



Laboratory for Acoustics

Determination of the sound absorption (reverberation room method) of BuzziSpace designs, manufacturer BuzziSpace

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4 Measurements

The products are installed for the laboratory test in the same manner as they are typically installed in practice;

- free-standing on the floor of the reverberation room
- free hanging from the ceiling of the reverberation room
- lying on the floor of the reverberation room (BuzziBlocks)

For discrete absorbers like this particular case, the results are expressed as the equivalent sound absorption area per object A (m^2).

In addition the sound absorption coefficient of the wall panels (BuzziBlocks) separately is measured. Therefore a number of panels, total area of $10,7 m^2$, is placed directly on the floor of the reverberation room. The sides of the set-up were enclosed by 18 mm thick plastic covered chip-wood board and sealed by tape. This measurement is according type A mounting ISO 354:2003, Annex B (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

$$A_1 = \frac{55,3V}{cT_1} - 4Vm_1 \quad (1)$$

in which:

- V = the volume of the reverberation room [m³]
 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⁻¹]
 c = the speed of sound in the air, in m/s, calculated according to [m/s]

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

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:

- α = "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 m²

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

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⁻¹]

The equivalent sound absorption A of the test specimen has been calculated according to formula 5 and is expressed in m²

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

When the test specimen consists of one plane with an area between 10 and 12 m² the sound absorption coefficient α_s has to be calculated according to formula 6:

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

in which:

- S = the area of the test specimen [m²]

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

4.3.1 Environmental conditions during the measurements

reverberation room		temperature [°C]	barometric pressure [kPa]	relative humidity [%]
empty	03-11-15	18	102,3	56
	23-11-15	17	102,3	52
with objects	03-11-15	18	101,9 - 102,3	52 - 57
	23-11-15	17 - 18	102,3	48 - 53

4.4 Results

The results of the measurements are given in the tables 4.2 up to including 4.10 and in the figures 4 up to and including 29. 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.

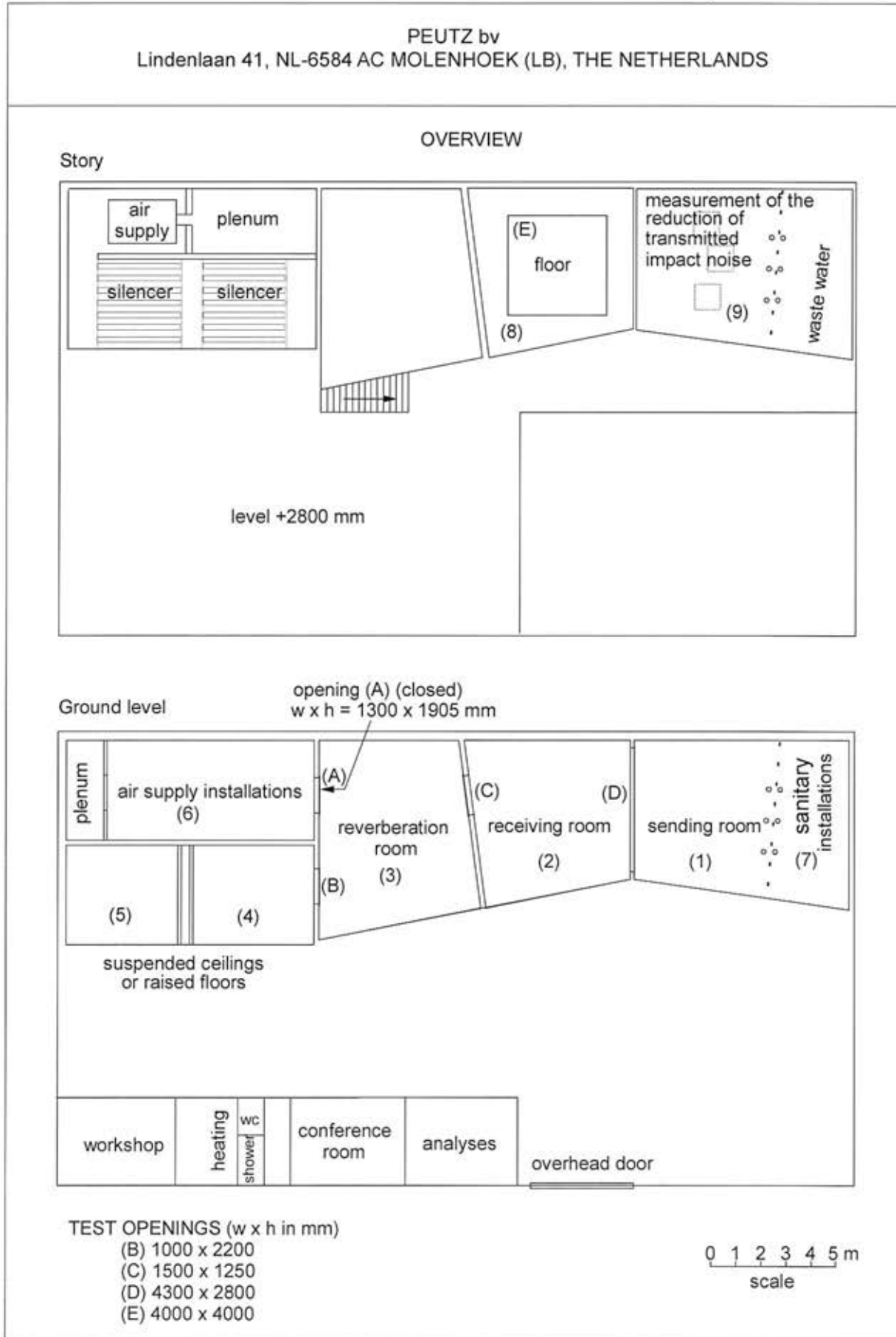
From those values the following one-figure ratings have been calculated and stated :

