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TURKU UNIVERSITY OF APPLIED SCIENCES

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FINAS Finnish Accreditation Service T293 (EN ISO/IEC 17025)

DETERMINATION OF ACOUSTIC ABSORPTION COEFFICIENT IN LABORATORY CONDITIONS

1 CLIENT

P. Rotola-Pukkila Oy, Pauli Rotola-Pukkila. Tender February 10, 2020.

2 DESCRIPTION OF THE COMMISSION

Sound absorption coefficient α_S was measured for the specimen within 100–5000 Hz according to ISO 354:2003. Sound absorption class was determined according to EN ISO 11654:1997.

3 RESULTS

The weighted sound absorption coefficient α_w and the sound absorption class for the specimens are described in table 1. Detailed results are presented in Annex 1.

Table 1. The weighted sound absorption coefficient α_w and the sound absorption class for the specimen with different configurations.

Specimen	α_w	Absorption class
Laatupaneeli + mineral wool 50 mm + air gap 150 mm	0.65	C
Laatupaneeli + air gap 200 mm	0.55	D
Laatupaneeli + mineral wool 50 mm	0.65	C
Laatupaneeli + air gap 50 mm	0.60	C

4 SIGNATURES

Valtteri Hongisto
Research Group Leader

Reijo Alakoivu
Research Engineer

Turku University of Applied Sciences
Engineering and Business, Construction Industry
Laboratory of acoustics

ANNEXES

Annex 1 – Test results (4 pages)
Annex 2 – Structure drawings (1 page)
Annex 3 – Mounting of specimen (2 page)
Annex 4 – Measurement arrangements (1 page)

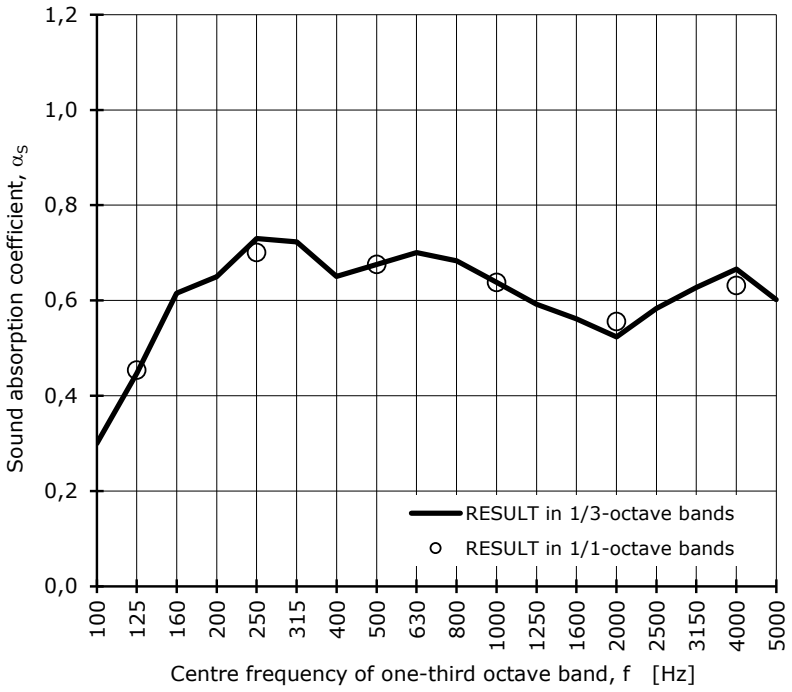
Determination of acoustic absorption coefficient according to ISO 354:2003 in laboratory conditions

Specimen id: **Laatupaneeli + mineral wool 50 mm + air gap 150 mm**

Manufacturer: P. Rotola-Pukkila Oy
Client: P. Rotola-Pukkila Oy
Contact person: Pauli Rotola-Pukkila
Mounting by: Hannu Rotola-Pukkila
Test laboratory: Turku University of Applied Sciences, Laboratory of Acoustics
Lemminkäisenkatu 14-18 B, 20520 Turku, Finland. www.turkuamk.fi

