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M111250/18 MSG/STEG

Fabric Formoza
Vescom B.V.

Measurement of sound absorption in a reverberation room according to EN ISO 354

Test report no. M111250/18

Client:	Vescom B.V. Sint Jozefstraat 20 5753 AV Deurne The Netherlands
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1 Task

On behalf of the company Vescom B.V., NL-5753 AV Deurne, the sound absorption of the fabric Formoza had to be measured according to EN ISO 354 [1] in the reverberation room. The fabric was tested as a curtain in a flat and a folded arrangement.

2 Basis

This test report is based on the following documents:

[1] EN ISO 354: Acoustics - Measurement of sound absorption in a reverberation room. 2003-05

[2] EN ISO 11654: Acoustics – Sound absorbers for use in buildings – Rating of sound absorption. 1997-04

[3] ASTM C 423-09a: Standard Test Method for Sound Absorption and Sound Absorption Coefficients by the Reverberation Room Method. Revision: 09a October 2009

[4] ISO 9613-1: Acoustics; Attenuation of sound during propagation outdoors; part 1: calculation of the absorption of sound by the atmosphere. June 1993

[5] EN 29053: Acoustics – Materials for acoustical applications – Determination of airflow resistance. 1993-05

3 Test object and test assembly

3.1 Test object

The tested material is described by the manufacturer as follows:

- curtain fabric type Formoza
- material 100 % Trevira CS

The following parameters were determined by the testing laboratory:

- thickness: t = 0.7 mm
- specific airflow resistance acc. to EN 29053 [5]: R_s = 323 Pa·s/m
- area-related mass: m'' = 129 g/m²

3.2 Test assembly

The installation of the test objects was carried out by employees of the test laboratory in the reverberation room of Müller-BBM. The test objects were installed in a flat and a folded arrangement.

Both arrangements were mounted as follows:

- clear distance to the reflective wall 150 mm
- fixed directly underneath the ceiling on a metal rail (*h* = 50 mm)
- measurement without enclosing frame
- visible side corresponding to marking by the manufacturer faced to the reverberation room

The mounting details for the tested arrangements are as follows:

a) flat arrangement

- mounting type G-150 acc. to EN ISO 354 [1], section 6.2.1 and Appendix B of EN ISO 354 [1]
- one curtain width x height = 3500 mm x 3000 mm
- total dimensions of the test surface (starting at the lower edge of the metal rail) width x height = 3500 mm x 2950 mm

b) folded arrangement

- mounting type following G-150 acc. to EN ISO 354 [1]
- 100 % fabric addition
- two curtains: width x height = 3500 mm x 3000 mm each
- total dimensions of the test surface (starting at the lower edge of the metal rail) width x height = 3500 mm x 2950 mm

Appendix B contains photos of the tested arrangements.

4 Execution of the measurements

The measurements were executed and evaluated according to EN ISO 354 [1].

The test procedure, the test stand and the test equipment used for the measurements are described in Appendix C.

5 Evaluation

The sound absorption coefficient α_S was determined in one-third octave bands between 100 Hz and 5000 Hz according to EN ISO 354 [1].

In addition to the sound absorption coefficients the following characteristic values were determined according to EN ISO 11654 [2].

- practical sound absorption coefficient α_p in octave bands
- weighted sound absorption coefficient α_w as single value:

  The weighted sound absorption coefficient α_w is determined from the practical sound absorption coefficients α_p in the octave bands of 250 Hz to 4000 Hz.

According to ASTM C 423-09a [3] the following characteristic values were determined:

- noise reduction coefficient *NRC* as single value:

  Arithmetical mean value of the sound absorption coefficients in the four one-third octave bands 250 Hz, 500 Hz, 1000 Hz and 2000 Hz; mean value rounded to 0.05.

- sound absorption average *SAA* as single value:

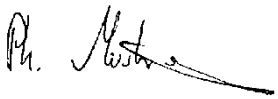
  Arithmetical mean value of the sound absorption coefficients in the twelve one-third octave bands between 250 Hz and 2500 Hz; mean value rounded to 0.01.

