

INFORME DE ENSAYO ACÚSTICO EN LABORATORIO

 **AIDIMME** 
INSTITUTO TECNOLÓGICO
METALMECÁNICO, MUEBLE, MADERA, EMBALAJE Y AFINES

System: Seat model AUDIT, by ACTIU

Ref: CAM19090076/REV

**Fecha de Emisión:
3 de marzo de 2020**



TEST REPORT

TEST LOCATION **AUDIOTEC STANDARDIZED REVERBERATION ROOM. C/JUANELO TURRIANO, 4. PARQUE TECNOLÓGICO DE BOECILLO. BOECILLO. (VALLADOLID) ESPAÑA**

TEST Measurement of sound absorption of an acoustic material in a reverberation room.

PRODUCT **Auditorium seat model Audit**, by ACTIU, reference BU10316M12. Upholstered Mono-block with upholstered side panels which are feet and arms at the same time. Upholstered backrest finish. The seat and backrest can be folded. Seat and backrest made of self-extinguishing polyurethane foam (60-65 kg/m3).

TEST METHOD **UNE EN ISO 354:2004. Acoustics. Measurement of sound absorption in a reverberation room.**

CUSTOMER **AIDIMME**
Parque Tecnológico. C/ Benjamín Franklin, 13.
46980 Paterna (Valencia)

TEST DATE: **February 21, 2020**

Done

Signed: Ángel Arenaz Gombau

CONTENT

1.- Test object

2.- Test procedure

2.1.- Procedures and standards used

2.2.- Methodology and test parameters

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1.- TEST OBJECT.

This report has the object of analyzing sound absorption by obtaining the sound absorption coefficient, α_s , and the weighted sound absorption coefficient, α_w , of a system, measured in a reverberation room.

Tested sample was as follows:

- Auditorium seat model Audit, by ACTIU, reference BU10316M12. Upholstered Mono-block with upholstered side panels which are feet and arms at the same time. Upholstered backrest finish. The seat and backrest can be folded. Seat and back made of self-extinguishing polyurethane foam (60-65 kg/m³), ergonomics. Arms lined-up seats. Silent folded mechanism of the seat. Steel frame that fixes the seat, sides and back. Moulded aluminium. Support legs are moulded aluminium epoxy finish 2,5 cm for aesthetics improvement as well as cleaning and maintenance.

This test has been carried out in AUDIOTEC's standardized reverberation room in Boecillo Technology Park (Valladolid).

2.- TEST PROCEDURE.

2.1- Procedures and standards used.

The test has been carried out taking into account the following laboratory standards and procedures:

- *UNE-EN ISO 354:2004 (Acoustics. Measurement of sound absorption in a reverberation room.*
- *UNE EN ISO 11654:1998 (Acoustics. Acoustic absorbers for use in buildings. Rating of sound absorption).*
- *Measurement procedure and calculations presented in specific procedure PE-27 of AUDIOTEC's Acoustics Laboratory.*

2.2.- Methodology and test parameters

Inside the reverberation room, two source positions were chosen. This positions were placed separated more than 3 m from each other. The source has an omnidirectional radiation pattern.

For each source position, 6 microphone positions were chosen, distributed inside the room, at least 1.5 m apart from each other, 1 m from the walls and 2 m from the sound source. For each microphone position, three measurements of the decay of the sound pressure level were made and reverberation time resulting from the average of the three decays was registered in each frequency band.

Wide band pink noise was generated with the sound source, at a level at least 45 dB over the background level that was previously measured, in each frequency band inside the evaluated frequency range, and with a sound spectrum such the differences in the sound pressure levels resulting inside the room were smaller than 6 dB between adjacent third octave bands. Interrupted noise method was used.

In each microphone position, reverberation time, TR20, was measured, in the third octave bands comprehended between 100 and 5000 Hz.

This operating method was used both for T1 (empty room) and T2 (sample inside the room) measurements.

T1 was measured with an empty room, no sample installed.

T2 was measured with the sample installed over lacquered wood boards, thickness 30 mm. Also, a laminated plasterboard perimeter was installed surrounding the sample, with the same height. T2 was measured with occupied and empty seats. They were occupied with 15 people, as it would be in practice.

In every moment corrections for sound absorption change in the air due to meteorological conditions variations were applied during T1 and T2 measurements. For this purpose, air sound absorption coefficient was obtained following ISO 9613-1 (Acoustics. Para ello, se calculó el coeficiente de atenuación sonora en el aire, según la Norma Internacional ISO 9613-1 (Acústica. Attenuation of sound during propagation outdoors – Part 1: Calculation of the absorption of sound by the atmosphere).

2.3.- Instrumentation used

The instrumentation used for this test was:

- Brüel&Kjaer Sound source type 4292, serial number 004007.
- Analyzer Brüel&Kjaer type 2250, class 1, serial number 3011769, previously verified.
- PHONIC MAX 860 Amplifier, serial number ABA2GBA171.
- 1/3 octave band equalizer BEHRINGER model DEQ2496.
- B&K Sound calibrator type 4231, class 1, serial number 2136530.
- BARIGO Thermoanemometer, modelnum. 525.