Specimen area:		10,5	m^2		Test room volume:	155 m^3
Temperature of test room:	21	21	°C	(without / with specimen)	Room boundary area:	179 m^2
Relative humidity:	62	66	%	(without / with specimen)	Test date:	17.2.2020
Atmospheric pressure:	98	98	kPa	(without / with specimen)	Test file identification:	T170220b

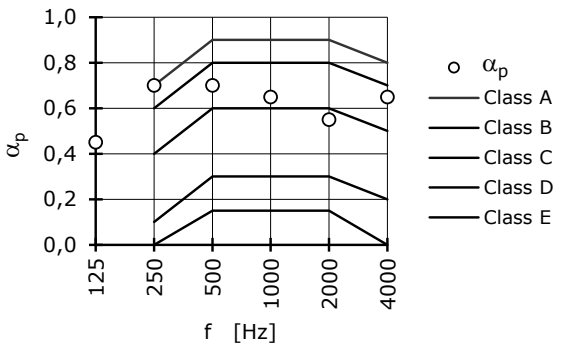
	1/3	1/1	1/1	
f (Hz)	**α_S**	**α_S**	**α_p**	
100	0,30			
125	0,45	0,45	0,45	**
160	0,62			**
200	0,65			
250	0,73	0,70	0,70	
315	0,72			
400	0,65			
500	0,68	0,68	0,70	
630	0,70			
800	0,68			
1000	0,64	0,64	0,65	
1250	0,59			
1600	0,56			
2000	0,52	0,56	0,55	
2500	0,58			
3150	0,63			
4000	0,67	0,63	0,65	
5000	0,60			



Absorption class (EN ISO 11654)
C

** Total absorption area of the empty test room is higher than ISO 354 requires.

The uncertainty of the test result is higher than ISO 354 expects.



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Reijo Alakoivu
Research Engineer
test performer

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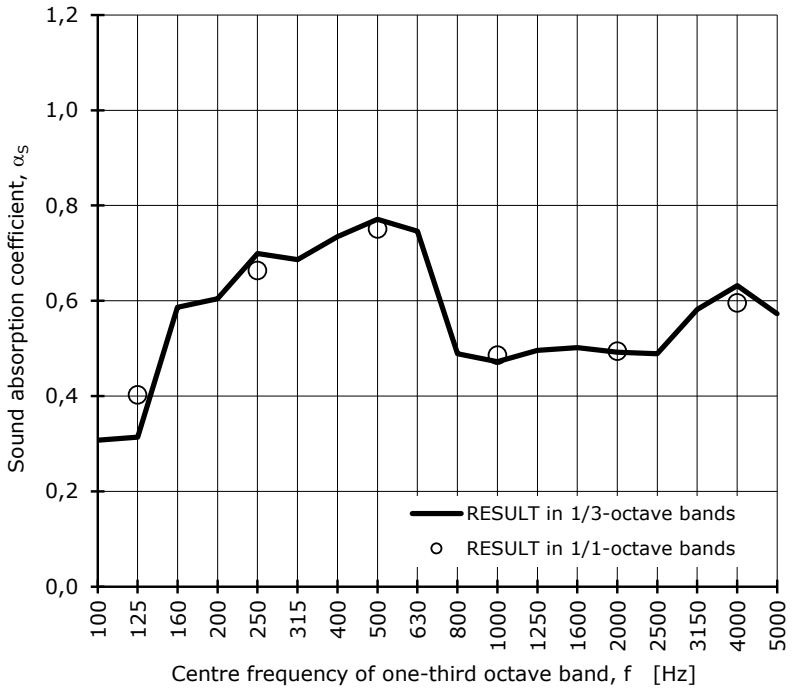
Determination of acoustic absorption coefficient according to ISO 354:2003 in laboratory conditions

Specimen id: **Laatupaneeli + air gap 200 mm**

Manufacturer: P. Rotola-Pukkila Oy
Client: P. Rotola-Pukkila Oy
Contact person: Pauli Rotola-Pukkila
Mounting by: Hannu Rotola-Pukkila
Test laboratory: Turku University of Applied Sciences, Laboratory of Acoustics
Lemminkäisenkatu 14-18 B, 20520 Turku, Finland. www.turkuamk.fi