6 Measurement results

The sound absorption coefficients α_S in one third-octave bands, the practical sound absorption coefficients α_p in octave bands and the single values α_w, *NRC* and *SAA* are indicated in the test certificates in Appendix A.

7 Remarks

The test results exclusively relate to the investigated subjects and conditions described.



M. Eng. Philipp Meistring

DAkkS
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Durch die DAkkS Deutsche Akkreditierungsstelle GmbH
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Die Akkreditierung gilt für die in der Urkunde aufgeführten Prüfverfahren.

Sound absorption coefficient ISO 354

Measurement of sound absorption in reverberation rooms

Client: Vescom B.V.
Sint Jozefstraat 20, 5753 AV Deurne, The Netherlands

Test specimen: Fabric Formoza
Mounting type G-150, flat arrangement

Curtain fabric:

- curtain fabric Formoza
- material 100 % polyester (Trevira CS)
- area-related mass m'' = 129 g/m²
- airflow resistance R_S = 323 Pa s/m
- thickness t = 0.7 mm

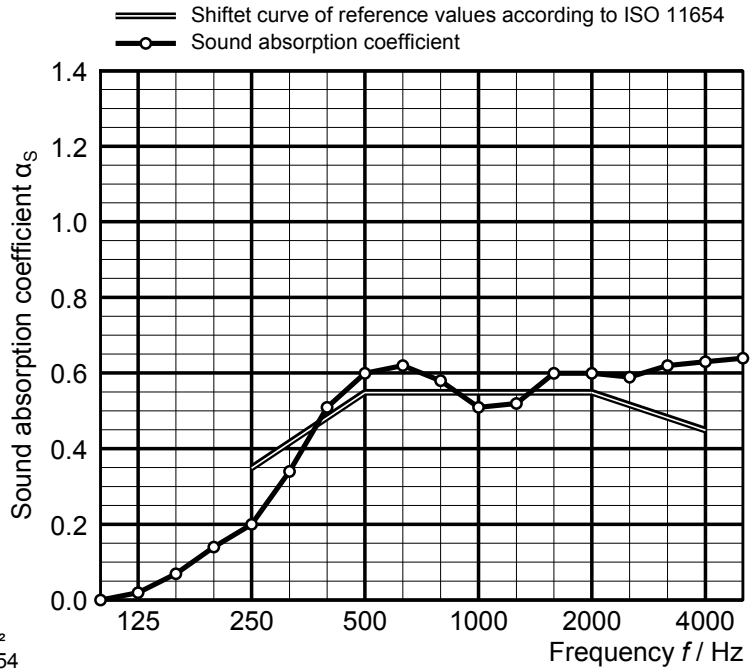
Tested arrangement:

- mounting type G-150 acc. to EN ISO 354, without enclosing frame
- one curtain width x height = 3500 mm x 3000 mm
- fixed underneath the ceiling on a 50 mm high metal rail
- wall distance 150 mm
- test surface width x height = 3500 mm x 2950 mm (starting at the lower edge of the metal rail)

Room: E
Volume: 199.60 m³
Size: 10.33 m²
Date of test: 2014-04-28

	θ [°C]	r. h. [%]	B [kPa]
without specimen	20.9	40.9	94.5
with specimen	21.0	41.7	94.5

Frequency [Hz]	α_S 1/3 octave	α_p octave
100	◦ -0.00	
125	◦ 0.02	0.05
160	◦ 0.07	
200	0.14	
250	0.20	0.25
315	0.34	
400	0.51	
500	0.60	0.60
630	0.62	
800	0.58	
1000	0.51	0.55
1250	0.52	
1600	0.60	
2000	0.60	0.60
2500	0.59	
3150	0.62	
4000	0.63	0.65
5000	0.64	



◦ Equivalent sound absorption area less than 1.0 m²
α_S Sound absorption coefficient according to ISO 354
α_p Practical sound absorption coefficient according to ISO 11654

Rating according to ISO 11654:	Rating according to ASTM C423:
Weighted sound absorption coefficient α_w = 0.55	**Noise Reduction Coefficient *NRC* = 0.50**
Sound absorption class: D	**Sound Absorption Average *SAA* = 0.48**

