CENTRUM TECHNIKI OKRĘTOWEJ S.A.

Maritime Advanced Research Centre

AB 1241

RESEARCH AND DEVELOPMENT DEPARTMENT

ENVIRONMENTAL LABORATORIES DIVISION

VIBROACOUSTIC TESTS LABORATORY

NOTIFIED BODY
NB 2434

TEST REPORT

No. RS-2023/B-363/E

Evaluation of sound absorption coefficient of
Two PET panels inserted in an aluminium frame and their modifications
producer Apico S.A.

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80-392 Gdańsk

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Contents

1. Basic data

Table 1. Summary of data and test parameters

<table>
<tr><td rowspan="4">Customer:
Apico S.A.
TVA : CHE-100.467.953
Impasse Praz Sallaz 8
1522 Lucens</td><td colspan="3">Order: e-mail from 03.07.2023

CTO S.A. order number: 8:818:07:223</td></tr>
<tr><td colspan="3">Delivery date of test object:
17.10.2023

Date and place of measurements:
Gdańsk, 24-25.10.2023
Maritime Advanced Research Centre
Environmental Laboratories Division
Vibroacoustic Tests Laboratory</td></tr>
<tr><td rowspan="2">Name and type of test object:

Two PET panels inserted in an aluminium frame – on the MDF frame</td><td colspan="3">Method and analysis according to:
• Standard PN-EN ISO 354:2005
• Standard PN-EN ISO 11654:1997</td></tr>
<tr><td rowspan="5">Conditions:</td><td colspan="2"></td></tr>
<tr><td rowspan="4">Manufacturer:
Apico S.A.
Impasse Praz Sallaz 8
1522 Lucens</td><td>Relative humidity</td><td>Tab. 4</td></tr>
<tr><td rowspan="3">Designation of the test object in CTO S.A.:
LA2146, LA2150</td><td>Temperature</td><td>Tab. 4</td></tr>
<tr><td>Atmospheric pressure</td><td>Tab. 4</td></tr>
<tr><td>Measuring equipment:</td><td>Channel 1</td><td>Channel 2</td></tr>
<tr><td>measuring wires</td><td>0SvankK3</td><td>1SvankK3</td></tr>
<tr><td>microphone</td><td>Norsonic 1225
Nr ser. 284627</td><td>Norsonic 1225
Nr ser. 285516</td></tr>
<tr><td>preamplifier</td><td>Norsonic 1209
Nr ser. 21138</td><td>Norsonic 1209
Nr ser. 21137</td></tr>
<tr><td>sound analyzer</td><td>Norsonic Nor 140
nr ser. 1406930</td><td>Norsonic Nor 140
nr ser. 1406929</td></tr>
<tr><td>calibrator</td><td colspan="2">Larson Davis, typ CAL200, nr 11524,</td></tr>
<tr><td>sound source</td><td colspan="2">Larson Davis BAS001
nr seryjny 1225-DIC08</td></tr>
<tr><td>thermo-hygro-barometer</td><td colspan="2">typ LB-706BP, nr 846
typ LB-701, nr 3605</td></tr>
<tr><td>measuring tape</td><td colspan="2">RS/0003</td></tr>
<tr><td colspan="3">Sound absorption results:</td></tr>
<tr><td>Measured value</td><td colspan="2">Actual value</td></tr>
<tr><td>α_w – sound absorption coefficient</td><td colspan="2">Tab. 4</td></tr>
<tr><td colspan="3">Graph of sound absorption as a function of frequency and other relevant information is presented in a form compatible with the PN-EN ISO 354:2005 in chapter 5.</td></tr>
<tr><td colspan="3">Attention: Presented values are valid only for the tested object.</td></tr>
</table>

2. Test method

Measurement of sound absorption was performed in reverberation chamber with a volume of 200 m^3 in the Ship Design and Research Centre, in Acoustic Laboratory. Chamber specification is presented in Table 3 and Fig. 1. Reverberation chamber was tuned to achieve reverberation time required by the standard *PN-EN ISO 354:2005*. This was achieved by setting up 3 attenuator-diffusers and 8 diffusers. Their sound absorption area complies with Table 2.