Notes: Measurement and calibration equipment have in force the corresponding periodic verification certificate which certifies the compliance of the “Orden Ministerial ITC/2845/2007”, from September, 25, which moderates metrological control by the State of measurement instruments meant to audible sound measurement and acoustic calibrators (B.O.E. nº 237 del miércoles 3 de octubre de 2007).

2.4.- Features, description and dimensions of the sample and the room.

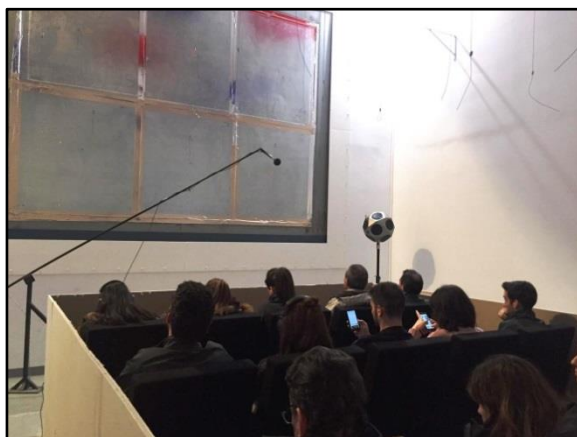
Tested sample description:

The sample consisted of unitary absorbers, in this case being **Audit auditorium seats, by ACTIU, reference BU10316M12**. The seats were tested in 3 parallel rows, installed on lacquered wood boards placed on the floor. Total surface of the boards was 10 m². On each board, one row of 5 seats was installed, screwed on the base to the boards. The seats were not independent, sharing arms with the adjacent ones. The seats could be folded, being folded when they were unoccupied.

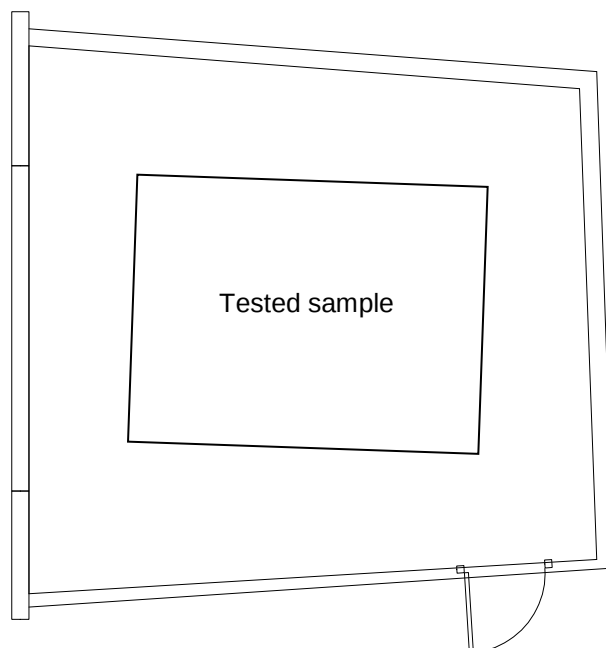
Distance from any seat to any room surface except from the floor was at least 1 m. Altogether the sample had 15 seats in 3 parallel rows, 5 seats per row, with a distance of 1.10 m between row axes.

Surrounding the sample, a perimeter of 12.5 mm laminated plasterboard was installed. This perimeter was 95 cm high, same height of the sample (Board height: 3 cm + seat height: 92 cm). Perimeter walls perpendicular to seat rows were touching the ends of the rows, while the other two walls were at a 0.55 m distance from the closest row axis (half the distance between row axes).

Some pictures of the installation and position of the tested sample are shown next:



A sketch showing the sample position in the reverberation room is displayed next:



Plain view: sample position regarding the side walls of the room

Test room features:

Standardized reverberation room has the shape of an irregular 6-faced prism with no parallel sides between them, and it has a 202.12 m^3 volume.

The reverberation room has eleven fixed diffusers, slightly curved, suspended from the ceiling in order to obtain the wanted diffusion inside the room.

These diffusers are made of methacrylate sheets, they have dimensions of $1 \times 1.60 \text{ m}$ and $0.80 \times 1.20 \text{ m}$, and are distributed in the room, randomly oriented.

Total surface of the room (walls, floor and ceiling), S_t , is 211.1 m^2 .

Room temperature during T1 measurements was 18.6°C at the beginning and 17.7°C at the end, and relative humidity was of 41 % at the beginning and 42 % at the end.

Room temperature during T2 measurements with **occupied seats** was 18.4°C at the beginning 18.1°C at the end and relative humidity was of 41 % at the beginning and 41 % at the end.

Room temperature during T2 measurements with **unoccupied seats** was 18.1°C at the beginning 17.5°C at the end and relative humidity was of 41 % at the beginning and 42 % at the end.