Sound absorption coefficient ISO 354

Measurement of sound absorption in reverberation rooms

Client: Vescom B.V.
Sint Jozefstraat 20, 5753 AV Deurne, The Netherlands

Test specimen: Fabric Formoza
wall distance 150 mm, folded arrangement

Curtain fabric:

- curtain fabric Formoza
- material 100 % polyester (Trevira CS)
- area-related mass m'' = 129 g/m²
- airflow resistance R_S = 323 Pa s/m
- thickness t = 0.7 mm

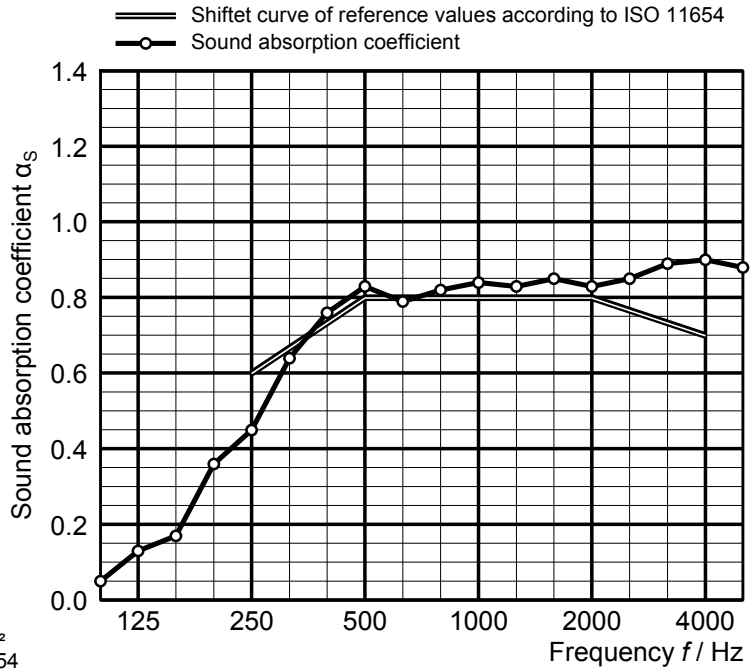
Tested arrangement:

- mounting type G-150 acc. to EN ISO 354, without enclosing frame
- two curtains width x height = 3500 mm x 3000 mm each
- fixed underneath the ceiling on a 50 mm high metal rail
- wall distance 150 mm
- test surface width x height = 3500 mm x 2950 mm (starting at the lower edge of the metal rail)

Room: E
Volume: 199.60 m³
Size: 10.33 m²
Date of test: 2014-04-28

	θ [°C]	r. h. [%]	B [kPa]
without specimen	20.9	40.9	94.5
with specimen	21.0	42.3	94.5

Frequency [Hz]	α_S 1/3 octave	α_p octave
100	◦ 0.05	
125	0.13	0.10
160	0.17	
200	0.36	
250	0.45	0.50
315	0.64	
400	0.76	
500	0.83	0.80
630	0.79	
800	0.82	
1000	0.84	0.85
1250	0.83	
1600	0.85	
2000	0.83	0.85
2500	0.85	
3150	0.89	
4000	0.90	0.90
5000	0.88	



◦ Equivalent sound absorption area less than 1.0 m²
α_S Sound absorption coefficient according to ISO 354
α_p Practical sound absorption coefficient according to ISO 11654

Rating according to ISO 11654:	Rating according to ASTM C423:
Weighted sound absorption coefficient α_w = 0.80	**Noise Reduction Coefficient *NRC* = 0.75**
Sound absorption class: B	**Sound Absorption Average *SAA* = 0.74**