Table 2. Equivalent sound absorption areas for a 200 m^3 reverberation chamber for sound absorption coefficient measurements

Frequency, Hz	100	125	160	200	250	315	400	500	630	800
A_1, m^2 - Value measured in laboratory	4,2	4,0	4,6	4,8	5,5	5,6	5,6	5,6	5,8	5,9
A_1 Max value acc. to norm	6,5	6,5	6,5	6,5	6,5	6,5	6,5	6,5	6,5	6,5

Frequency, Hz	1000	1250	1600	2000	2500	3150	4000	5000
A_1, m^2 - Value measured in laboratory	6,1	6,3	6,7	7,1	8,0	9,4	11,1	13,6
A_1 Max value acc. to norm	7,0	7,5	8,0	9,5	10,5	12,0	13,0	14,0

Measurements were conducted for 12 *microphone-sound source* positions. Measurement in each position was repeated 3 times, in accordance with requirements of *PN-EN ISO 354:2005*.

Test was carried out using sound analyzer *Nor 140* by Norsonic and analysis was performed in *Nor 850 – Building Acoustics* application. Measurements were performed using methods in accordance with norm *PN-EN ISO 354:2005. Acoustics — Measurement of sound absorption in a reverberation room.*

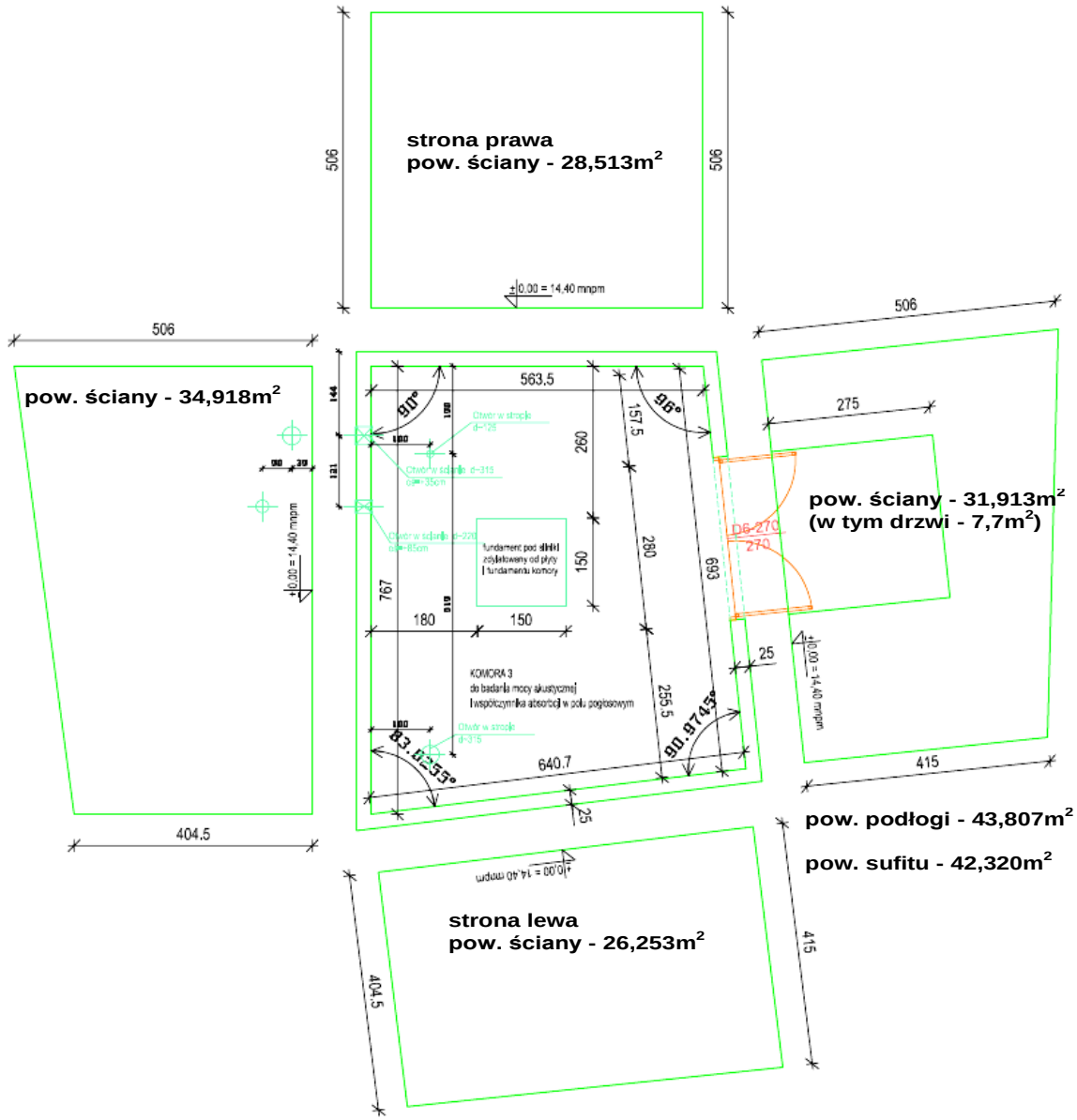


Fig. 1. Reverberation chamber no. 3

Table 3. Dimensions of the reverberation chamber for sound absorption coefficient αs measurements

Volume and wall surface areas of chamber No. 3

	Chamber	No. 3
volume	V [m³]	200,095
floor	S1 [m²]	43,807
ceiling	S2 [m²]	42,320
on the right	S3 [m²]	28,513
wall with door	S4 [m²]	31,913
on the left	S5 [m²]	26,253
opposite of the door	S6 [m²]	34,918
	total area [m²]	207,724

Diagonals of the reverberation chamber No. 3

Chamber No. 3 [m]
10,77
10,34
10,65
10,25

3. Description of the test object

Description has been declared by the Customer. Dimensions and description are presented in APPENDIX section at the end of the report.

Modifications of the test object:

- Two PET panels inserted in an aluminium frame – on the MDF frame – 200mm from the floor – LA2146
- Two PET panels inserted in an aluminium frame – directly on the floor – LA2150

MDF and wood frames have not been enclosed around – there was empty air space behind the test object.

Photos of tested object in Laboratory's reverberation chamber are presented in fig. 1 and 2.

