CENTRUM TECHNIKI OKRĘTOWEJ S.A.

Ship Design and Research Centre S.A.

AB 1241

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RESEARCH AND DEVELOPMENT DEPARTMENT

ENVIRONMENTAL LABORATORIES DIVISION

VIBROACOUSTIC TESTS LABORATORY

TEST REPORT

No RS-2016/B-370/E

Evaluation of sound absorption of "Duo" acoustic panels, manufactured by Creative Design Group Szymon Rychlik

Address:
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Issue date : 27.09.2016

Specimen No : ..0.....

Contents

1. Basic data

Tab. 1. Summary of data and test parameters.

<table>
<tr><td>Customer:
Creative Design Group,
Szymon Rychlik Sp. Jawna
ul. Chodkiewicza 3/118
02-593 Warszawa</td><td colspan="3">Order (e-mail): 08.07.2016

CTO S.A. order number: 8.372.03.223</td></tr>
<tr><td rowspan="2">Name and type of test object:

"Duo" acoustic panels, in two options</td><td colspan="3">Delivery date of test object:
29.08.2016; 16.09.2016

Date and place of measurements:
30.08.2016; 20.09.2016
Gdańsk,

Ship Design And Research Centre
Environmental Laboratories Division
Vibroacoustic Tests Laboratory</td></tr>
<tr><td rowspan="2">Manufacturer:

Creative Design Group,
Szymon Rychlik Sp. Jawna
ul. Chodkiewicza 3/118
02-593 Warszawa</td><td colspan="3">The method of measurement and analysis of the results:

According to the standards:
• Standard No.: PN-EN ISO 354:2005
• Standard No.: PN-EN ISO 11654:1997</td></tr>
<tr><td>Designation of the test object in CTO S.A.:
LA619, LA646</td><td colspan="3"><table><tr><th>Conditions of measurement</th><th>(start / end) of measurement</th></tr><tr><td>Air humidity</td><td rowspan="3">Detailed values are presented in chapter 5</td></tr><tr><td>Temperature</td></tr><tr><td>Atmospheric pressure</td></tr></table></td></tr>
<tr><td>Measuring equipment:</td><td>Channel 1</td><td colspan="2">Channel 2</td></tr>
<tr><td>measuring wires</td><td>0SvankK3</td><td colspan="2">1SvankK3</td></tr>
<tr><td>microphone</td><td>G.R.A.S. 40AR
Serial No. 119088</td><td colspan="2">G.R.A.S. 40AR
Serial No. 119096</td></tr>
<tr><td>preamplifier</td><td>G.R.A.S. 26TK
Serial No. 210489</td><td colspan="2">G.R.A.S. 26TK
Serial No. 210490</td></tr>
<tr><td>sound analyzer</td><td colspan="3">Norsonic type N–121 Serial No. 31378</td></tr>
<tr><td>calibrator</td><td colspan="3">Larson Davis CAL200, Serial No. 11524</td></tr>
<tr><td>sound source</td><td colspan="3">Larson Davis BAS001
Serial No. 1225-DIC08</td></tr>
<tr><td>thermo-hygro-barometer</td><td colspan="3">type LB-706BP, No. 846
type LB-701, No. 3605</td></tr>
<tr><td>measuring tape</td><td colspan="3">RS/0003</td></tr>
<tr><td colspan="4">Sound absorption results:</td></tr>
<tr><td>Measured values</td><td colspan="3">Actual values</td></tr>
<tr><td>A - equivalent sound absorption area in octaves and terces</td><td colspan="3">Results are presented in chapter 5</td></tr>
<tr><td colspan="4">Graph of equivalent sound absorption area 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="4">Attention: Presented values are valid only for the tested object.</td></tr>
</table>

2. Test method

Measurement of sound absorption of "Creative Design Group Szymon Rychlik" acoustic panels was performed in reverberation chamber with a volume of 200 m^3 in the Ship Design and Research Centre, in Vibroacoustic Tests Laboratory. Chamber specifications are placed in appendix No. 1. Reverberation chamber was tuned to achieve reverberation time required by the PN-EN ISO 354:2005. This was achieved through setting up 3 attenuator – diffusers and 8 diffusers. Their sound absorption area comply with Tab. 2.