3.- RESULTS OF REVERBERATION TIME AND SOUND ABSORPTION COEFFICIENT.

Next, for each specific configuration of seats (*occupied seats* first and *empty seats* second) four pages are shown with the results obtained in the tests.

In the first page contains a chart showing the average reverberation time (with sample, T2 and empty, T1) and the average sound absorption coefficient, α_s , all of it in third octave bands. It also shows a graph comparing T1 and T2.

In the second page there is a chart and a graph of the sound absorption coefficient, α_s , in third octave bands

The third page presents a graph and a chart of the sound absorption coefficient calculated in octave bands, α_p , as well as a global value of the weighted sound absorption coefficient, α_w , calculated according to the standard UNE EN ISO 11654:1998 together with its shape indicator (if there were such) and the sound absorption class of the absorber according to chart B.1 of Annex B of the same standard.

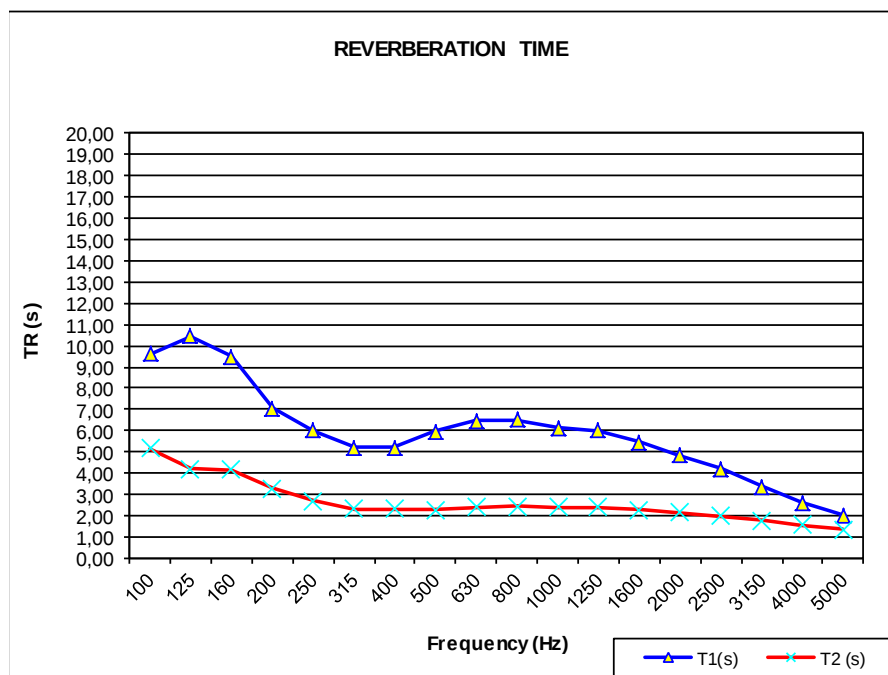
In the four page a chart is displayed containing the values, in third octave bands, of the equivalent sound absorption area per object, A_{obj} , along with its graphical representation.

Notes:

- ♦ The results of this test only concern the objects presented for testing and at the time and conditions in which the measurements were made.
- ♦ Measurement uncertainty is available to all customers in the AUDIOTEC Acoustics Laboratory.
- ♦ This report should not be reproduced by any means unless it is done entirely and with the authorization of the Acoustics Laboratory of AUDIOTEC S.A.

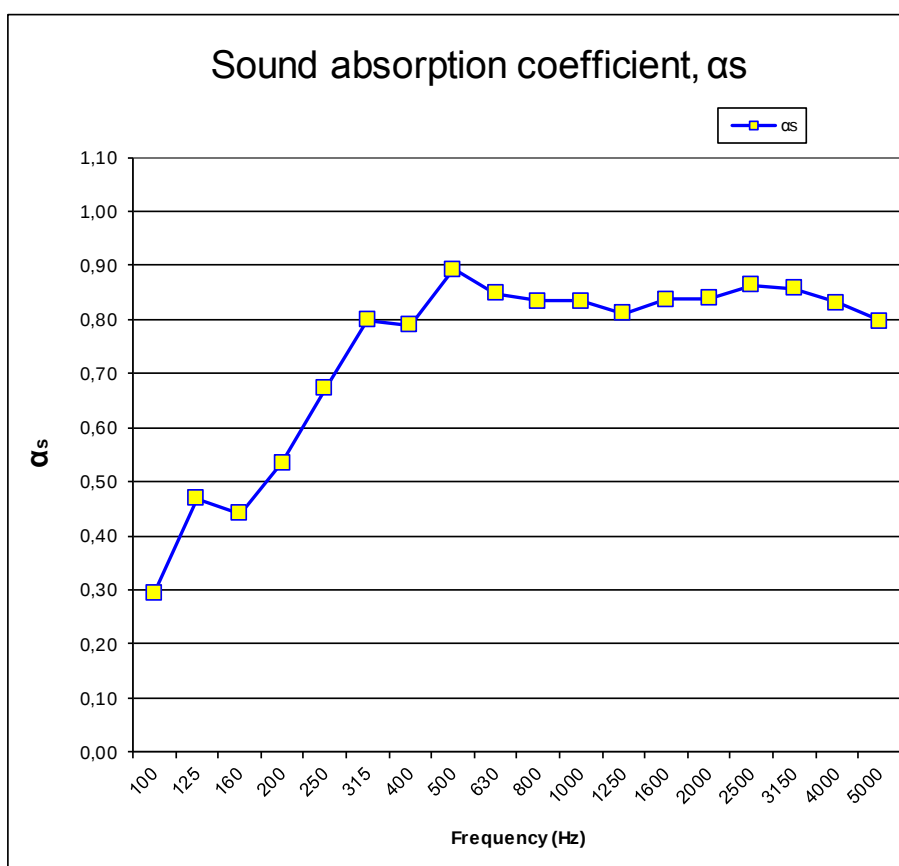
Place of test: AUDIOTEC standardized reverberation room, in C/ Juanelo Turriano, 4, Boecillo Technology Park, Valladolid, España.
Test: Measurement of sound absorption in reverberation room.
Customer: AIDIMME
Test date: February 21, 2020
Sample: Auditorium seat model Audit, by ACTIU, reference BU10316M12.
Occupied seats
Sample surface: 10 m². **Room volume:** 202,12 m³.
Standard: UNE-EN ISO 354:2004.