- the "weighted sound absorption coefficient α_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 and including 2500 Hz, rounded to the nearest 0,01.

PEUTZ bv
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PEUTZ bv
Lindenlaan 41, 6584 AC MOLENHOEK (LB)

REVERBERATION ROOM

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

additional data:

volume : 214 m³

total area S_t (walls, floor and ceiling) : 219 m²

diffusion: by the shape of the room and by adding 6 curved and 2 flat reflecting elements with a total area of approx. 13 m² a sufficient diffusion has been gained.

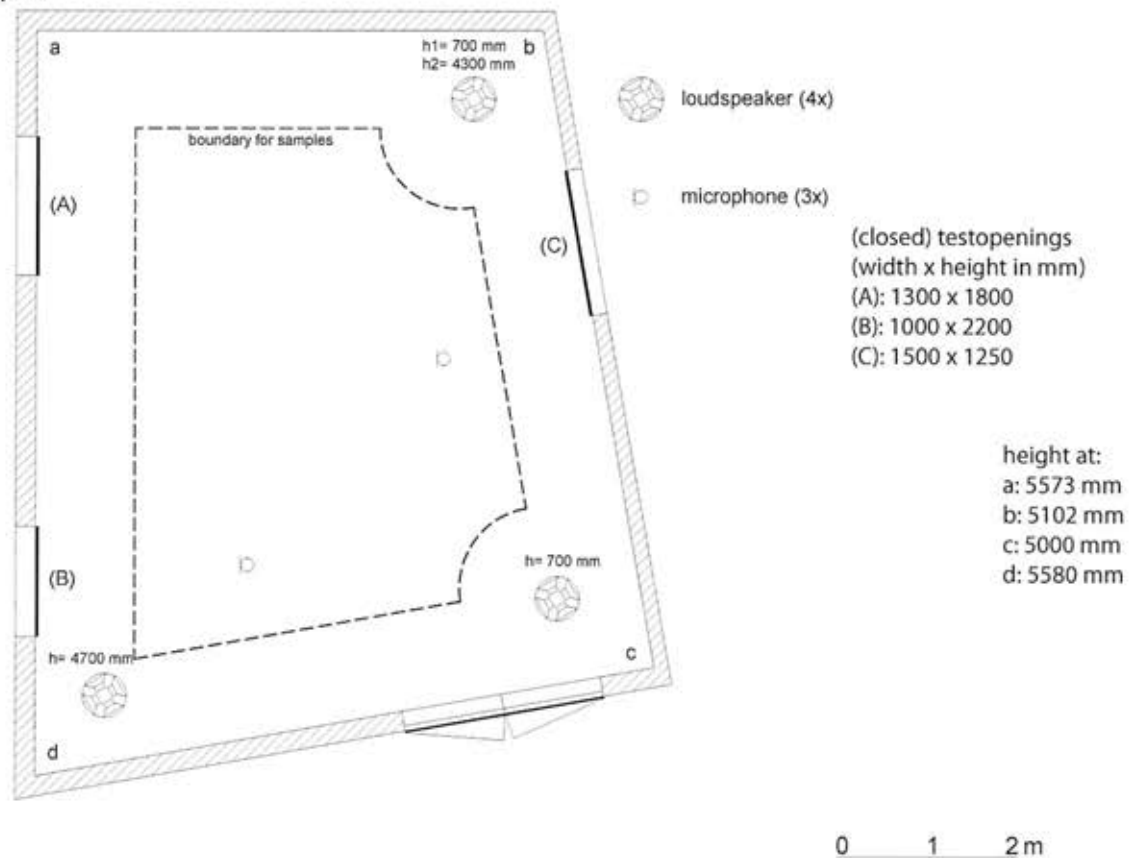
reverberation time of the empty reverberation room during measurements of 03-11-2015