Tab. 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 carried out in 12 microphone – sound source positions. Measurement in each position was repeated 3 times, in accordance with requirements in PN-EN ISO 354:2005. The tested objects designated as LA619 and LA646, consisted of 4 acoustic panels mounted directly on the floor of reverberation chamber. The tested objects were arranged in loose order at minimum distance of 2000mm from one another and 1000mm from the wall. In the chamber were hanged 8 diffusers with surface area 16m^2. Test was carried out using sound analyzer Nor 121 from Norsonic, and analysis was performed in NorBuild application. Measurements were done with methodology in accordance with norm PN-EN ISO 354:2005. "Measurement of sound absorption in reverberation chamber."

3. Description of the tested object

Technical description

Test sample LA619 - "Duo" acoustic panels. Tested object consisted of 4 pieces with dimensions of 1000x1600x33mm. Panels construction: wooden frame, 30mm of Basotect melamine foam, polyester fabric.

Test sample LA646 - "Duo" acoustic panels. Tested object consisted of 4 pieces with dimensions of 1000x1600x33mm. Panels construction: wooden frame, 30mm of polyurethane foam, polyester fabric.

Photo of "Creative Design Group Szymon Rychlik" acoustic panels in reverberation chamber with volume of 200m^3 in Vibroacoustic Tests Laboratory in CTO S.A., presented in fig. 1 and fig. 2.

Fig. 1. Test object LA619 photo, "Creative Design Group Szymon Rychlik" acoustic panels, in reverberation chamber in Vibroacoustic Tests Laboratory in CTO S.A.

Fig. 2. Test object LA646 photo, "Creative Design Group Szymon Rychlik" acoustic panels, in reverberation chamber in Vibroacoustic Tests Laboratory in CTO S.A.

Arrangement of "Creative Design Group Szymon Rychlik" acoustic panels in reverberation chamber in CTO S.A is illustrated in fig. 3.