Freq(Hz)	T1(s)	T2 (s)	A ₁ (m ²)	A ₂ (m ²)	A _T (m ²)	α_s
100	9,59	5,15	3,3	6,3	2,9	0,29
125	10,45	4,18	3,0	7,7	4,7	0,47
160	9,49	4,16	3,3	7,7	4,4	0,44
200	7,05	3,27	4,4	9,8	5,3	0,53
250	5,99	2,68	5,2	11,9	6,7	0,67
315	5,21	2,29	6,0	14,0	8,0	0,80
400	5,22	2,31	5,9	13,8	7,9	0,79
500	5,97	2,27	5,0	14,0	8,9	0,89
630	6,44	2,41	4,5	13,0	8,5	0,85
800	6,49	2,44	4,4	12,7	8,3	0,83
1000	6,14	2,39	4,5	12,8	8,3	0,83
1250	6,02	2,41	4,4	12,5	8,1	0,81
1600	5,47	2,28	4,5	12,9	8,4	0,84
2000	4,83	2,15	4,7	13,1	8,4	0,84
2500	4,20	1,99	4,7	13,4	8,6	0,86
3150	3,37	1,79	5,2	13,7	8,6	0,86
4000	2,58	1,56	5,6	13,9	8,3	0,83
5000	2,02	1,35	5,6	13,5	8,0	0,80



Place of test: AUDIOTEC standardized reverberation room, in C/ Juanelo Turriano, 4, Boecillo Technology Park, Valladolid, España.
Test: Measurement of sound absorption in reverberation room.
Customer: AIDIMME
Test date: February 21, 2020
Sample: Auditorium seat model Audit, by ACTIU, reference BU10316M12.
Occupied seats
Sample surface: 10 m². **Room volume:** 202,12 m³.
Standard: UNE-EN ISO 354:2004.

Freq(Hz)	α_s
100	0,29
125	0,47
160	0,44
200	0,53
250	0,67
315	0,80
400	0,79
500	0,89
630	0,85
800	0,83
1k	0,83
1,25k	0,81
1,6k	0,84
2k	0,84
2,5k	0,86
3,15k	0,86
4k	0,83
5k	0,80



Done:

Signed: Ángel Arenaz Gombau

Place of test: AUDIOTEC standardized reverberation room, in C/ Juanelo Turriano, 4, Boecillo Technology Park, Valladolid, España.

Test: Measurement of sound absorption in reverberation room.

