CENTRUM TECHNIKI OKRĘTOWEJ S.A.

Ship Design and Research Centre S.A.

AB 1241

RESEARCH AND DEVELOPMENT DEPARTMENT

ENVIRONMENTAL LABORATORIES DIVISION

VIBROACOUSTIC TESTS LABORATORY

NOTIFIED BODY
NB 2434

TEST REPORT

No RS-2016/B-291/E

Evaluation of sound absorption coefficent for
Tower acoustic absorbers, manufactured by
Creative Design Group, Szymon Rychlik

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Specimen No : .....0.....

Contents

1. Basic data

Tab. 1. Summary of data and test parameters.

Customer: Creative Design Group, Szymon Rychlik Sp. Jawna ul. Chodkiewicza 3/118 02-593 Warszawa	**Order (e-mail):** 30.06.2016 **CTO S.A. order number**: 8.372.03.223
Name and type of test object: Tower acoustic absorbers	**Delivery date of test object:** 22.07.2016 **Date and place of measurements:** 25.07.2016 Gdańsk, Ship Design And Research Centre Environmental Laboratories Division Vibroacoustic Tests Laboratory
Manufacturer: Creative Design Group, Szymon Rychlik Sp. Jawna ul. Chodkiewicza 3/118 02-593 Warszawa	**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
Designation of the test object in CTO S.A.: LA613	**Conditions of measurement** (start / end) of measurement Air humidity Temperature Atmospheric pressure **Detailed values are presented in chapter 5**

Measuring equipment:	**Channel 1**	**Channel 2**
measuring wires	0SvankK3	1SvankK3
microphone	G.R.A.S. 40AR Serial No. 119088	G.R.A.S. 40AR Serial No. 119096
preamplifier	G.R.A.S. 26TK Serial No. 210489	G.R.A.S. 26TK Serial No. 210490
sound analyzer	Norsonic type N–121 Serial No. 31378	
calibrator	Larson Davis CAL200, Serial No. 11524	
sound source	Larson Davis BAS001 Serial No. 1225-DIC08	
thermo-hygro-barometer	type LB-706BP, No. 846 type LB-701, No. 3605	
measuring tape	RS/0003	

Sound absorption results:

Measured value	Actual value
α_w - sound absorption coefficient	$\alpha_w = 1{,}00$

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.

Attention: Presented values are valid only for the tested object.

2. Test method

Measurement of sound absorption of Creative Design Group Szymon Rychlik acoustic absorbers, designated as LA613, 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. Tested object, designated as LA613, consisted of 4 acoustic pillars mounted directly on the floor of reverberation chamber. 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 methodoly 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 object consisted of 4 rectangular acoustic absorbers designated as Tower, with dimensions of 2000x360x360mm. Tested absorbers are made of melamine foam and are covered with polyester fabric.

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

Fig. 1. Test object LA613 photo, Creative Design Group Szymon Rychlik acoustic absorbers, in reverberation chamber in Vibroacoustic Tests Laboratory in CTO S.A.

Arrangement of Creative Design Group Szymon Rychlik acoustic absorbers in reverberation chamber in CTO S.A is illustrated in fig. 2.