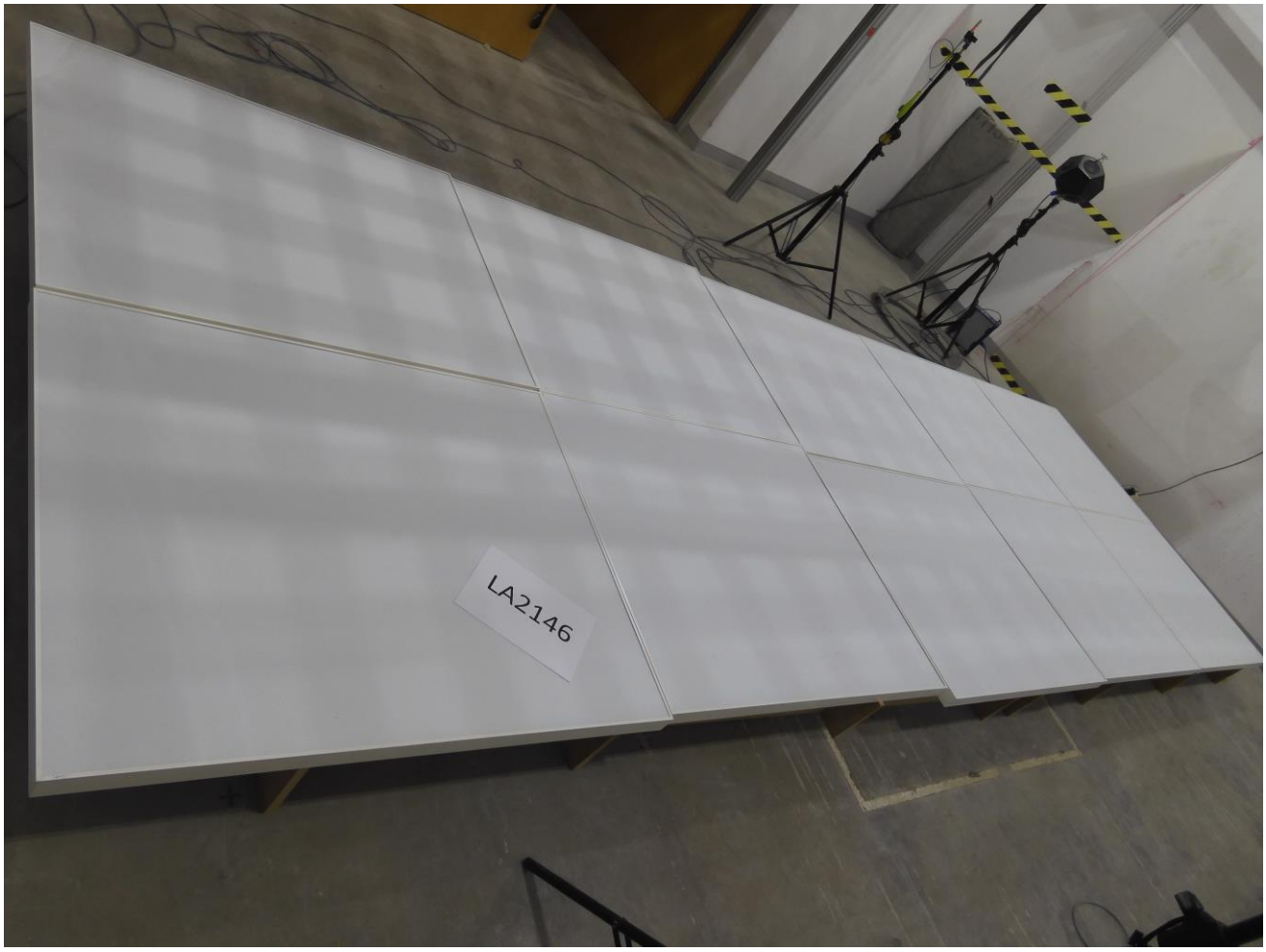


Fig. 1. A photo of tested object No. LA2146 in Laboratory's reverberation chamber

