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2019-08-08
M83419/08 MSG/STEG

Wall sandwich panel ROMA AFP 060, one side perforated of the company Romakowski

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

Test Report No. M83419/08

Client:	Romakowski GmbH & Co. KG Postfach 53 86644 Buttenwiesen GERMANY
Consultant:	M. Eng. Philipp Meistring
Report date:	2019-08-08
Delivery date of test object:	2019-08-08
Date of test:	2019-08-08
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1 Aufgabenstellung

On behalf of the company ROMA-Dämmsysteme, Romakowski GmbH & Co. KG, 86647 Buttenwiesen, Germany the sound absorption coefficient of wall sandwich panels of the type ROMA AFP 060 with one sided perforated decking was to be determined in the reverberation room according to DIN EN ISO 354 [1].

The results are to be evaluated according to DIN EN ISO 11654 [2] and ASTM C 423 [1].

2 Basis

This test report is based on the following standards:

[1] DIN EN ISO 354 „Acoustics – Measurements of sound insulation in reverberation rooms.“ December 2003

[2] DIN EN ISO 11654 „Acoustics – Sound absorbers for use in buildings – Rating of sound absorption.“, July 1997.

[1] ASTM C 423-17: Standard Test Method for Sound Absorption and Sound Absorption Coefficients by the Reverberation Room Method.
Revision: 17. February 2017.

[2] ISO 9613-1: Acoustics - Attenuation of sound during propagation outdoors - Part 1: calculation of the absorption of sound by the atmosphere. 1993-06

3 Test conditions and test objects

3.1 Test conditions

The test assembly was mounted according to DIN EN ISO 354 [1], section 6.2.1 as type A according to Appendix B.

The assembly of the test object was carried out by employees of the client on the day of testing.

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3.2 Test objects

The wall sandwich panels, type ROMA AFP 060, one side perforated are built up as follows (from top to bottom):

- 0.6 mm plastic coated perforated steel skin layer t = 0.6 mm, perforation type DIN 24041 – Rv 4 – 7: round perforation in staggered rows, size of hole (diameter) w = 4 mm, hole pitch p = 7 mm, percentage of perforation A_0 = 30 % holohedral perforated, imperforated border (width approx. 40 mm) alongside the longitudinal edges
- approx. 60 mm core layer: mineral fibre insulation, adjusted to web (fibers vertical to skin layers), density > 100 kg/m^3 (acc. to manufacturer's information), covered with glass fleece on the side of the perforated skin layer
- 0.5 mm plastic coated steel skin layer t = 0.5 mm

Bondings of skin layers with core layer are factory-made with a polyurethane adherence system.

The test assembly was made of three equal sized part elements. The elements had the following dimensions and masses (specification determined by testing laboratory):

- dimensions L x W x H = 3000 mm x1150 mm x 60 mm
- mass m = 47.5 kg
- area specific mass m'' = 13.8 kg/m^2

The elements were positioned on the floor of the reverberation room with the perforated side top. The part elements were jointed alongside the profiled longitudinal edge in practical arrangement. The clearance between the elements was adjusted corresponding to the practical-oriented value.

The test object was bordered circumferential by an enclosing frame made of 19 mm thick wood composite panels (frame height 60 mm).

The joints between the frame and the floor of the reverberation room as well as between the frame and the test object were sealed with adhesive tape.

The total dimensions of the test area (excl. enclosing frame) were
length x width = 3470 mm x 3000 mm = 10.41 m².

Photographs of the test assembly on the floor of the reverberation room can be seen in appendix B. Appendix C contains manufacturer's drawings of the test object.

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4 Test procedure

The measurements of the sound absorption in the reverberation room were effected according to DIN EN ISO 354 [1].

Test procedure, test facility and test equipment used are listed in Appendix D.

5 Evaluation

The sound absorption coefficient α_S was determined in one-third octave bands in the range of 100 Hz…5000 Hz according to DIN EN ISO 354 [1].

In addition to the sound absorption coefficients the following characteristic values were determined according to DIN 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 [1] 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 certificate in Appendix A.