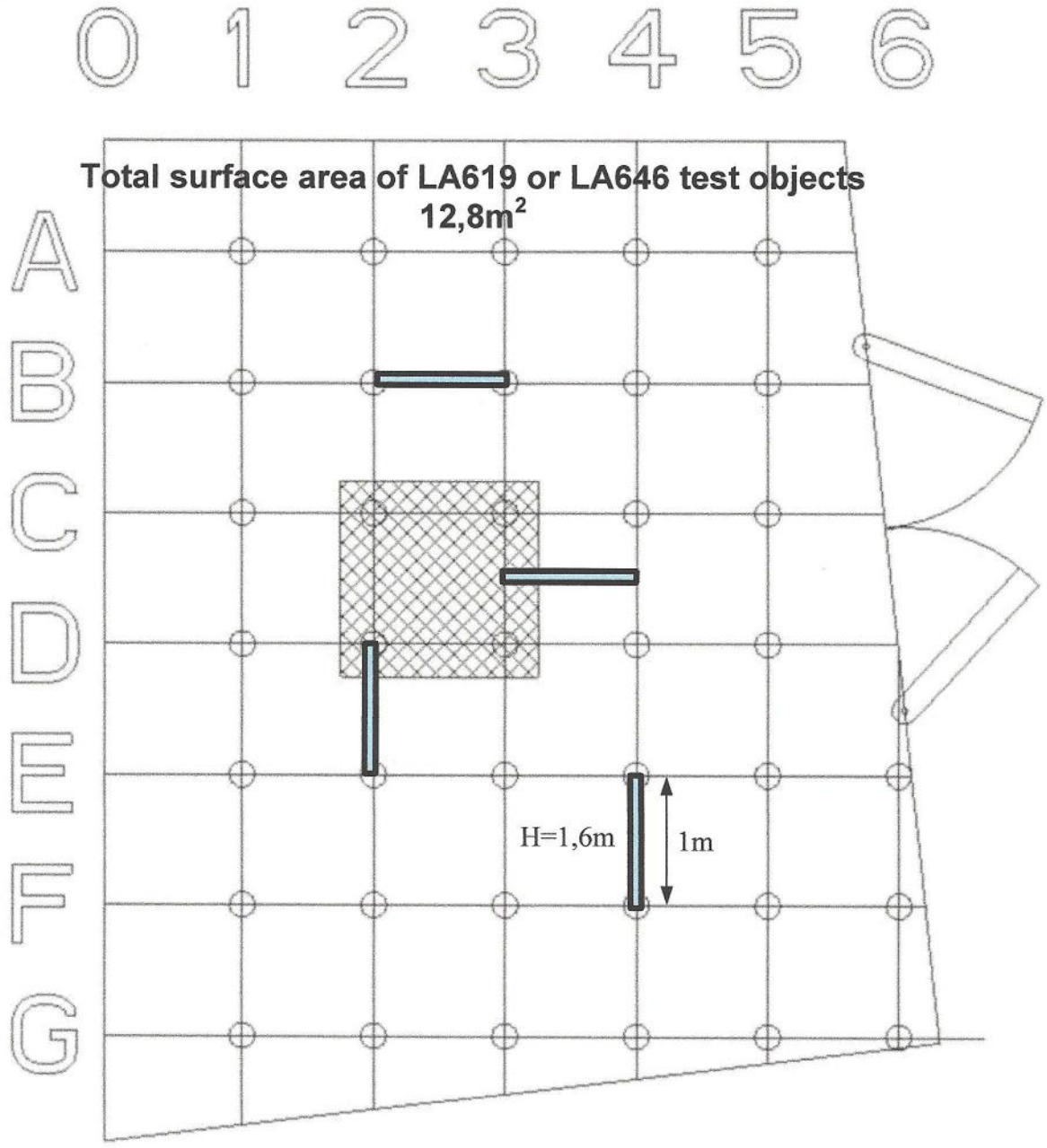


Fig. 3. Arrangement of "Creative Design Group Szymon Rychlik" acoustic panels in reverberation chamber in Vibroacoustic Tests Laboratory in CTO S.A.

Tested "Duo" acoustic panels designated as LA619 and LA646, with total surface area of 12,8m^2, were placed directly on the floor of reverberation chamber, at minimum distance of 2000mm from one another and 1000mm from the wall. The test was carried out for 4 pieces of panels at the same time, which were arranged in loose order.

Tab. 3 shows schedule of the study.

Tab. 3. Schedule of the test

Test object designation	Step	Date
LA619	Delivery date	29.08.2016
	Acclimatization	29.08.2016
	Mounting	30.08.2016
	Measurement	30.08.2016
	Removal of the test object	30.08.2016
LA646	Delivery date	16.09.2016
	Acclimatization	16-19.09.2016
	Mounting	20.09.2016
	Measurement	20.09.2016
	Removal of the test object	20.09.2016

Test object was acclimatized in reverberation chamber in accordance with procedure RS-11/R-06.

4. Measurement

Study was carried out in accordance with methodology 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 summary of the test results

After the test, data from the analyzer were uploaded to NorBuild application and analyzed. The analysis resulted with a graph showing equivalent sound absorption area as a function of frequency in 1/3 octave band, together with reverberation time. Furthermore equivalent sound absorption area of a single object A_{obj} was calculated. The results are presented in tab. 4 and 5.

Tab. 4. Results of sound absorption measurements for test object LA619 performed in Vibroacoustic Tests Laboratory in CTO S.A., in accordance with PN-EN ISO 354:2005.

Sound absorption coefficient according to norm PN-EN ISO 354:2005

Sound absorption measurement in reverberation chamber.

Client: Creative Design Group, Szymon Rychlik Sp. Jawna, ul. Chodkiewicza 3/118, 02-593 Warszawa — **Date of test:** 30.08.2016

Test room ID: CTO S.A. Environmental Laboratories Division. Vibroacoustic Tests Laboratory