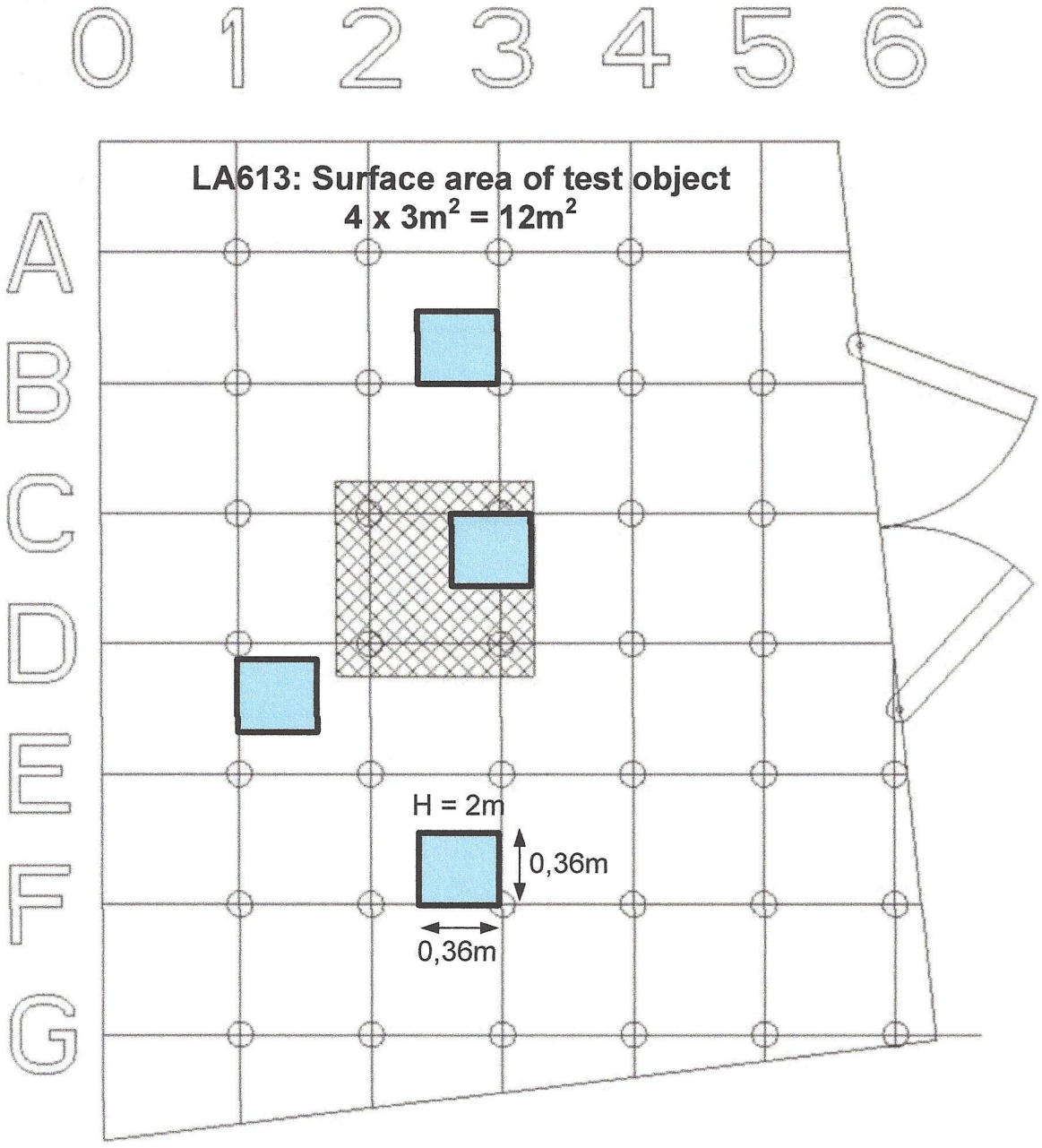


Fig. 2. Arrangement of Creative Design Group Szymon Rychlik acoustic absorbers in reverberation chamber in Vibroacoustic Tests Laboratory in CTO S.A.

Tested Tower acoustic absorbers designated as LA613, with total sound absorption area of 12m^2, were installed directly on the floor of reverberation chamber, at a minimum distance of 2000mm from one another and 1000mm from the wall. 4 pieces of acoustic absorbers were tested and they were arranged in loose order.

Tab. 3 shows schedule of the study.

Tab. 3. Schedule of the test

Test object designation	Step	Date
LA613	Delivery date	22.07.2016
	Acclimatization	22-25.07.2016
	Mounting	22.07.2016
	Measurement	25.07.2016
	Removal of the test object	27.07.2016

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. The measurement was repeated 3 times for each arrangement. 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 sound absorption as a function of frequency in 1/3 octave band, together with reverberation time. The results are presented in tab. 4. Sound absorption coefficient and sound absorption class in accordance with norm PN-EN ISO 11654:1997 are also shown in tab. 4. Moreover equivalent sound absorption area per object A_{obj} was calculated and presented in Tab. 5.