Customer: AIDIMME

Test date: February 21, 2020

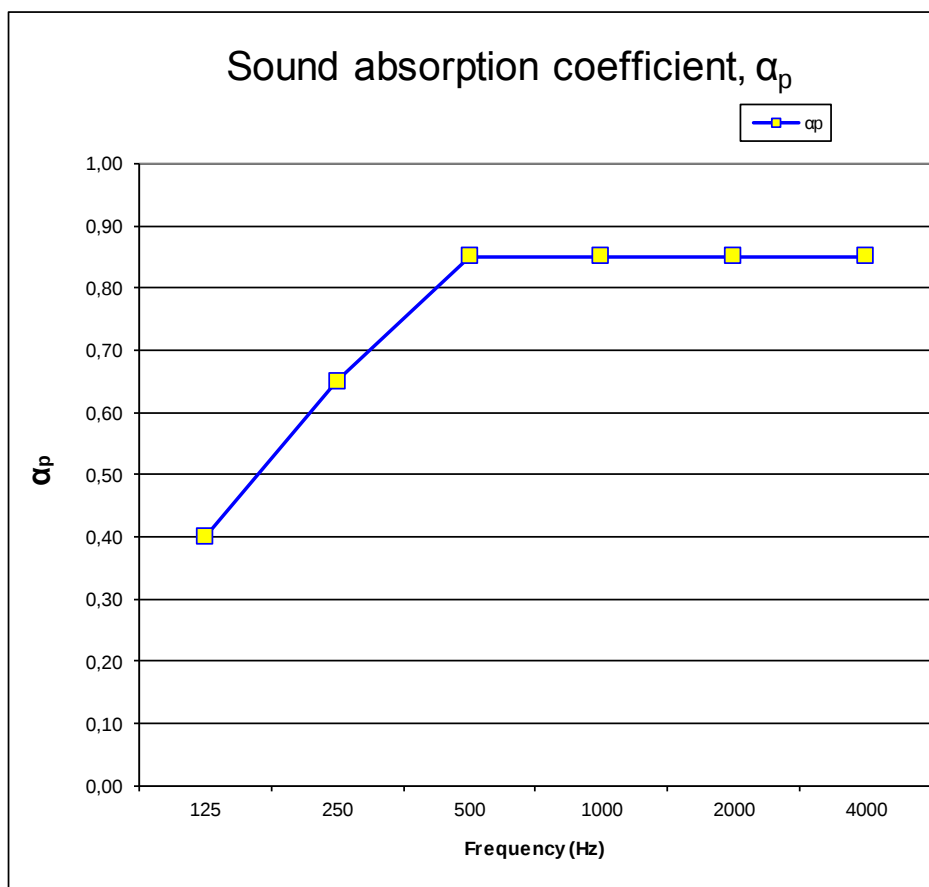
Sample: Auditorium seat model Audit, by ACTIU, reference BU10316M12.

Occupied seats

Sample surface: 10 m². **Room volume:** 202,12 m³.

Standard: UNE-EN ISO 354:2004.

Freq(Hz)	125	250	500	1000	2000	4000	$\alpha_w = 0,85$
α_p	0,40	0,65	0,85	0,85	0,85	0,85	



SOUND ABSORPTION CLASS

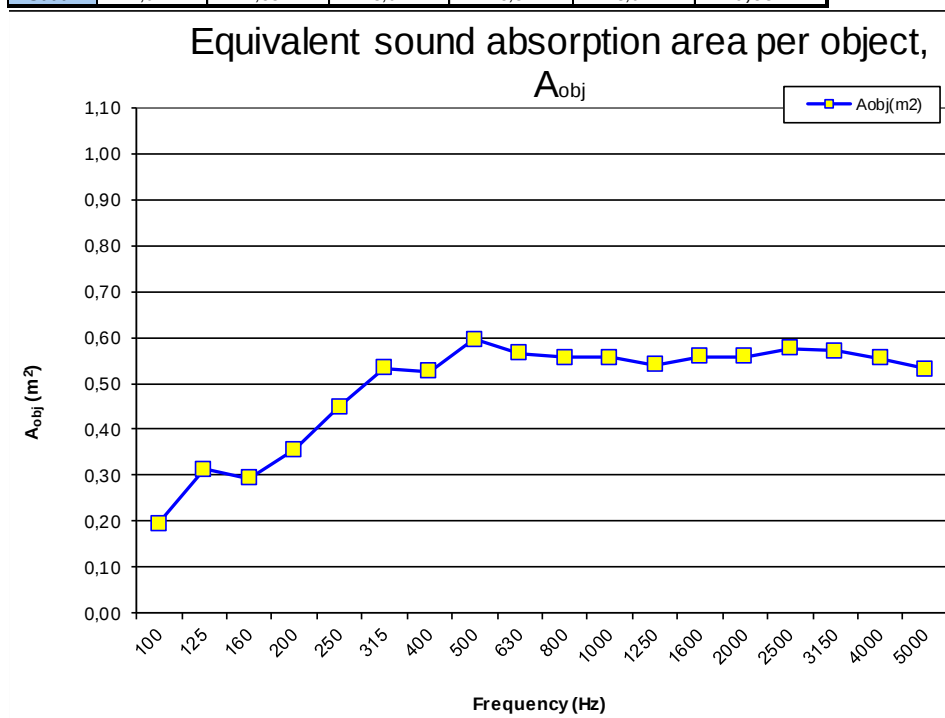
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Done:

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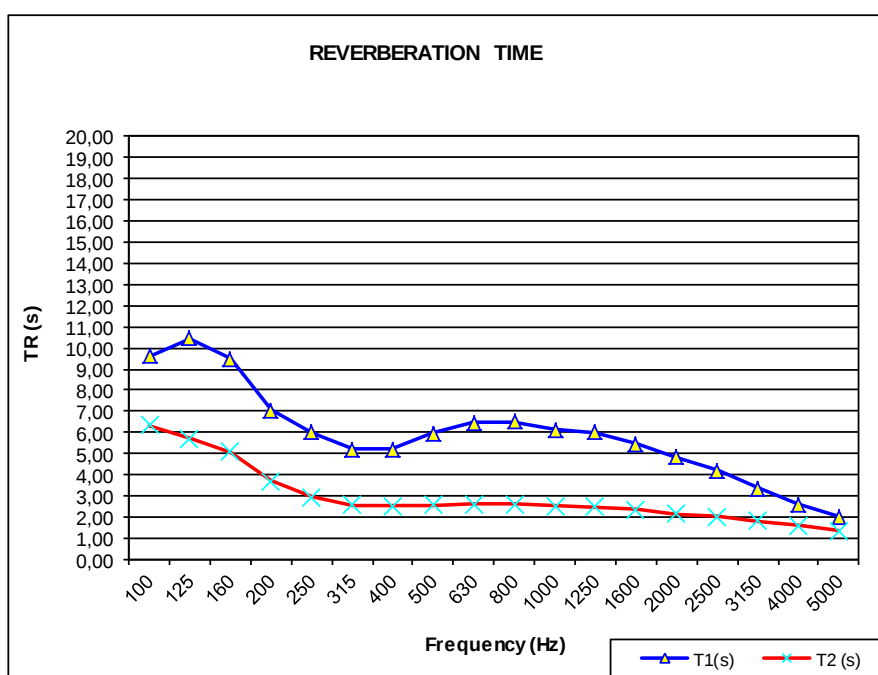
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Standard: UNE-EN ISO 354:2004.

Freq(Hz)	T1(s)	T2 (s)	A ₁ (m ²)	A ₂ (m ²)	A _T (m ²)	A _{obj} (m ²)
100	9,59	5,15	3,3	6,3	2,9	0,20
125	10,45	4,18	3,0	7,7	4,7	0,31
160	9,49	4,16	3,3	7,7	4,4	0,29
200	7,05	3,27	4,4	9,8	5,3	0,36
250	5,99	2,68	5,2	11,9	6,7	0,45
315	5,21	2,29	6,0	14,0	8,0	0,53
400	5,22	2,31	5,9	13,8	7,9	0,53
500	5,97	2,27	5,0	14,0	8,9	0,60
630	6,44	2,41	4,5	13,0	8,5	0,57
800	6,49	2,44	4,4	12,7	8,3	0,56
1000	6,14	2,39	4,5	12,8	8,3	0,56
1250	6,02	2,41	4,4	12,5	8,1	0,54
1600	5,47	2,28	4,5	12,9	8,4	0,56
2000	4,83	2,15	4,7	13,1	8,4	0,56
2500	4,20	1,99	4,7	13,4	8,6	0,58
3150	3,37	1,79	5,2	13,7	8,6	0,57
4000	2,58	1,56	5,6	13,9	8,3	0,55
5000	2,02	1,35	5,6	13,5	8,0	0,53



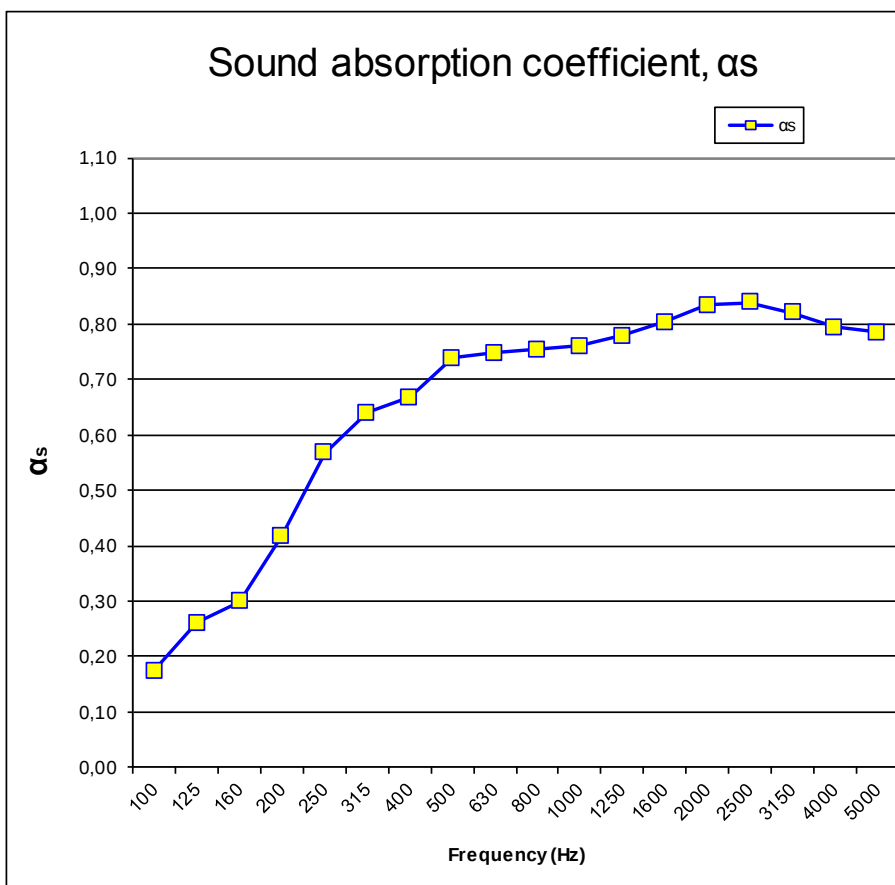
Place of test: AUDIOTEC standardized reverberation room, in C/ Juanelo Turriano, 4, Boecillo Technology Park, Valladolid, España.
Test: Measurement of sound absorption in reverberation room.
Customer: AIDIMME
Test date: February 21, 2020
Sample: Auditorium seat model Audit, by ACTIU, reference BU10316M12.
Empty seats
Sample surface: 10 m². **Room volume:** 202,12 m³.
Standard: UNE-EN ISO 354:2004.