Specimen area:		10,5 m^2		Test room volume:	155 m^3
Temperature of test room:	21	21 °C	(without / with specimen)	Room boundary area:	179 m^2
Relative humidity:	62	61 %	(without / with specimen)	Test date:	17.2.2020
Atmospheric pressure:	98	98 kPa	(without / with specimen)	Test file identification:	T170220c

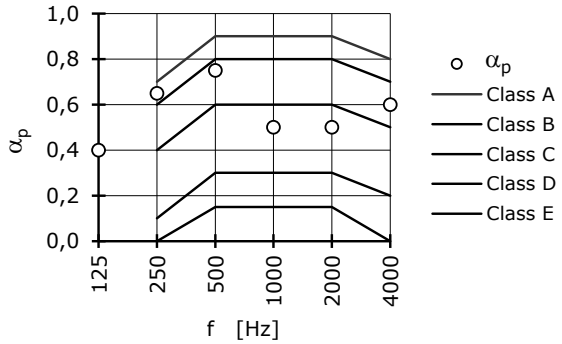
	1/3	1/1	1/1	
f (Hz)	α_s	α_s	α_p	
100	0,31			
125	0,31	0,40	0,40	**
160	0,59			**
200	0,60			
250	0,70	0,66	0,65	
315	0,69			
400	0,73			
500	0,77	0,75	0,75	
630	0,75			
800	0,49			
1000	0,47	0,49	0,50	
1250	0,50			
1600	0,50			
2000	0,49	0,49	0,50	
2500	0,49			
3150	0,58			
4000	0,63	0,60	0,60	
5000	0,57			



Absorption class (EN ISO 11654)
D

** Total absorption area of the empty test room is higher than ISO 354 requires.

The uncertainty of the test result is higher than ISO 354 expects.



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Research Engineer
test performer

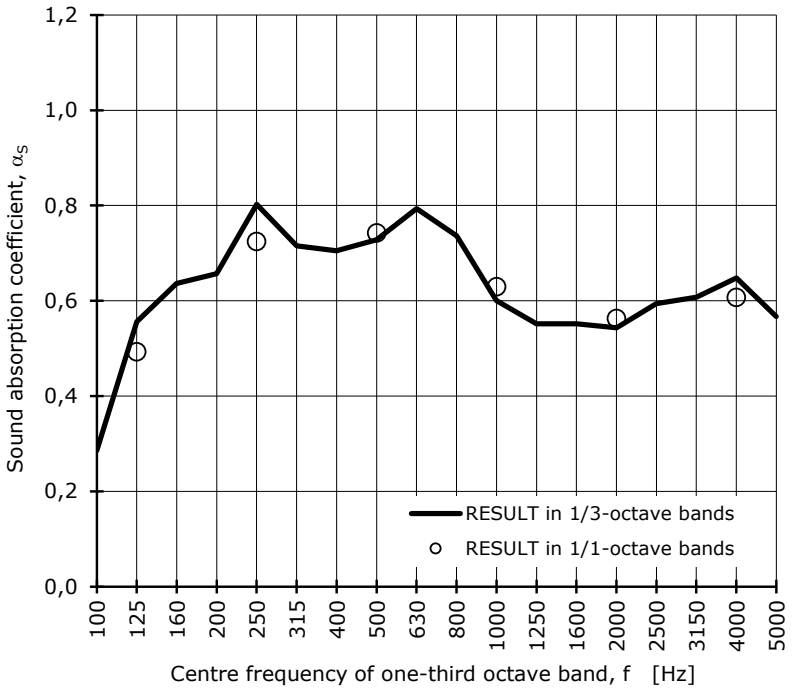
Determination of acoustic absorption coefficient according to ISO 354:2003 in laboratory conditions

Specimen id: **Laatupaneeli + mineral wool 50 mm**

Manufacturer: P. Rotola-Pukkila Oy
Client: P. Rotola-Pukkila Oy
Contact person: Pauli Rotola-Pukkila
Mounting by: Hannu Rotola-Pukkila
Test laboratory: Turku University of Applied Sciences, Laboratory of Acoustics
Lemminkäisenkatu 14-18 B, 20520 Turku, Finland. www.turkuamk.fi