Tab. 4. Results of sound absorption measurements for test object LA613 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:** 25.07.2016

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

Test object designation: LA613

Description: Tower acoustic absorbers; 4 pieces with dimensions of 2000x360x360mm; Absorbers are made of melamine foam and are covered with polyester fabric

Surface area of test object: 12,00 m^2

Reverberation chamber volume: 200,0 m^3

Empty reverberation chamber:

Relative humidity: 62,5 %

Air temperature: 21,9 °C

Atmospheric pressure: 101,0 kPa

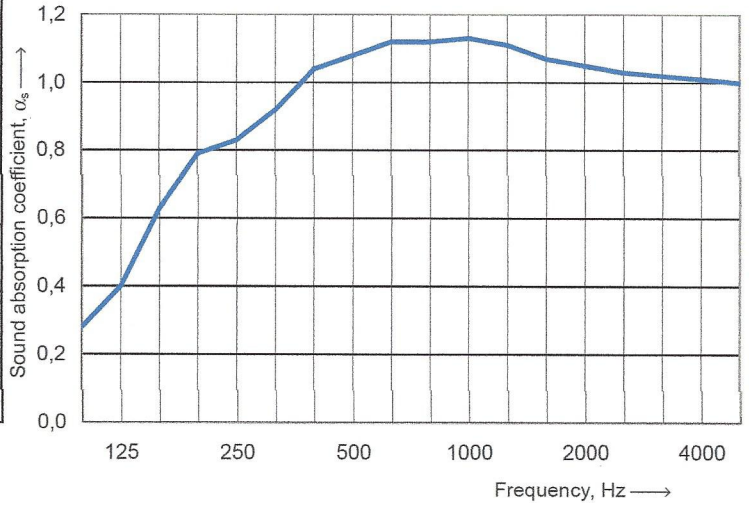
Reverberation chamber with test object:

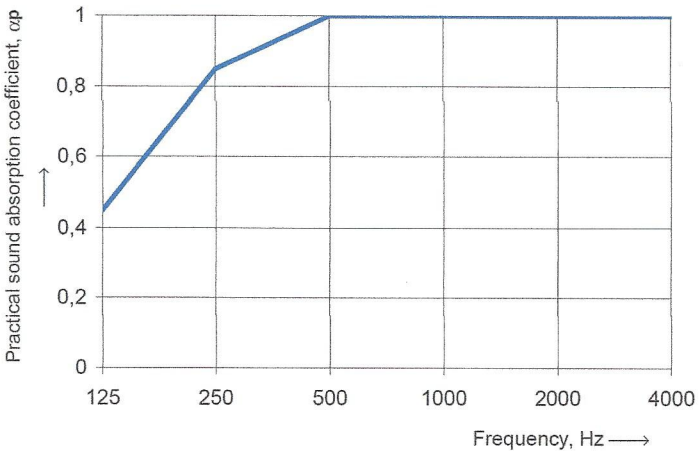
Relative humidity: 65,6 %

Air temperature: 22,2 °C

Atmospheric pressure: 101,4 kPa

Frequency f [Hz]	Empty T1 [s]	Object T2 [s]	α_s	α_p	A_{obj} [m^2]
100	7,76	6,19	0,28		0,83
125	10,39	5,47	0,40	0,45	1,20
160	7,63	4,52	0,63		1,90
200	6,73	3,98	0,79		2,38
250	7,36	3,52	0,83	0,85	2,48
315	6,20	2,52	0,92		2,75
400	5,50	2,09	1,04		3,13
500	5,11	1,99	1,08	1,00	3,25
630	5,08	1,85	1,12		3,35
800	5,13	1,71	1,12		3,35
1000	5,08	1,66	1,13	1,00	3,40
1250	4,90	1,61	1,11		3,33
1600	4,67	1,58	1,07		3,20
2000	4,34	1,53	1,05	1,00	3,15
2500	4,24	1,54	1,03		3,08
3150	4,00	1,54	1,02		3,05
4000	3,69	1,51	1,01	1,00	3,03
5000	3,30	1,46	1,00		3,00