frequency (1/1 oct.)	125	250	500	1000	2000	4000	Hz
reverberationtime	8,08	6,31	6,10	5,56	4,22	2,80	sec.

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

r bij hoge α	0,13	0,04	0,04	0,02	0,02	0,08	-
r bij lage α	0,09	0,02	0,01	0,02	0,02	0,04	-

plan



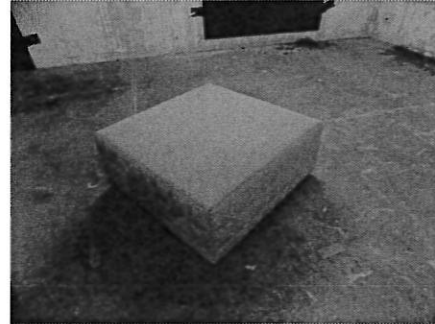
Absorb, versie 5.8.1 mode 7, PNT-BA, file: a 2979 Ef:1 -36 T₁ = 17,7 °C p₁ = 102,3 kPa h₁ = 56,1 %

EQUIVALENT SOUND ABSORPTION AREA PER OBJECT conform ISO 354:2003



principal: BuzziSpace

Variant 1: BuzziPouf Square 3D
 dimensions: 940 mm x 940 mm
 height: 380 mm



Absorb, versie 5.8.2, mode 9, PM: MH, file: a 2979 E#:1076-1111 F#:1112-1147 A#:1148 T₁ = 19,0 °C T₂ = 19,1 °C p₁ = 101,5 kPa p₂ = 101,6 kPa h₁ = 50,9 % h₂ = 53,7 %