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7 Remarks

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

M. Eng. Philipp Meistring
(Project manager)

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Sound absorption coefficient ISO 354

Measurement of sound absorption in reverberation rooms

Client: Roma DÄMM-SYSTEME, Romakowski GmbH und Co. KG,
Herdweg 31, D-86647 Buttenwiesen

Test specimen: ROMA wall sandwich element AFP 060, one side perforated

Test object:

- Wall sandwich element type ROMA AFP 060, one side perforated
- Test set-up (from top to bottom):
  - 0.6 mm — plastic coated perforated steel skin layer t = 0.6 mm, perforation type DIN 24041 - Rv 4 - 7; percentage of perforation A_0 = 30 %, perforated all-over, imperforated border alongside the longitudinal edges
  - approx. 60 mm — core layer: mineral fibre insulation, adjusted to web (fibers vertical to skin layers), density ρ > 100 kg/m³ (acc. to manufacturer's information), covered with glass fleece on the side of the perforated skin layer
  - 0.5 mm — plastic coated steel skin layer t = 0.5 mm (imperforated)
  - floor of the reverberation room
- bondings of skin layers with polyurethane adherence system
- area specific mass m'' = 13.8 kg/m², determined by the mass of a test object

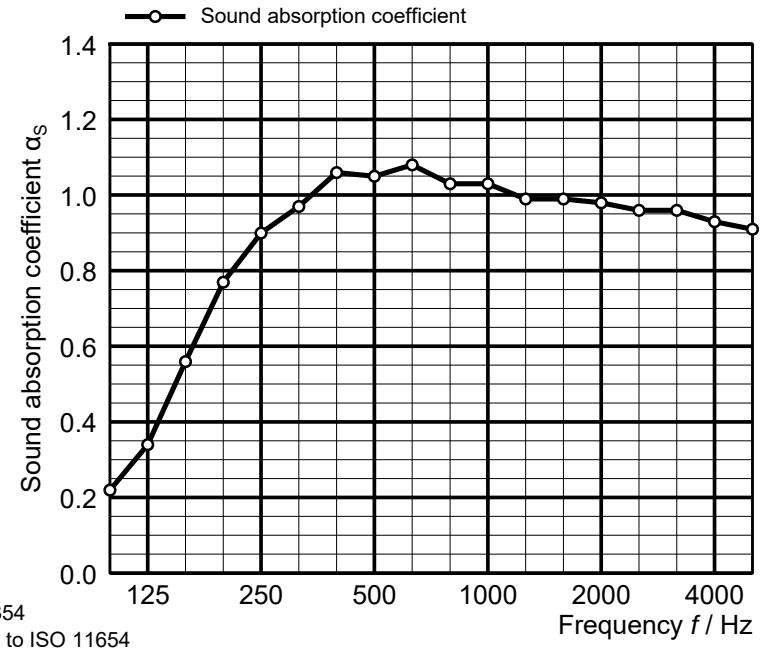
Test arrangement:

- mounting type A according to EN ISO 354
- 3 elements (each length x width x height = 3000 mm x 1150 mm x 60 mm) laid flatly, with the perforated cover on top on the reverberation room floor
- element joints with slot spring profiles of the elements in practical arrangement
- circumferential enclosing frame made of 19 mm thick wood composite panels (frame height 60 mm).
- test surface (inside the enclosing frame) length x width = 3470 mm x 3000 mm

Room: Hallraum E
Volume: 199.60 m³
Size: 10.41 m²
Date of test: 2019-08-08

	θ [°C]	*r. h.* [%]	*B* [kPa]
without specimen	22.7	68.8	95.2
with specimen	22.8	70.4	95.1

Frequency [Hz]	α_S 1/3 octave	α_p octave
100	0.22	
125	0.34	0.35
160	0.56	
200	0.77	
250	0.90	0.90
315	0.97	
400	1.06	
500	1.05	1.00
630	1.08	
800	1.03	
1000	1.03	1.00
1250	0.99	
1600	0.99	
2000	0.98	1.00
2500	0.96	
3150	0.96	
4000	0.93	0.95
5000	0.91	



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 = 1.00	**Noise Reduction Coefficient *NRC* = 1.00**
Sound absorption class: A	**Sound Absorption Average *SAA* = 0.98**

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Wall sandwich element type ROMA AFP060, one side perforated

Figure B.1. Element section with connecting profile (slot side).