Specimen area:		10,5	m^2		Test room volume:	155 m^3
Temperature of test room:	21	21	°C	(without / with specimen)	Room boundary area:	179 m^2
Relative humidity:	62	63	%	(without / with specimen)	Test date:	17.2.2020
Atmospheric pressure:	98	98	kPa	(without / with specimen)	Test file identification:	T170220d

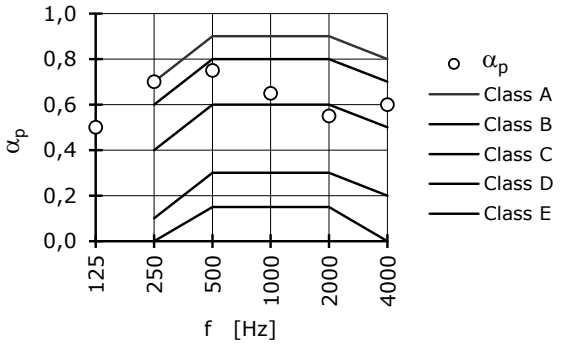
	1/3	1/1	1/1	
f (Hz)	α_S	α_S	α_p	
100	0,29			
125	0,56	0,49	0,50	**
160	0,64			**
200	0,66			
250	0,80	0,72	0,70	
315	0,72			
400	0,71			
500	0,73	0,74	0,75	
630	0,79			
800	0,74			
1000	0,60	0,63	0,65	
1250	0,55			
1600	0,55			
2000	0,54	0,56	0,55	
2500	0,59			
3150	0,61			
4000	0,65	0,61	0,60	
5000	0,57			



Absorption class (EN ISO 11654)
C

** Total absorption area of the empty test room is higher than ISO 354 requires.

The uncertainty of the test result is higher than ISO 354 expects.



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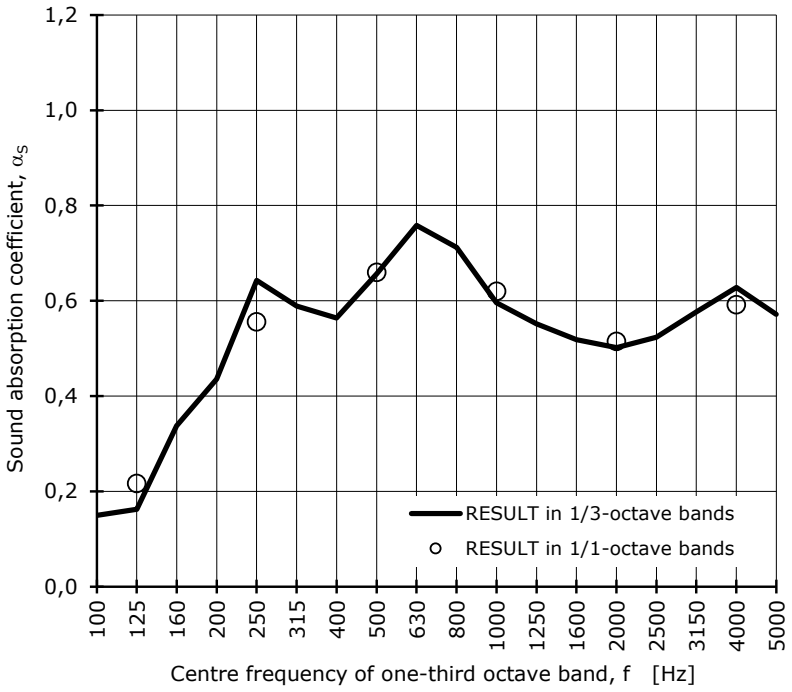
Determination of acoustic absorption coefficient according to ISO 354:2003 in laboratory conditions

Specimen id: **Laatupaneeli + air gap 50 mm**

Manufacturer: P. Rotola-Pukkila Oy
Client: P. Rotola-Pukkila Oy
Contact person: Pauli Rotola-Pukkila
Mounting by: Hannu Rotola-Pukkila
Test laboratory: Turku University of Applied Sciences, Laboratory of Acoustics
Lemminkäisenkatu 14-18 B, 20520 Turku, Finland. www.turkuamk.fi