Test object No.: LA619

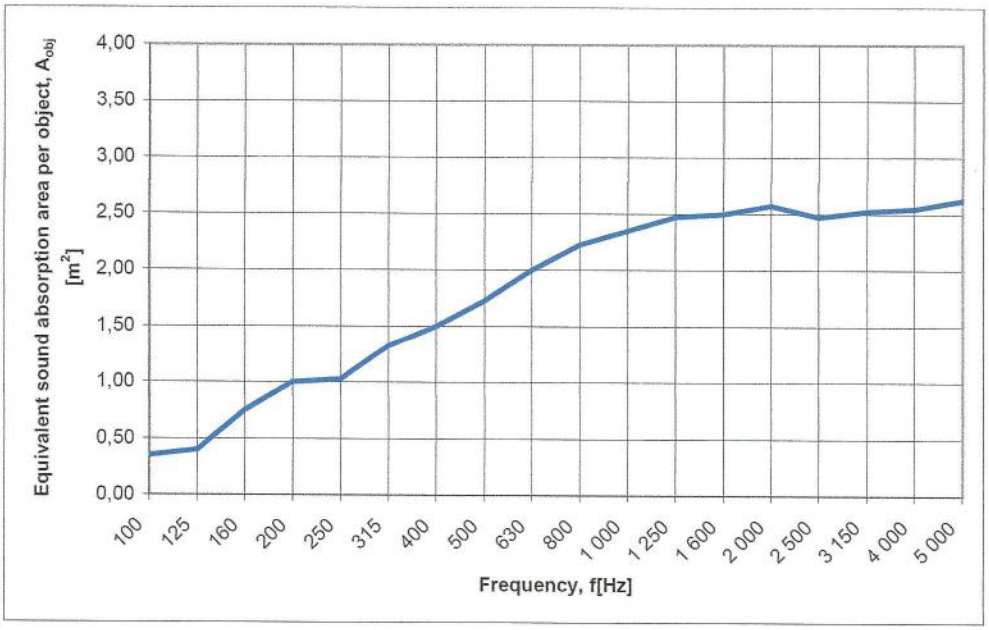
Description: Duo - free standing acoustic panels; Dimensions: 1000x1600x33mm; Construction: wooden frame, Basotect melamine foam with thickness of 30mm, polyester fabric; 4 pieces tested at the same time

Surface area of test object: 12,80 m^2
Reverberation chamber volume: 200,0 m^3

Empty reverberation chamber:
Relative humidity: 62,8 %
Air temperature: 21,9 °C
Atmospheric pressure: 101,0 kPa

Reverberation chamber with test object:
Relative humidity: 58,0 %
Air temperature: 21,0 °C
Atmospheric pressure: 101,9 kPa

Frequency f [Hz]	Empty T1 [s]	Object T2 [s]	A [m^2]	A_{obj} in terces [m^2]	A_{obj} in octaves [m^2]
100	6,73	5,23	1,4	0,35	
125	7,36	5,43	1,6	0,40	0,50
160	6,20	3,95	3,0	0,75	
200	5,50	3,27	4,0	1,00	
250	5,11	3,10	4,1	1,03	1,12
315	5,08	2,76	5,3	1,33	
400	5,13	2,63	6,0	1,50	
500	5,08	2,44	6,9	1,73	1,74
630	4,90	2,22	8,0	2,00	
800	4,67	2,04	8,9	2,23	
1000	4,34	1,92	9,4	2,35	2,35
1250	4,24	1,85	9,9	2,48	
1600	4,00	1,79	10,0	2,50	
2000	3,69	1,69	10,3	2,58	2,52
2500	3,30	1,63	9,9	2,48	
3150	2,83	1,49	10,1	2,53	
4000	2,38	1,34	10,2	2,55	2,57
5000	1,98	1,18	10,5	2,63	



Test number: B61901

Date: 30.08.2016 **Sign:** Marek Panaś M. Panaś

Tab. 5. Results of sound absorption measurements for test object LA646 performed in Vibroacoustic Tests Laboratory in CTO S.A., in accordance with PN-EN ISO 354:2005.

Sound absorption coefficient according to norm PN-EN ISO 354:2005

Sound absorption measurement in reverberation chamber.