Sound absorption coefficient according to PN-EN ISO 11654:1997

α_w=1,00

Sound absorption class: A

Test Number: B61301

Date: 25.07.2016 **Sign:** Marek Panaś M. Panaś

Tab. 5. Results of sound absorption measurements for test object LA613 performed in Vibroacoustic Tests Laboratory in CTO S.A., in accordance with PN-EN ISO 354:2005. - Equivalent sound absorption area of the test object

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:** 25.07.2016

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

Test object No.: LA613

Description: Tower acoustic absorbers; 4 pieces with dimensions of 2000x360x360mm; Absorbers are made of melamine foam and are covered with polyester fabric

Surface area of test object: 12,00 m^2

Reverberation chamber volume: 200,0 m^3

Empty reverberation chamber:

Relative humidity: 62,5 %

Air temperature: 21,9 °C

Atmospheric pressure: 101,0 kPa

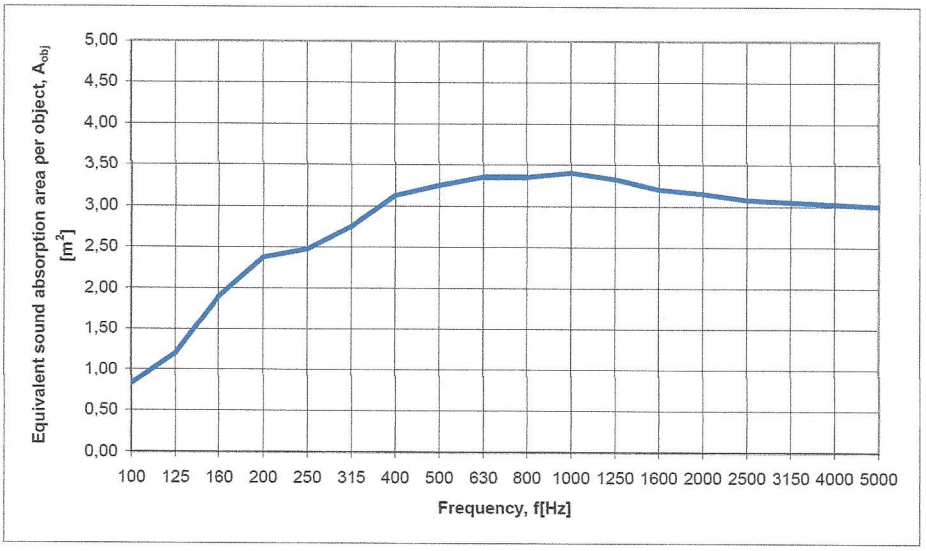
Reverberation chamber with test object:

Relative humidity: 65,6 %

Air temperature: 22,2 °C

Atmospheric pressure: 101,4 kPa

Frequency f [Hz]	Empty T1 [s]	Object T2 [s]	α_s	α_p	A [m^2]	A_{obj} in terces [m^2]	A_{obj} in octaves [m^2]
100	6,73	3,98	0,28		3,3	0,83	
125	7,36	3,52	0,40	0,45	4,8	1,20	1,31
160	6,20	2,52	0,63		7,6	1,90	
200	5,50	2,09	0,79		9,5	2,38	
250	5,11	1,99	0,83	0,85	9,9	2,48	2,53
315	5,08	1,85	0,92		11,0	2,75	
400	5,13	1,71	1,04		12,5	3,13	
500	5,08	1,66	1,08	1,00	13,0	3,25	3,24
630	4,90	1,61	1,12		13,4	3,35	
800	4,67	1,58	1,12		13,4	3,35	
1000	4,34	1,53	1,13	1,00	13,6	3,40	3,36
1250	4,24	1,54	1,11		13,3	3,33	
1600	4,00	1,54	1,07		12,8	3,20	
2000	3,69	1,51	1,05	1,00	12,6	3,15	3,14
2500	3,30	1,46	1,03		12,3	3,08	
3150	2,83	1,37	1,02		12,2	3,05	
4000	2,38	1,26	1,01	1,00	12,1	3,03	3,03
5000	1,98	1,15	1,00		12,0	3,00	