Specimen area:		10,5 m^2		Test room volume:	155 m^3
Temperature of test room:	21	21 °C	(without / with specimen)	Room boundary area:	179 m^2
Relative humidity:	62	62 %	(without / with specimen)	Test date:	17.2.2020
Atmospheric pressure:	98	98 kPa	(without / with specimen)	Test file identification:	T170220e

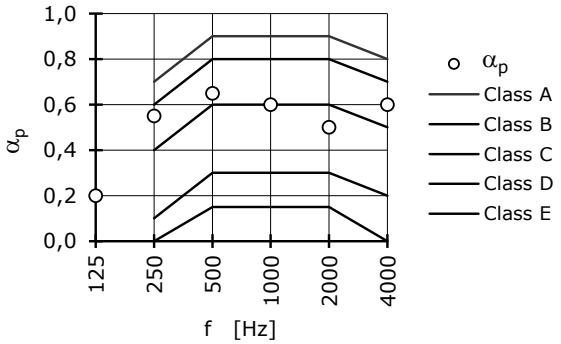
	1/3	1/1	1/1	
f (Hz)	**α_S**	**α_S**	**α_p**	
100	0,15			
125	0,16	0,22	0,20	**
160	0,34			**
200	0,44			
250	0,64	0,56	0,55	
315	0,59			
400	0,56			
500	0,66	0,66	0,65	
630	0,76			
800	0,71			
1000	0,60	0,62	0,60	
1250	0,55			
1600	0,52			
2000	0,50	0,51	0,50	
2500	0,52			
3150	0,58			
4000	0,63	0,59	0,60	
5000	0,57			



Absorption class (EN ISO 11654)
C

** Total absorption area of the empty test room is higher than ISO 354 requires.

The uncertainty of the test result is higher than ISO 354 expects.



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ANNEX 2 – STRUCTURE DRAWINGS

The client did not provide specific structure drawings for the four products. Annex 3 describes the four structures.

ANNEX 3 – MOUNTING OF SPECIMEN

The specimens were mounted on the floor of the reverberation room in conformance with **ISO 354:2003 Annex B, Type E mounting**. Laatupaneeli panels were installed on the floor (Figure A3.1) with four different configurations:

1. Laatupaneeli + mineral wool 50 mm + air gap 150 mm
2. Laatupaneeli + air gap 200 mm
3. Laatupaneeli + mineral wool 50 mm
4. Laatupaneeli + air gap 50 mm

The specimen was surrounded on the edges by a wooden vertical frame. The height of the frame was 200 mm for configurations 1-2 and 50 mm for configurations 3-4. The side edges of the specimen were covered with adhesive tape. The panels were screwed onto the rack. The total size of specimen area was 10.5 m^2. The wooden frame was ignored when calculating the total area. The weight of one Laatupaneeli panel was 6.7 kg.