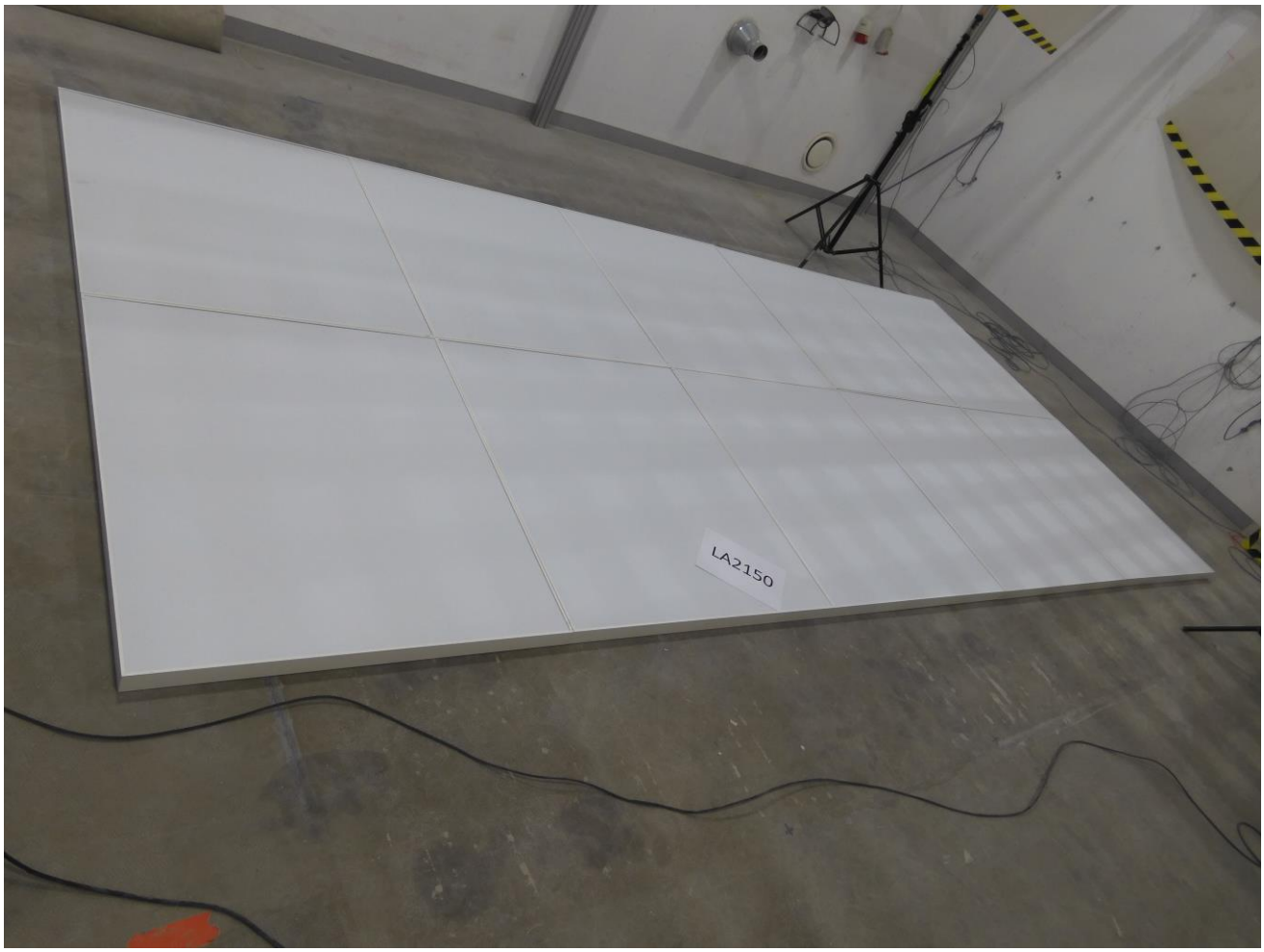


Fig. 2. A photo of tested object No. LA2150 in Laboratory's reverberation chamber

The scheme of measuring chamber K3 in the Vibroacoustic Research Laboratory together with the placement of test object are shown in Fig. 3.