Figure B.2. Element section with connecting profile (key side).

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Wall sandwich element type ROMA AFP060, one side perforated

Figure B.3. Element section at element joint.

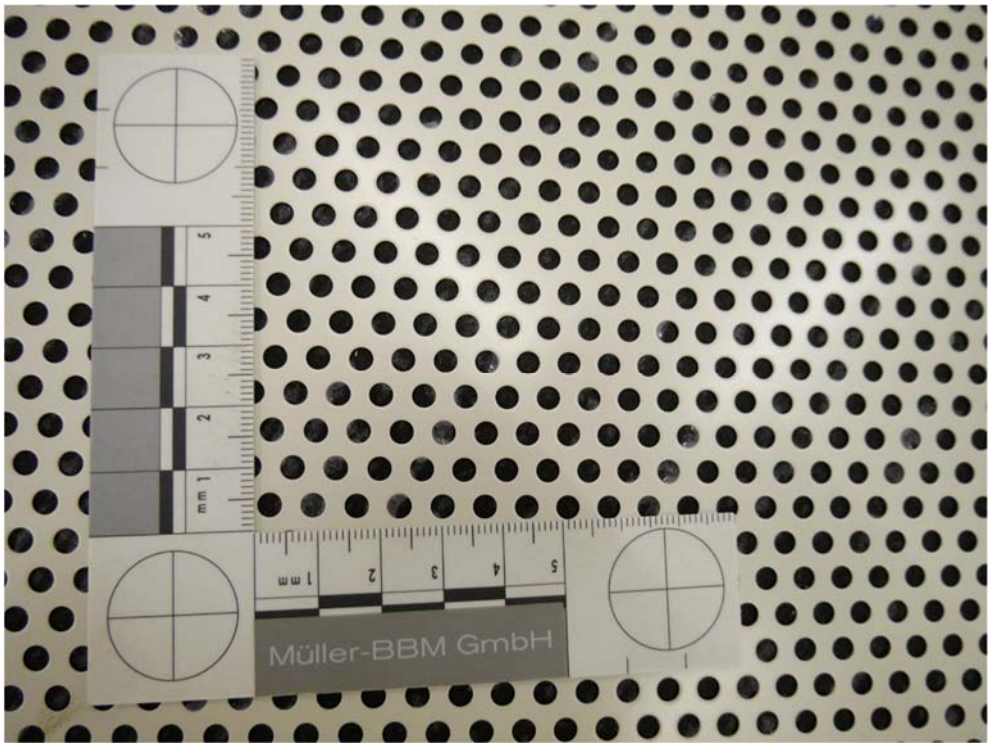

Figure B.4. Perforated surface, perforation type DIN 24041 – Rv 4 – 7

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Wall sandwich element type ROMA AFP060, one side perforated

Figure B.5. Test arrangement: detail element joint and enclosing frame.

Figure B.6. Test arrangement in the reverberation room.

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Wall sandwich element type ROMA AFP060, one side perforated

Manufacturer's drawings (without scale, dimensions in mm)