Fabric Formoza

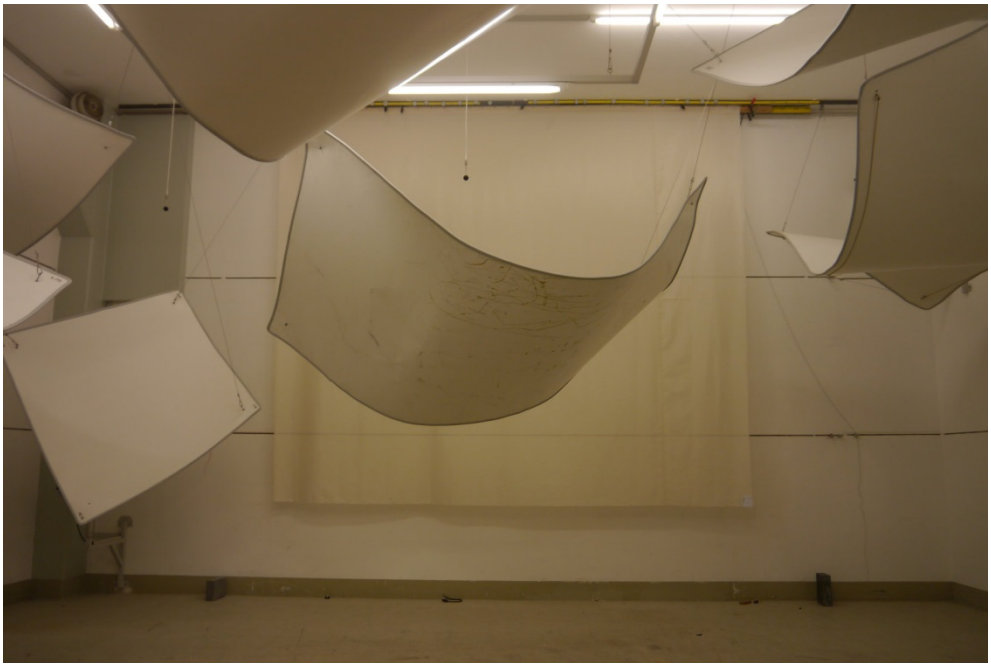


Figure B.1. Flat arrangement, test arrangement in the reverberation room.

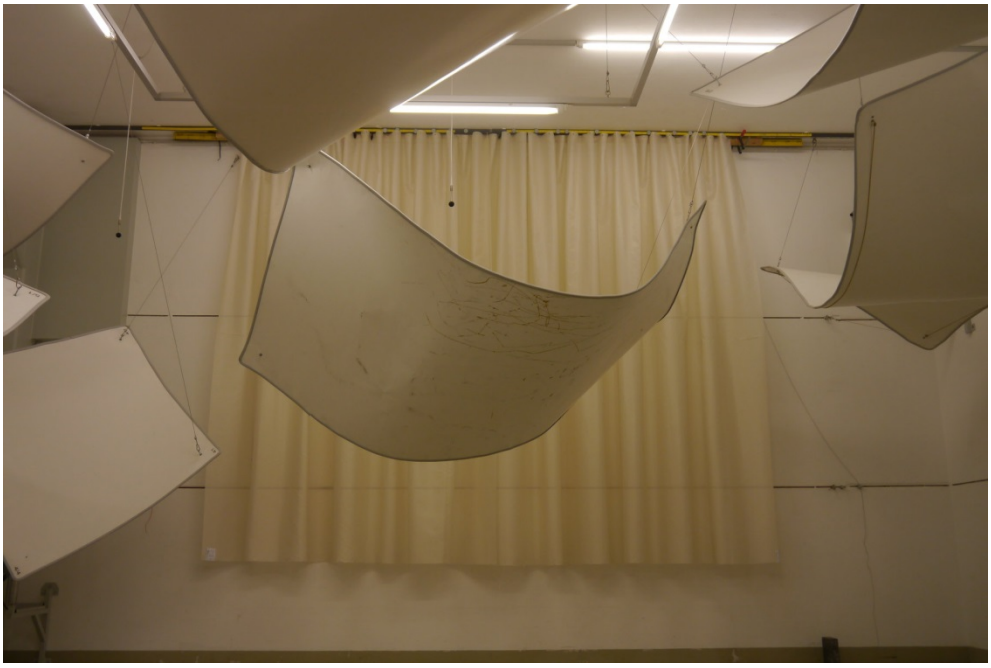


Figure B.2. Folded arrangement, test arrangement in the reverberation room.