Client: Creative Design Group, Szymon Rychlik Sp. Jawna, ul. Chodkiewicza 3/118, 02-593 Warszawa — **Date of test:** 20.09.2016

Test room ID: CTO S.A. Environmental Laboratories Division. Vibroacoustic Tests Laboratory

Test object No.: LA646

Description: Duo - free standing acoustic panels; Dimensions: 1000x1600x33mm; Construction: wooden frame, polyurethane foam with thickness of 30mm, polyester fabric; 4 pieces tested at the same time

Surface area of test object: 12,80 m^2

Reverberation chamber volume: 200,0 m^3

Empty reverberation chamber:

Relative humidity: 46,2 %

Air temperature: 19,3 °C

Atmospheric pressure: 99,2 kPa

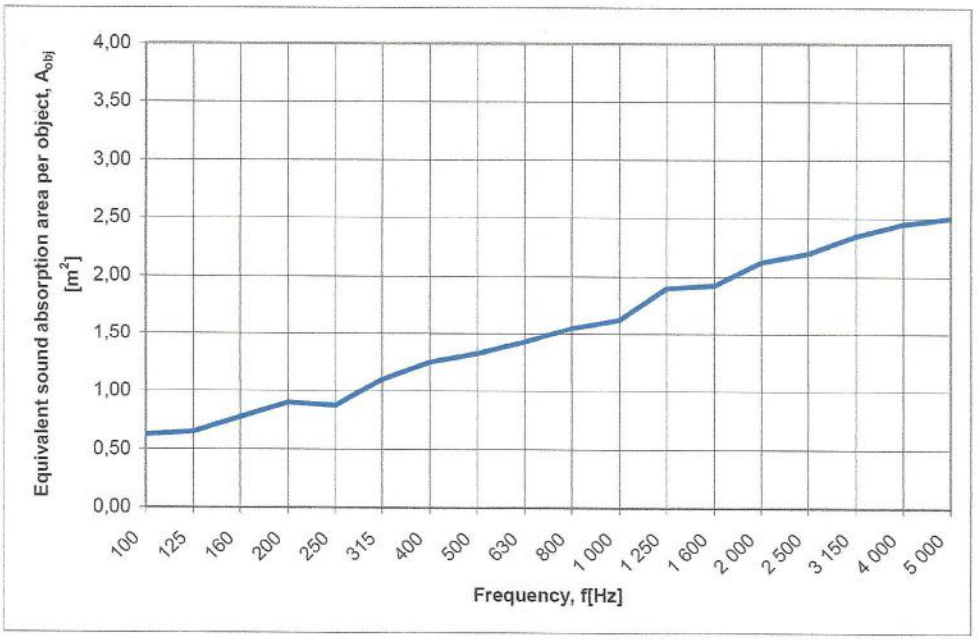
Reverberation chamber with test object:

Relative humidity: 49,6 %

Air temperature: 21,3 °C

Atmospheric pressure: 101,5 kPa

Frequency f [Hz]	Empty T1 [s]	Object T2 [s]	A [m^2]	A_{obj} in terces [m^2]	A_{obj} in octaves [m^2]
100	10,36	5,78	2,5	0,63	
125	10,24	5,61	2,6	0,65	0,68
160	7,56	4,37	3,1	0,78	
200	6,50	3,78	3,6	0,90	
250	6,35	3,77	3,5	0,88	0,96
315	6,10	3,33	4,4	1,10	
400	6,35	3,19	5,0	1,25	
500	6,17	3,05	5,3	1,33	1,33
630	5,66	2,81	5,7	1,43	
800	5,19	2,58	6,2	1,55	
1000	4,86	2,43	6,5	1,63	1,69
1250	4,88	2,25	7,6	1,90	
1600	4,38	2,13	7,7	1,93	
2000	3,97	1,94	8,5	2,13	2,08
2500	3,53	1,81	8,8	2,20	
3150	2,90	1,60	9,4	2,35	
4000	2,35	1,41	9,8	2,45	2,43
5000	1,84	1,22	10,0	2,50	