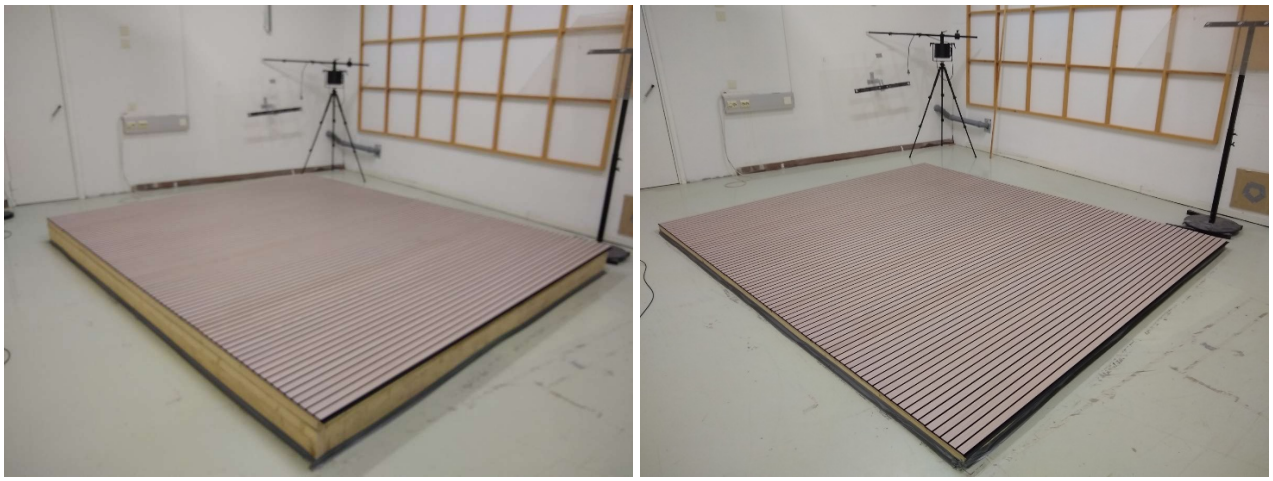


Figure A3.1. The specimens mounted on the floor of the reverberation room. Configurations 1-2 on the left and configurations 3-4 on the right.

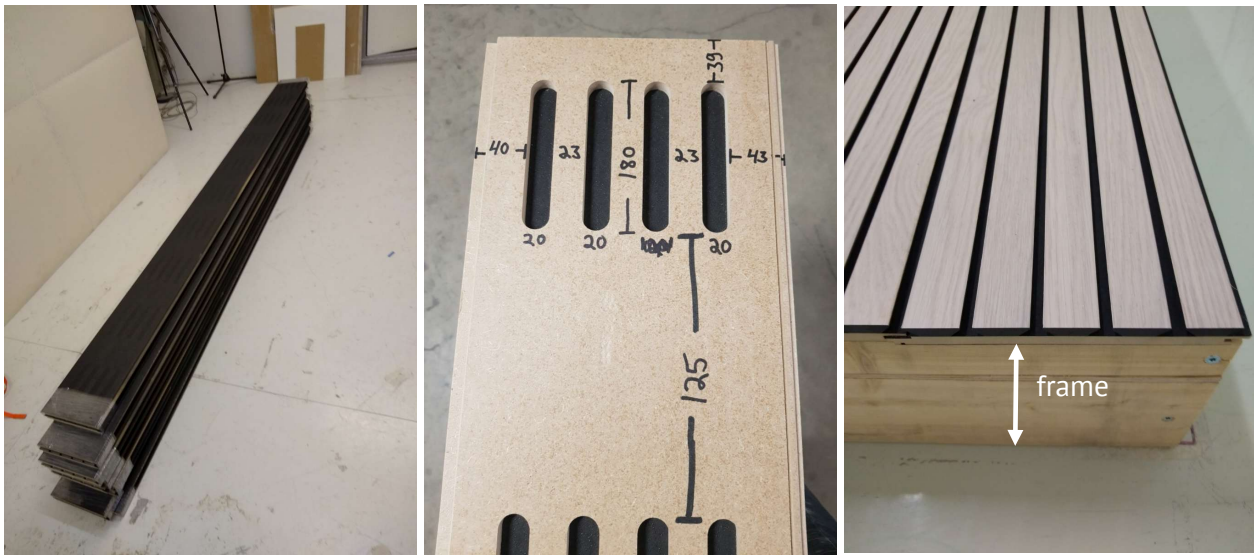


Figure A3.2. Laatupaneeli panels (L3000 × W217 mm). The panel has 40 openings on the back side (picture in the middle). The front of the panel is five 35 mm wooden lists and a 7 mm gap between them (picture in the right).

Figure A3.3. The panels were attached to the wooden frame (L3500 × W3000 × H50/200 mm). Total size of the installation was 10.5 m^2 (16 panels).

ANNEX 4 – MEASUREMENT ARRANGEMENTS

1 Acoustical measurements

The test signal was produced to the test room using three fixed omnidirectional loudspeakers (6 x Seas W12CY001). The test signal (pink noise) was produced by a real time analyzer (Norsonic 121) and amplified with terminal amplifier (QSC 1300 W USA). The sound pressure level in the reverberation room was measured with a condenser microphone on a tripod (Bruel&Kjær 4190 equipped with a pre-amplifier Bruel&Kjær 2669).