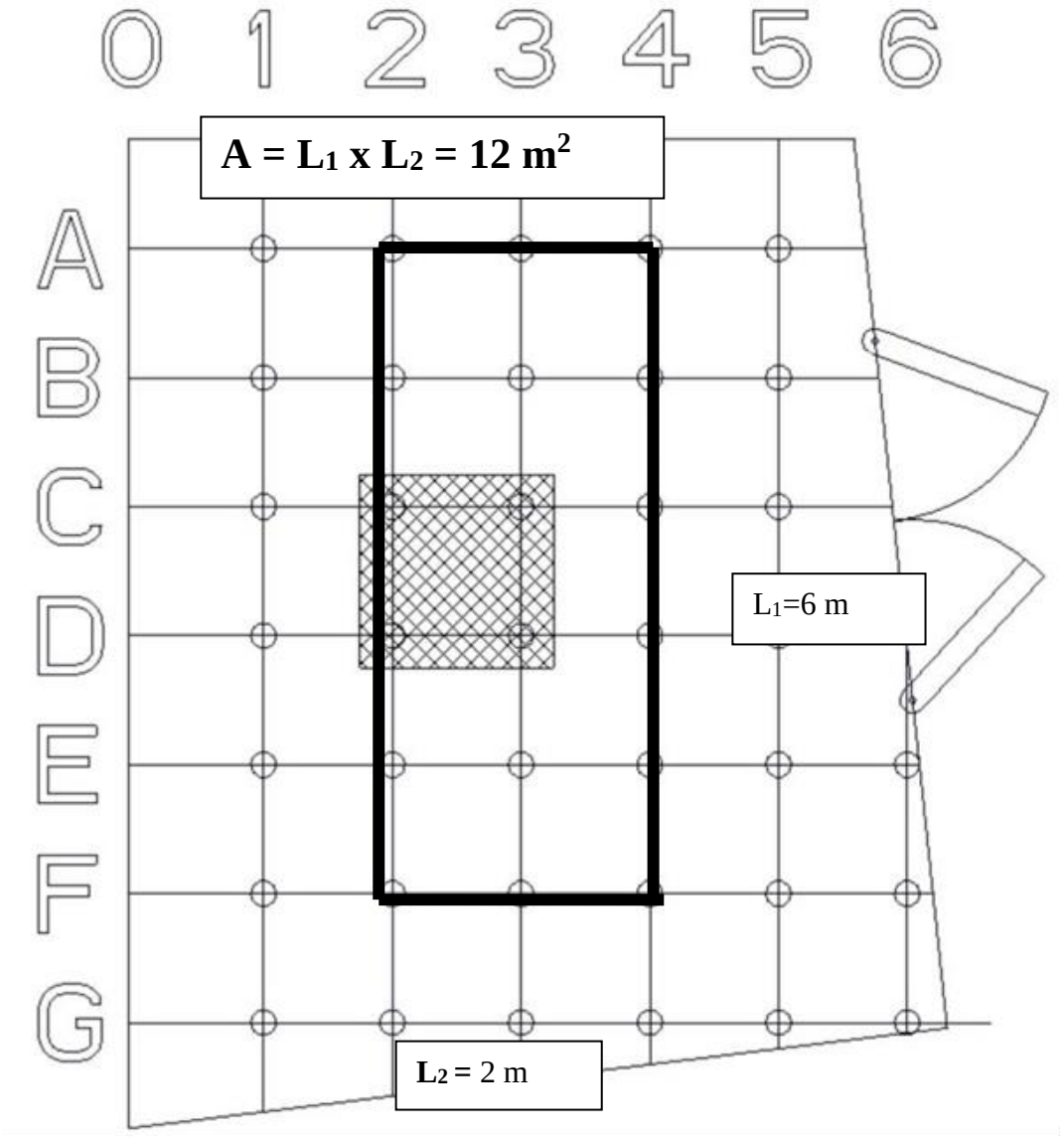


Fig. 3. Scheme of placing the samples in the measuring chamber at the Vibroacoustic Testing Laboratory CTO

Table 3 shows schedule of test. Test object was seasoned directly in reverberation chamber in Laboratory.

Table 3. Schedule of test

No. test object	**Action**	**Date**
LA2146, LA2150	Delivery date	17.10.2023
	Acclimatization	19-20.10.2023
	Installation	25.10.2023
	Measurement	25.10.2023
	Removal of the test object	25.10.2023

4. Measurement

Study was carried out in accordance with method described in PN-EN ISO 354:2005. Before the measurement, calibration of measuring channels was performed and conditions in reverberation chamber were written down. Test was done with two microphones in 6 positions and 2 positions of sound source. For each arrangement measurement was repeated 3 times. A total of 36 measurements was done for the test.

5. Analysis and test result

After the test, data from the analyzer were uploaded to *Nor 850 – Building Acoustics* application and analyzed. The analysis resulted with a graph showing sound absorption as a function of frequency in 1/3 octave band, together with reverberation time. According to "PN-EN ISO 11654:1999: *Acoustics — Sound absorbers for use in buildings — Rating of sound absorption*" sound absorption index α_W and class were evaluated. The results are presented in table 4 and 5.

Table 4. Test result: sound absorption coefficient, index and class – test object No. LA2146

Measurement of sound absorption in reverberation chamber according to *PN-EN ISO 354:2005*

Evaluation of sound absorption index according to *PN-EN ISO 11654:1999*

2023-10-25

Customer: Apico S.A. Impasse Praz Sallaz 8, 1522 Lucens
Producer: Apico S.A. Impasse Praz Sallaz 8, 1522 Lucens
Laboratory: Maritime Advanced Research Centre. Environmental Laboratories Division. Vibroacoustic Tests Laboratory
Test object: LA2146
Description: Two PET panels inserted in an aluminium frame - on the MDF frame - 200 mm from the floor. 10 sheets 120 x 100 cm. Side surfaces have not been included to the test specimen surface.