Test number: B64601

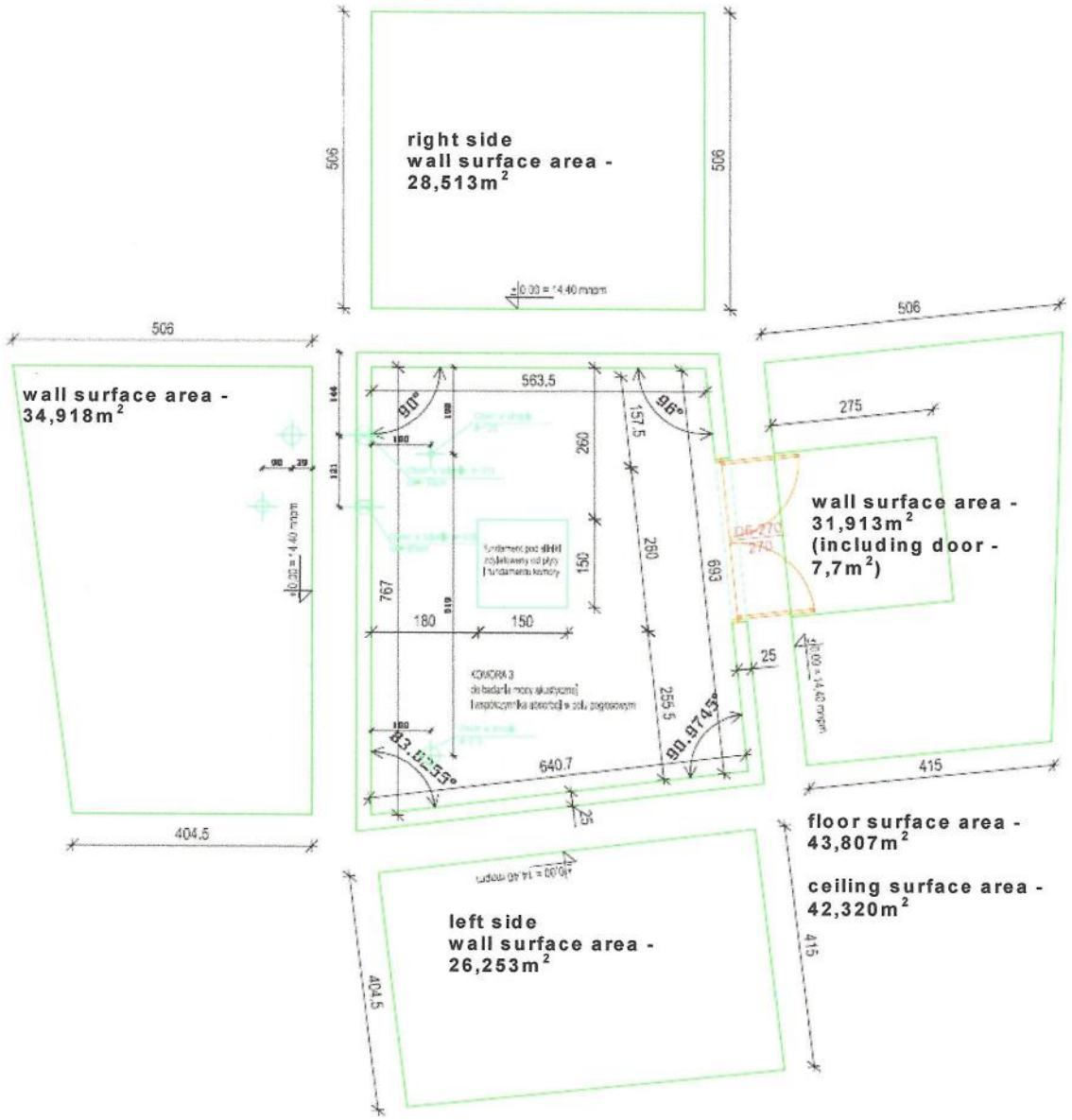
Date: 20.09.2016 **Sign:** Marek Panaś M. Panaś

1 appendix is attached to this test report:

- APPENDIX 1 - Configuration of reverberation chamber

Project leader	**Authorised by**	**Supervisor**
Senior Acoustics Assistant	***Head of the Vibroacoustic Tests Laboratory***	***Head of the Environmental Laboratories Division***
M. Panaś		
MSc Eng. Marek Panaś	Dr Eng. Piotr Jakubowski	Dr Eng. Mateusz Weryk
MP – initials of report author		

APPENDIX 1 – Configuration of reverberation chamber



Dimensions of the reverberation chamber for sound absorption coefficient α_s 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