Description of the test procedure for the determination of the sound absorption in a reverberation room

1 Measurand

The sound absorption coefficient α of the test object was determined. For this purpose the mean value of the reverberation time in the reverberation room with and without the test object was measured. The sound absorption coefficient was calculated using the following equation:

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

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

With:

α_S sound absorption coefficient;

A_T equivalent sound absorption area of the test object in m^2;

S area covered by the test object in m^2;

V volume of the reverberation room in m^3;

c_1 propagation speed of sound in air in the reverberation room without test object in m/s;

c_2 propagation speed of sound in air in the reverberation room with test object in m/s;

T_1 reverberation time in the reverberation room without test object in s;

T_2 reverberation time in the reverberation room with test object in s;

m_1 power attenuation coefficient in the reverberation room without test object in m^{-1};

m_2 power attenuation coefficient in the reverberation room with test object in m^{-1}.

The different dissipation during the sound propagation in the air was taken into account according to paragraph 8.1.2 of EN ISO 354 [1]. The dissipation was calculated according to ISO 9613-1 [4]. The climatic conditions during the measurements are indicated in the test certificates.

Information on the repeatability and reproducibility of the test procedure are given in EN ISO 354 [1].

2 Test procedure

2.1 Description of the reverberation room

The reverberation room complies with the requirements according to EN ISO 354 [1].

The reverberation room has a volume of V = 199.6 m^3 and a surface of S = 216 m^2.

Six omni-directional microphones and four loudspeakers were installed in the reverberation room.

In order to improve the diffusivity, six composite sheet metal boards dimensioned 1.2 m x 2.4 m and six composite sheet metal boards dimensioned 1.2 m x 1.2 m were suspended curved and irregularly.

Figure C.1 shows the drawings of the reverberation room.