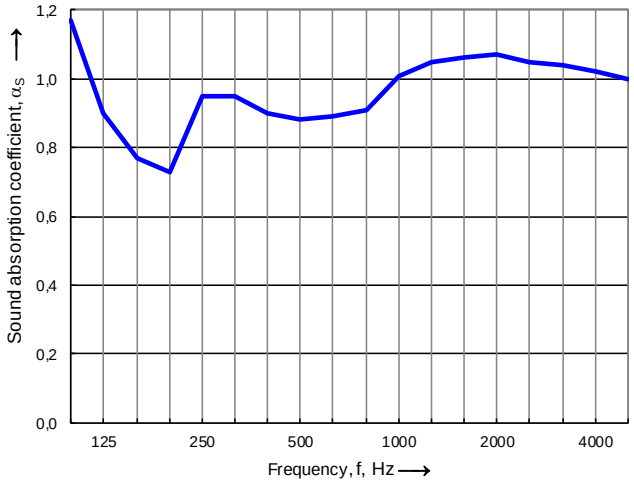
Mounting conditions type: -
Test object surface: 12,00 m^2
Volume of test chamber: 200,00 m^3

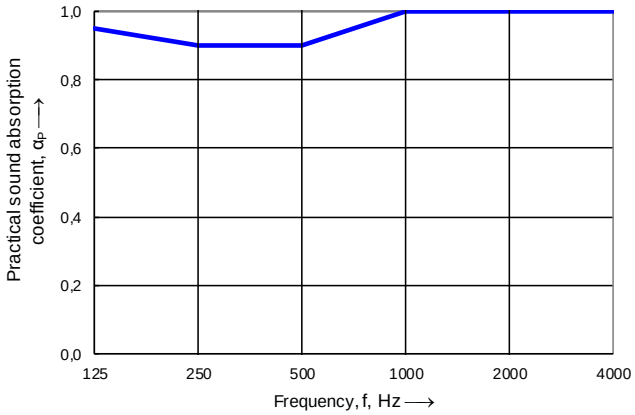
Conditions:

Test chamber, with test object:		Test chamber, without test object:	
Temperature:	18,4 °C	Temperature:	18,3 °C
Relative humidity:	57,8 %	Relative humidity:	57,3 %
Atmospheric presure:	100,0 kPa	Atmospheric presure:	100,0 kPa

f [Hz]	T_1 [s]	T_2 [s]	A_T [m^2]	α_S	α_P
100	7,3	1,8	14,0	1,17	
125	6,5	2,0	10,8	0,90	0,95
160	4,9	2,0	9,2	0,77	
200	5,2	2,2	8,7	0,73	
250	5,1	1,8	11,4	0,95	0,90
315	4,7	1,8	11,4	0,95	
400	4,7	1,8	10,8	0,90	
500	4,7	1,8	10,6	0,88	0,90
630	4,5	1,8	10,7	0,89	
800	4,3	1,7	10,9	0,91	
1000	4,0	1,6	12,1	1,01	1,00
1250	3,9	1,5	12,6	1,05	
1600	3,6	1,5	12,7	1,06	
2000	3,4	1,4	12,9	1,07	1,00
2500	3,0	1,4	12,6	1,05	
3150	2,6	1,3	12,5	1,04	
4000	2,2	1,2	12,2	1,02	1,00
5000	1,8	1,1	12,0	1,00	

Designations:
f - frequency, 1/3 octave [Hz]
T_1 - reverberation time, empty [s]
T_2 - reverberation time, with test object [s]
α_S - sound absorption coefficient
α_P - practical sound absorption coefficient
A_T - equivalent absorption area of test object [m^2]





Sound absorption index and class according to *PN-EN ISO 11654:1999*

α_W = 1,00

Sound absorption class: A

No. test: B214601
Test date: 2023-10-25 **Signature:** Adam Arentowicz