Frec(Hz)	T1(s)	T2 (s)	A ₁ (m ²)	A ₂ (m ²)	A _T (m ²)	α_s
100	9,59	6,36	3,3	5,1	1,7	0,17
125	10,45	5,71	3,0	5,6	2,6	0,26
160	9,49	5,08	3,3	6,3	3,0	0,30
200	7,05	3,71	4,4	8,6	4,2	0,42
250	5,99	2,94	5,2	10,9	5,7	0,57
315	5,21	2,58	6,0	12,4	6,4	0,64
400	5,22	2,53	5,9	12,6	6,7	0,67
500	5,97	2,54	5,0	12,4	7,4	0,74
630	6,44	2,61	4,5	12,0	7,5	0,75
800	6,49	2,60	4,4	11,9	7,5	0,75
1000	6,14	2,53	4,5	12,1	7,6	0,76
1250	6,02	2,47	4,4	12,1	7,8	0,78
1600	5,47	2,33	4,5	12,5	8,0	0,80
2000	4,83	2,16	4,7	13,0	8,3	0,83
2500	4,20	2,02	4,7	13,1	8,4	0,84
3150	3,37	1,82	5,2	13,4	8,2	0,82
4000	2,58	1,58	5,6	13,6	7,9	0,79
5000	2,02	1,35	5,6	13,4	7,9	0,79



Place of test: AUDIOTEC standardized reverberation room, in C/ Juanelo Turriano, 4, Boecillo Technology Park, Valladolid, España.
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Empty seats
Sample surface: 10 m². **Room volume:** 202,12 m³.
Standard: UNE-EN ISO 354:2004.

Freq(Hz)	α_s
100	0,17
125	0,26
160	0,30
200	0,42
250	0,57
315	0,64
400	0,67
500	0,74
630	0,75
800	0,75
1k	0,76
1,25k	0,78
1,6k	0,80
2k	0,83
2,5k	0,84
3,15k	0,82
4k	0,79
5k	0,79



Done:

Signed: Ángel Arenaz Gombau

Place of test: AUDIOTEC standardized reverberation room, in C/ Juanelo Turriano, 4, Boecillo Technology Park, Valladolid, España.

Test: Measurement of sound absorption in reverberation room.

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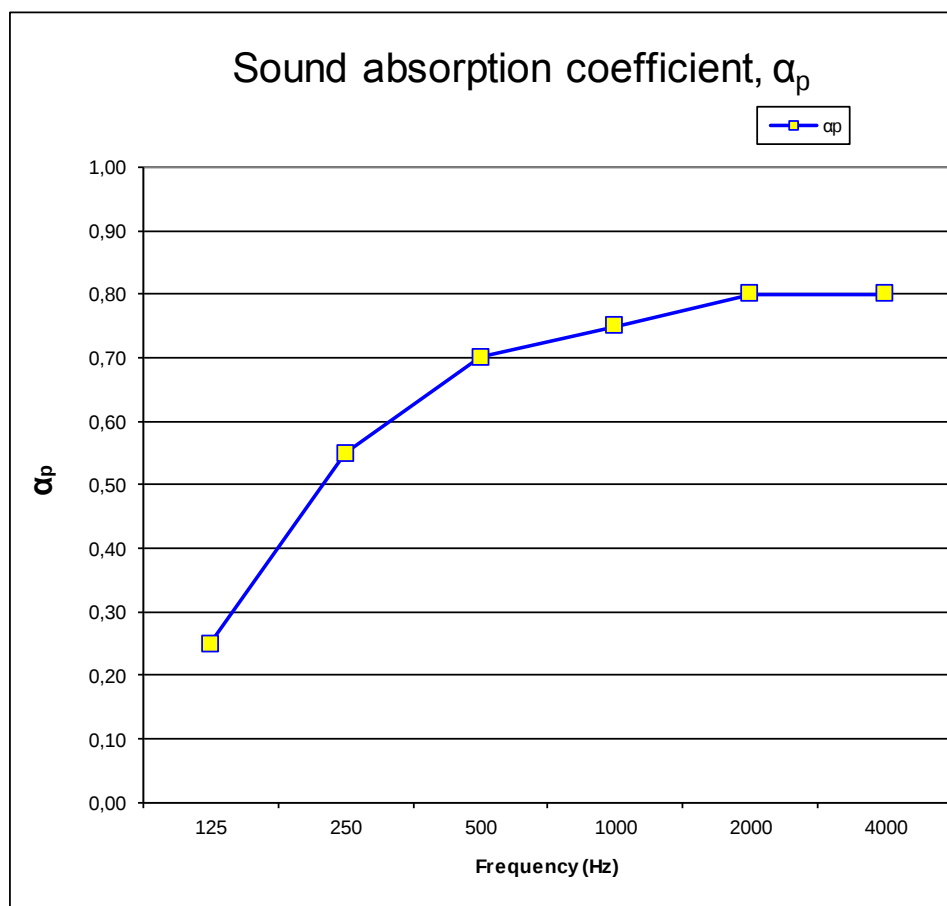
Sample: Auditorium seat model Audit, by ACTIU, reference BU10316M12.