The reverberation time at third-octave bands was measured with the real time analyzer (Norsonic 121) using 20 dB decay range. All frequency bands were measured using 2 sources simultaneously and 6 microphone locations. In every location 3 decays were measured. The total number of reverberation time measurements was 36.

The acoustical measurement equipment fulfilled the following IEC standards and grades of accuracy:

IEC 60651	Sound level meters (replaced by IEC 61672)	**type 1**
IEC 60804	Integrating sound level meters (replaced by IEC 61672)	**type 1**
IEC 61260	Octave-band and fractional-octave-band filters	**class 1**
IEC 60942	Sound level calibrators	**class 1**

The test laboratory operates in conformance with EN/ISO/IEC 17025.

2 Other measurements

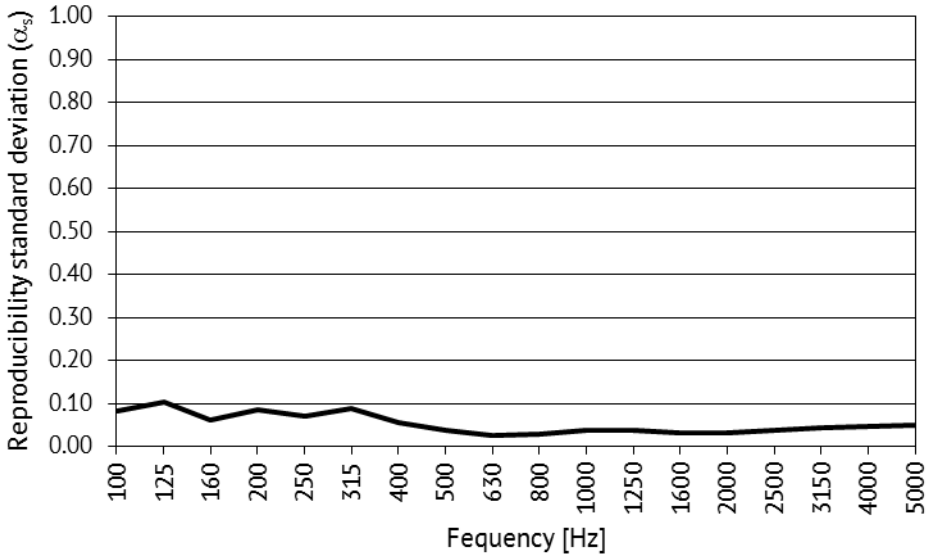
The temperature, the ambient atmospheric pressure and the relative humidity of the measurement room were measured using an environmental measurement device (Thermo Recorder TR-73U). The specimen was weighed with a 150 kg precision weighing machine (PM 150). The dimensions of the specimen were measured with a roll meter (Stanley FatMax).

3 The test room

The reverberation room was equipped with six fixed diffuser panels. The positions were selected randomly in respect with altitude, angle and position. The amount of diffusers and their arrangement fulfills the requirements of Annex A in ISO 354. The reverberation time of the reverberation room fulfills the requirements of ISO 354 for 155 m^3 test room except for the third octave bands 160 and 200 Hz, where the reverberation time was at most 17 % below the minimum required reverberation time.

4 The uncertainty of sound absorption coefficient

The uncertainty of reproducibility expresses the differences between the laboratories. In an Inter-Laboratory test (Tyrens Test Codes for Suspended Ceilings – Sound absorption RRT 2011), in which 22 laboratories were participating. The uncertainty of weighted sound absorption coefficient α_w was 0.028. The uncertainty of sound absorption coefficients α_S in one-third octave bands is presented in the figure below. The results of the Round Robin Test are reported by Andersson (2011).



5 References to the ISO standards

Test: ISO 354:2003 (E) Acoustics - Measurement of sound absorption in a reverberation room, International Organization for Standardization, 2003, Genève, Switzerland.

SFS-EN ISO 11654:1997 (E) Acoustics - Sound absorbers for use in buildings - Rating of sound absorption, International Organization for Standardization, 1997, Genève, Switzerland.

Andersson N-Å, Test Codes for Suspended Ceilings – Sound absorption RRT, Tyrens AB project no: 224628, Sweden, 2011.