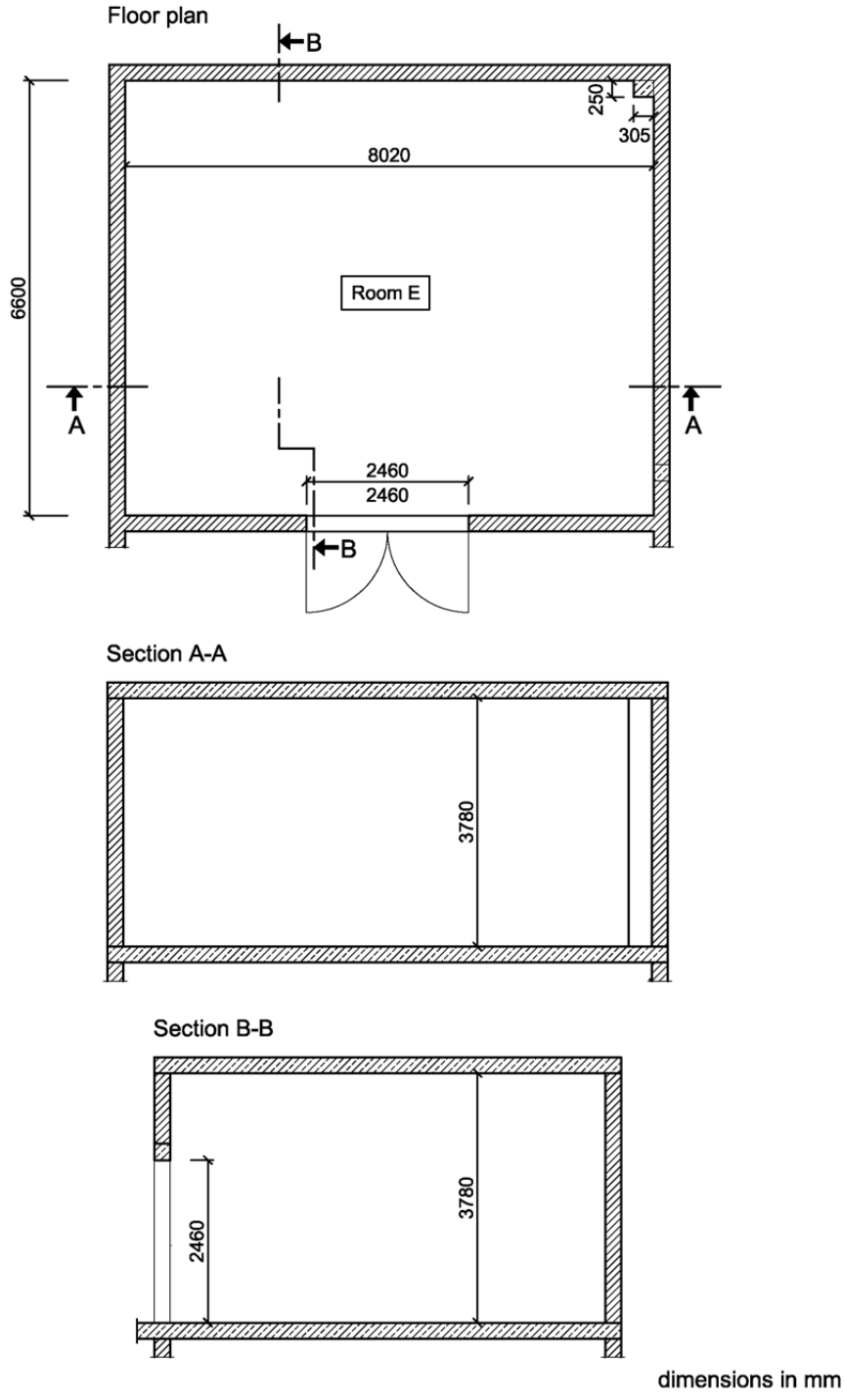


Figure C.1. Plan view and sections of the reverberation room.

2.2 Measurement of reverberation time

The determination of the impulse responses were carried out according to the indirect method. In all tests, a sinusoidal sweep with pink noise spectrum was used as test signal. In the reverberation room with and without test objects each 24 independent combinations of loudspeakers and microphones were measured. The reverberation time was evaluated according to EN ISO 354 [1], using a linear regression for the calculation of the reverberation time T_{20} from the level of a backward integrated impulse response.

The determined reverberation times in the reverberation room with and without test object are indicated in Table C.1.

Table C.1. Reverberation times without and with test objects.

Frequency *f* / Hz	**Reverberation time *T* / s**		
	T_1 (without test object	**T_2 (with test object)**	
	Appendix A page 1	**Appendix A page 1**	**Appendix A page 2**
100	4.90	4.91	4.55
125	4.66	4.54	3.92
160	4.86	4.41	3.82
200	5.53	4.41	3.38
250	5.31	3.96	3.01
315	5.13	3.27	2.49
400	5.52	2.91	2.36
500	5.46	2.67	2.23
630	5.19	2.54	2.24
800	5.09	2.62	2.18
1000	5.26	2.82	2.18
1250	5.46	2.85	2.22
1600	5.33	2.63	2.18
2000	4.82	2.50	2.11
2500	4.13	2.32	1.95
3150	3.32	2.01	1.71
4000	2.56	1.70	1.49
5000	1.93	1.40	1.27

2.3 List of test equipment

The test equipment used is listed in Table C.2.

Table C.2. Test equipment.

Name	Manufacturer	Type	Serial-No.
AD-/DA-converter	RME	Multiface II	22460388
Amplifier	APart	Champ One	09070394
Dodecahedron	Müller-BBM	DOD130B	265201
Dodecahedron	Müller-BBM	DOD130B	265202
Dodecahedron	Müller-BBM	DOD130B	265203
Dodecahedron	Müller-BBM	DOD130B	265204
Microphone	Microtech	M360	1783
Microphone	Microtech	M360	1785
Microphone	Microtech	M360	1786
Microphone	Microtech	M360	1787
Microphone	Microtech	M360	1788
Microphone	Microtech	M360	1789
Hygro-/Thermometer	Testo	Saveris H1E	01554624
Barometer	Lufft	Opus 10	030.0910.0003.9.4.1.30
Software for measurement and evaluation	Müller-BBM	Bau 4	Version 1.6