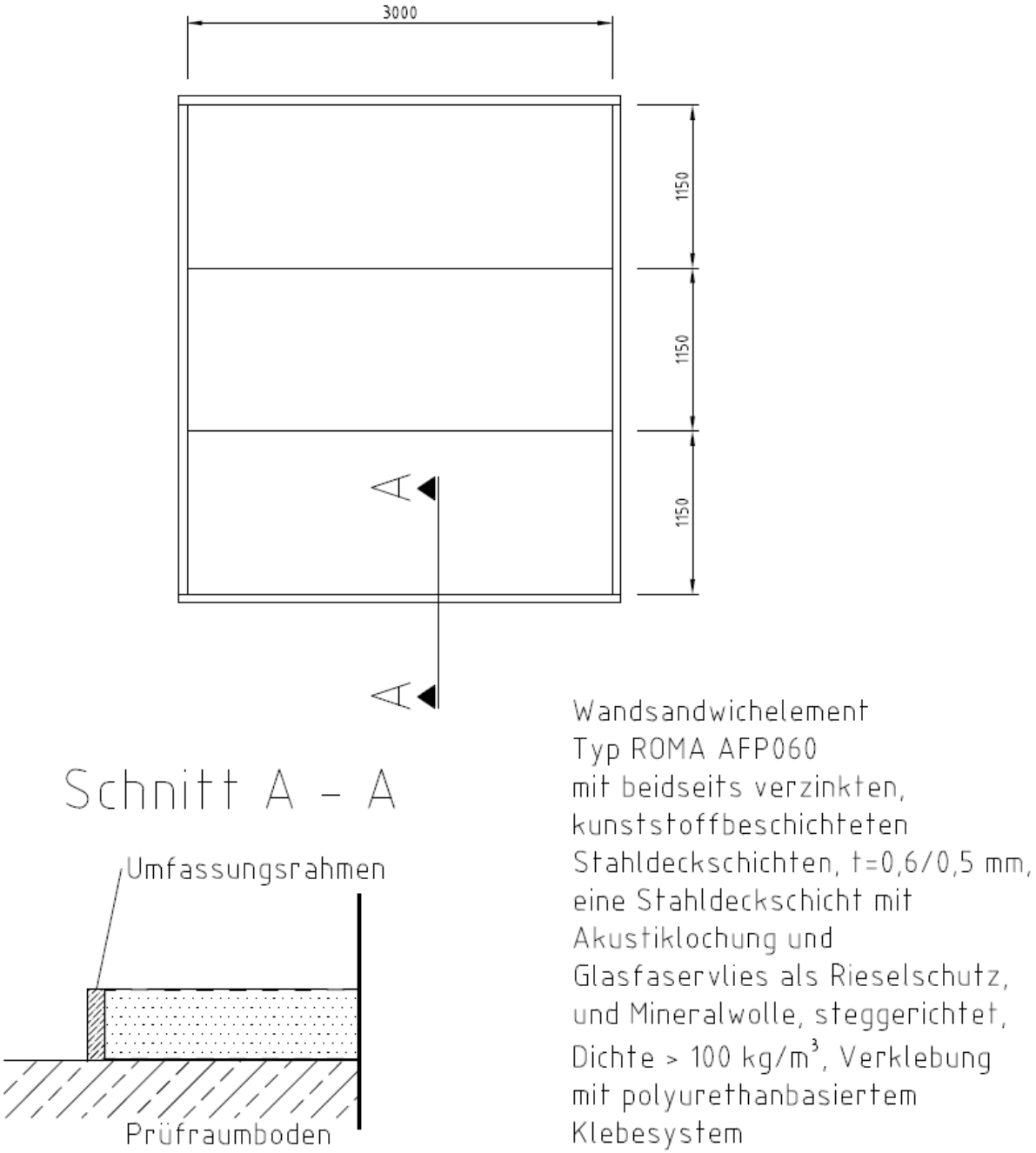

Figure C.1. Test arrangement in the reverberation room.

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Wall sandwich element type ROMA AFP060, one side perforated

Manufacturer's drawings (without scale, dimensions in mm)

