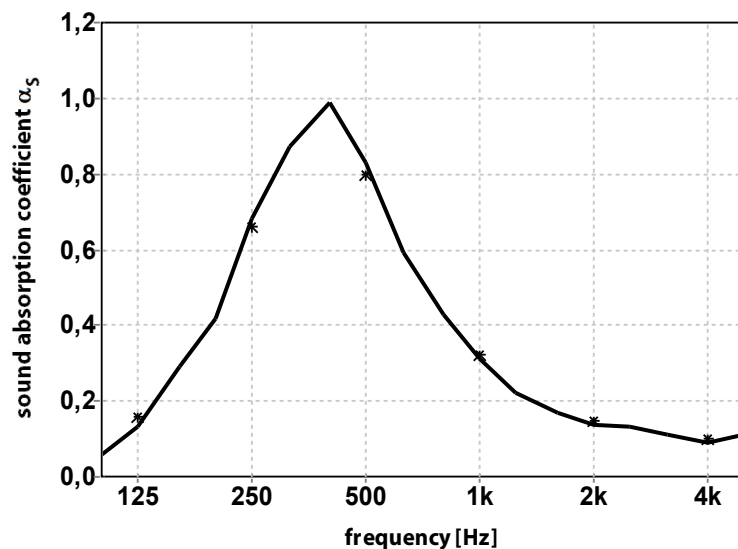
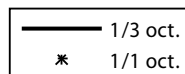
signal: broad-band noise

bandwidth: 1/3 octave

$\alpha_w$  (ISO 11654) = 0,20(LM)

NRC (ASTM - C423) = 0,50

SAA (ASTM - C423) = 0,48



	0,06	0,42	0,99	0,43	0,17	0,11
1/3 oct.	0,13	0,68	0,83	0,31	0,14	0,09
	0,29	0,87	0,59	0,22	0,13	0,11
<b>1/1 oct.</b>	<b>0,16</b>	<b>0,66</b>	<b>0,80</b>	<b>0,32</b>	<b>0,15</b>	<b>0,10</b>

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Mook, measured at  
12-12-2016

Absorb, versie 5.8.4 mode 7, PM: JK, file: a3233 E#:1-36 F#:223-258 A#:259 T<sub>1</sub> = 17,1 °C T<sub>2</sub> = 17,4 °C p<sub>1</sub> = 102,8 kPa p<sub>2</sub> = 102,7 kPa h<sub>1</sub> = 53,1 % h<sub>2</sub> = 52,8 %

**MEASUREMENT OF SOUND ABSORPTION IN A REVERBERATION ROOM  
ACCORDING TO ISO 354:2003**



principal: Vescom B.V.

Variant 6

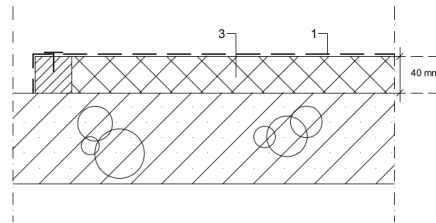
**Wallcovering 002**

manufacturer: Vescom  
 type: Color Choice  
 view side: Vinyl  
 weight 419 gr/m<sup>2</sup>  
 thickness 0,5 mm  
 backing: none



**Measurement set-up 3**

- 1: Vinyl wallcovering
- 3: Mineral wool



volume reverberation room: 214 m<sup>3</sup>

surface area sample: 11,7 m<sup>2</sup>

height of the construction: 0,040 m

measured at: Peutz Laboratory for Acoustics

signal: broad-band noise

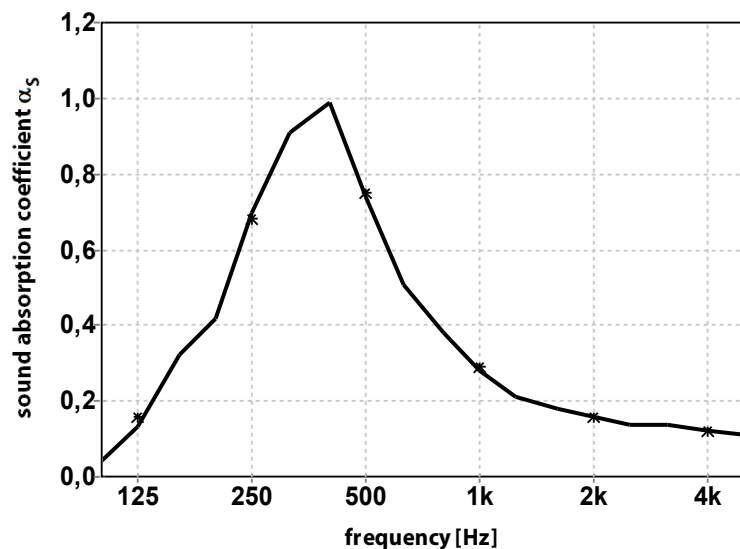
bandwidth: 1/3 octave

$\alpha_w$  (ISO 11654) = 0,20(LM)

NRC (ASTM - C423) = 0,45

SAA (ASTM - C423) = 0,47

— 1/3 oct.  
 \* 1/1 oct.



	0,04	0,42	0,99	0,38	0,18	0,14
1/3 oct.	0,13	0,70	0,74	0,28	0,16	0,12
	0,32	0,91	0,51	0,21	0,14	0,11
1/1 oct.	<b>0,16</b>	<b>0,68</b>	<b>0,75</b>	<b>0,29</b>	<b>0,16</b>	<b>0,12</b>

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Mook, measured at  
12-12-2016

Absorb, versie 5.8.4 mode 7, PM: JK, file: a3233 E#:1-36 F#:260-295 A#:296 T<sub>1</sub> = 17,1 °C T<sub>2</sub> = 17,1 °C p<sub>1</sub> = 102,8 kPa p<sub>2</sub> = 102,7 kPa h<sub>1</sub> = 53,1 % h<sub>2</sub> = 53,5 %