Sound absorption coefficient according to PN-EN ISO 11654:1997

α_w=1,00

Sound absorption class: A

Test Number: B61301

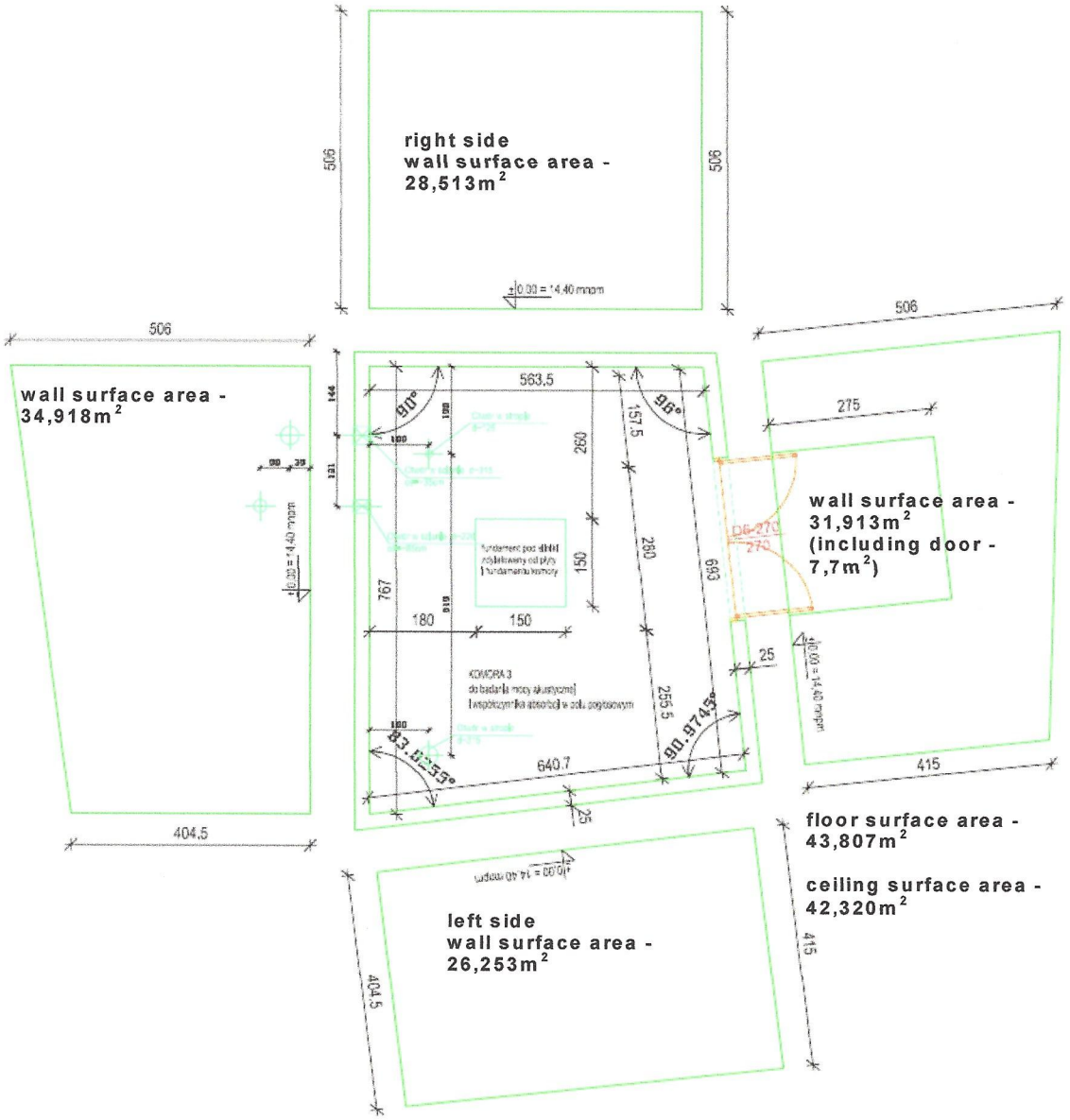
Date: 25.07.2016 **Signature:** Marek Panaś M Panaś

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