volume reverberation room: 214 m³

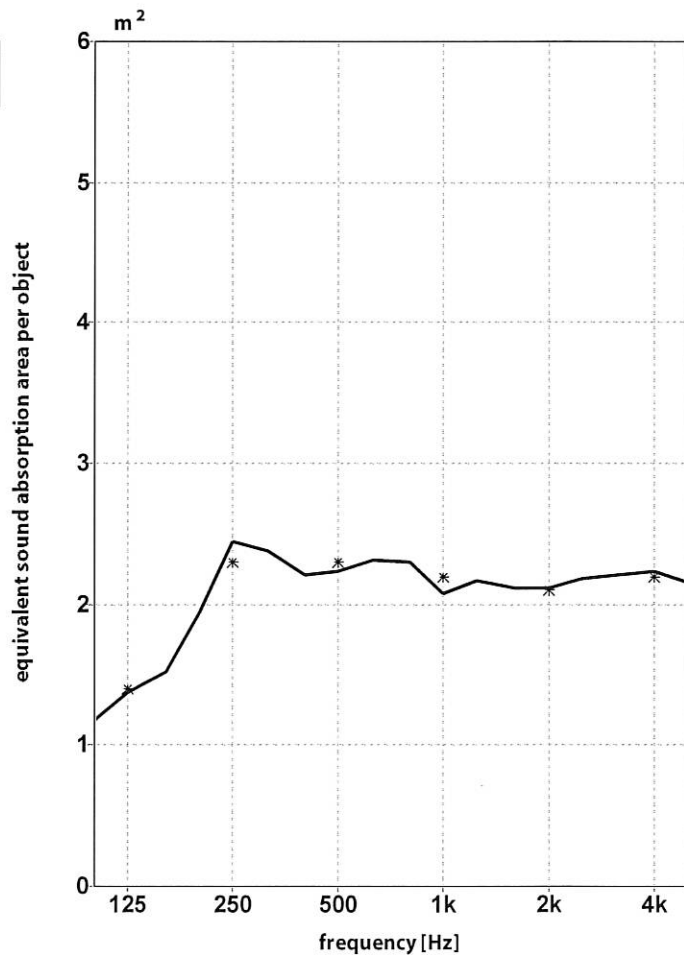
number of elements: 1

measured at: Peutz Laboratory for Acoustics

signal: broad-band noise

bandwidth: 1/3 octave

— 1/3 oct.
 * 1/1 oct.



1/3 oct.	1,2	1,9	2,2	2,3	2,1	2,2	m ²
	1,4	2,5	2,2	2,1	2,1	2,2	
	1,5	2,4	2,3	2,2	2,2	2,2	
1/1 oct.	1,4	2,3	2,3	2,2	2,1	2,2	m ²

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Mook, 09-05-2016

EQUIVALENT SOUND ABSORPTION AREA PER OBJECT conform ISO 354:2003

principal: BuzziSpace



Variant 2: BuzziPouf Round 3D

dimensions: Ø 930 mm

height: 380 mm



Absorb, versie 5.8.2, mode 9, PM: MH, file: a 2979 E#:1076-1111 F#:1149-1184 A#:1185 T₁ = 19,0 °C T₂ = 19,2 °C p₁ = 101,5 kPa p₂ = 101,6 kPa h₁ = 50,9% h₂ = 52,9%

volume reverberation room: 214 m³

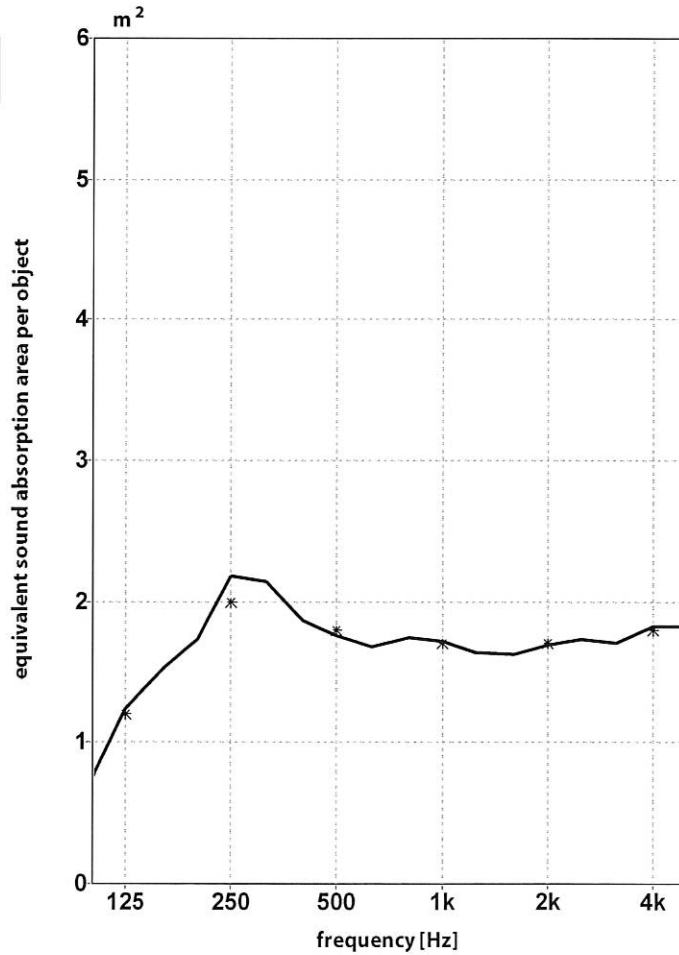
number of elements: 1

measured at: Peutz Laboratory for Acoustics

signal: broad-band noise

bandwidth: 1/3 octave

— 1/3 oct.
* 1/1 oct.



	0,8	1,7	1,9	1,8	1,6	1,7	
1/3 oct.	1,2	2,2	1,8	1,7	1,7	1,8	m ²
	1,5	2,1	1,7	1,6	1,7	1,8	
1/1 oct.	1,2	2,0	1,8	1,7	1,7	1,8	m ²

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Mook, 09-05-2016