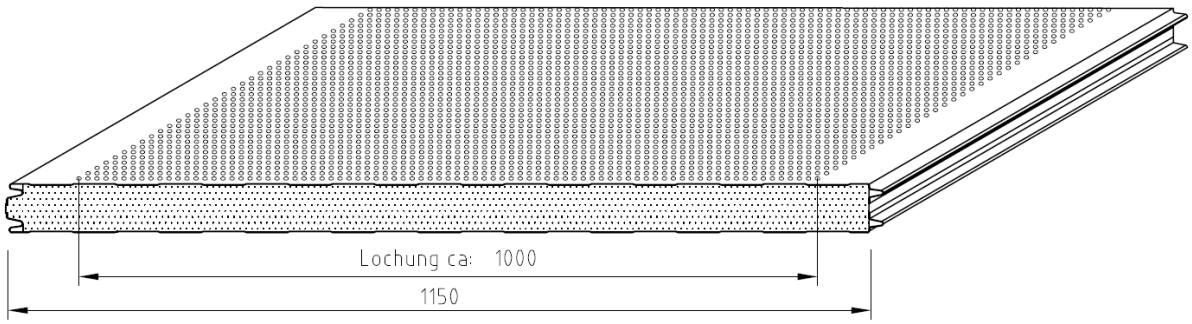

Figure C.2. Isometric drawing of the wall sandwich element.

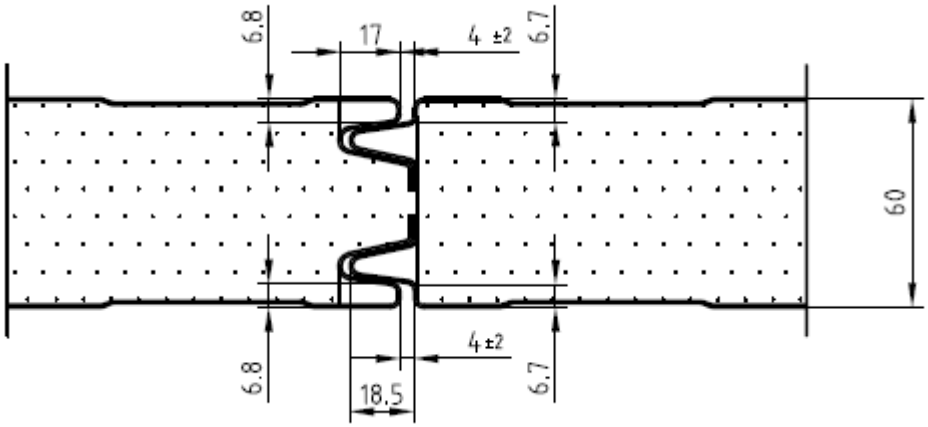

Figure C.3. Detail drawing: element joint.

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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 m²;

S area covered by the test object in m²;

V volume of the reverberation room in m³;

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 DIN EN ISO 354 [1]. The calculation of the power attenuation coefficients was effected according to ISO 9613-1 [2]. 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 DIN EN ISO 354 [1].

2 Test procedure

2.1 Description of the reverberation room

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

The reverberation room has a volume of V = 199.6 m³ and a surface of S = 216 m².

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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 D.1 shows the drawings of the reverberation room.

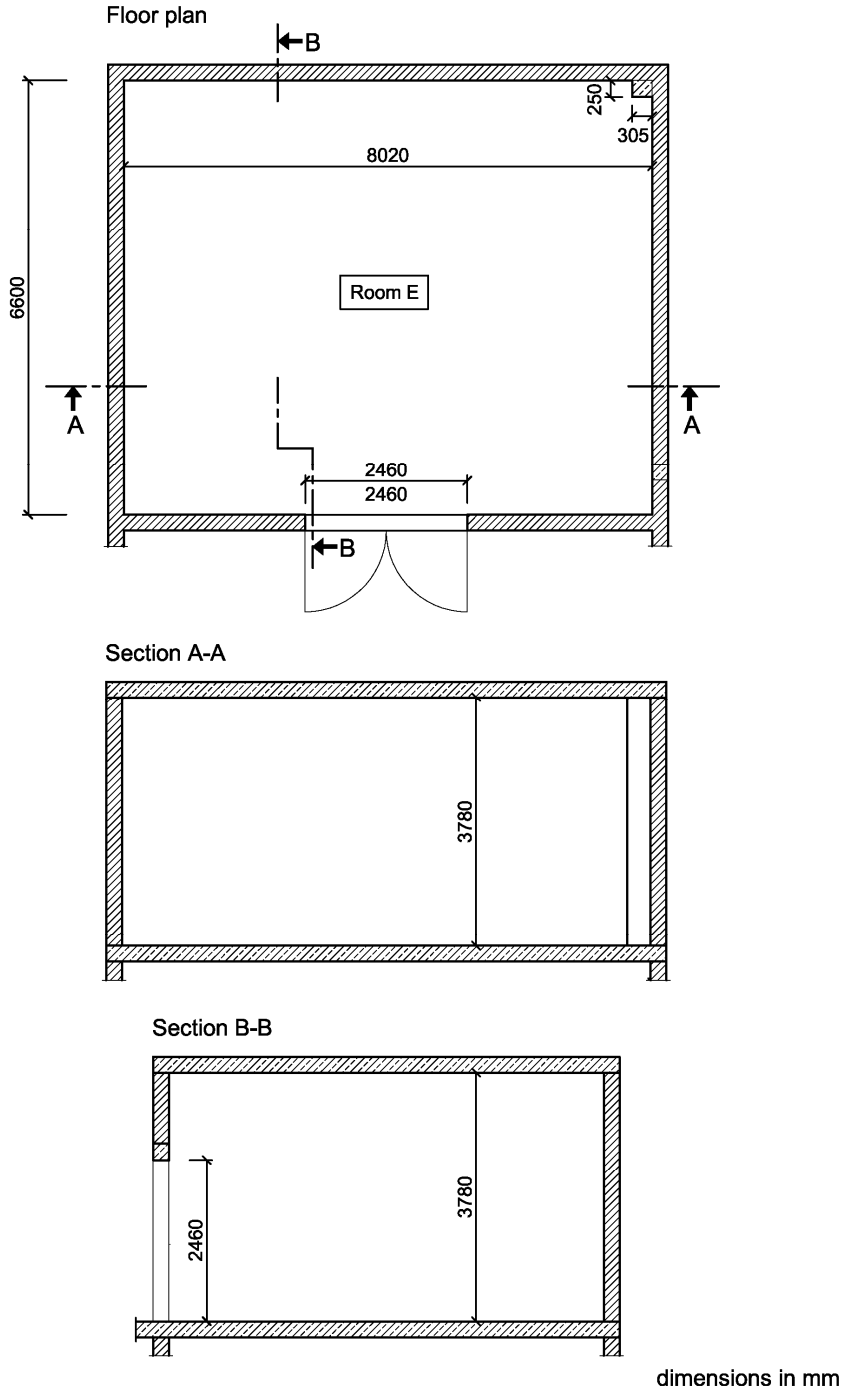

Figure D.1. Plan view and sections of the reverberation room.

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2.2 Measurement of reverberation time

The determination of the impulse responses was 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 DIN 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 D.1.

Frequency *f* / Hz	**Reverberation time *T* / s**	
	T_1 (without test object)	**T_2 (with test object)**
100	5.08	3.74
125	5.53	3.42
160	5.53	2.76
200	5.08	2.23
250	5.13	2.05
315	4.89	1.93
400	5.26	1.87
500	5.23	1.88
630	5.08	1.83
800	4.81	1.84
1000	5.09	1.88
1250	5.16	1.94
1600	5.20	1.94
2000	4.93	1.92
2500	4.35	1.85
3150	3.70	1.71
4000	2.98	1.57
5000	2.60	1.48

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2.3 List of test equipment

The test equipment used is listed in Table D.2

Table D.2. Test equipment.

Name	Manufacturer	Type	Serial-No.
AD-/DA-converter	RME	Fireface 802	23811470
Amplifier	APart	Champ 2	09050048
Dodecahedron	Müller-BBM	DOD360A	372828
Dodecahedron	Müller-BBM	DOD360A	372829
Dodecahedron	Müller-BBM	DOD360A	372830
Dodecahedron	Müller-BBM	DOD360A	372831
Microphone	Microtech	M370	1355
Microphone	Microtech	M370	1356
Microphone	Microtech	M360	1786
Microphone	Microtech	M360	1787
Microphone	Microtech	M360	1788
Microphone	Microtech	M360	1789
Microphone power supply	MFA	IV80F	330364
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 1.11

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