Empty seats

Sample surface: 10 m². **Room volume:** 202,12 m³.

Standard: UNE-EN ISO 354:2004.

Freq(Hz)	125	250	500	1000	2000	4000	$\alpha_w = 0,75$
α_p	0,25	0,55	0,70	0,75	0,80	0,80	



SOUND ABSORPTION CLASS

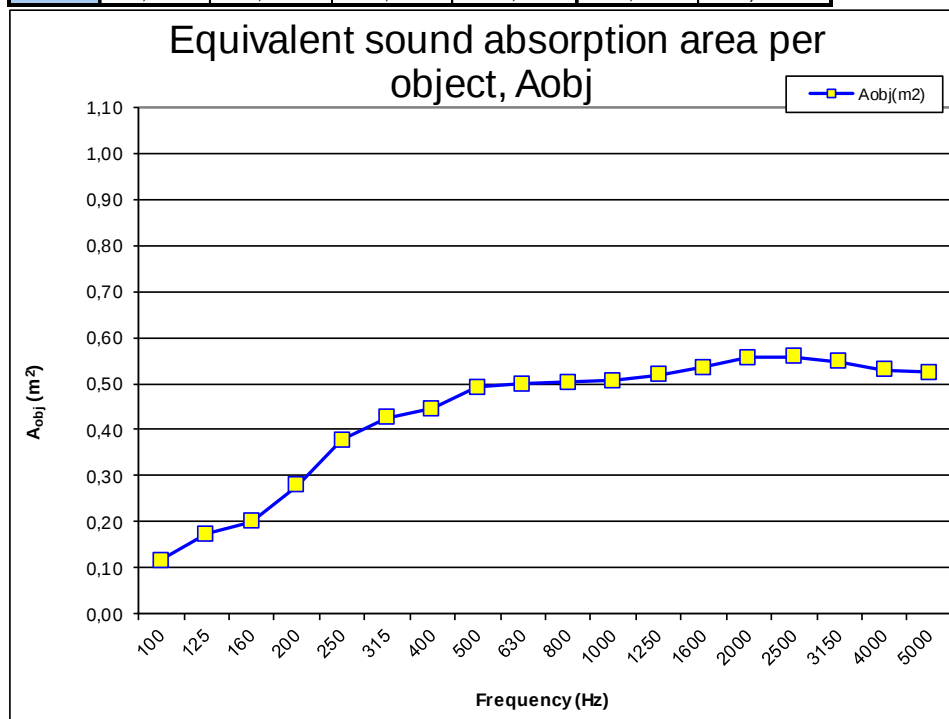
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Empty seats
Sample surface: 10 m². **Room volume:** 202,12 m³.
Standard: UNE-EN ISO 354:2004.

Freq(Hz)	T1(s)	T2 (s)	A ₁ (m ²)	A ₂ (m ²)	A _T (m ²)	A _{obj} (m ²)
100	9,59	6,36	3,3	5,1	1,7	0,12
125	10,45	5,71	3,0	5,6	2,6	0,17
160	9,49	5,08	3,3	6,3	3,0	0,20
200	7,05	3,71	4,4	8,6	4,2	0,28
250	5,99	2,94	5,2	10,9	5,7	0,38
315	5,21	2,58	6,0	12,4	6,4	0,43
400	5,22	2,53	5,9	12,6	6,7	0,45
500	5,97	2,54	5,0	12,4	7,4	0,49
630	6,44	2,61	4,5	12,0	7,5	0,50
800	6,49	2,60	4,4	11,9	7,5	0,50
1000	6,14	2,53	4,5	12,1	7,6	0,51
1250	6,02	2,47	4,4	12,1	7,8	0,52
1600	5,47	2,33	4,5	12,5	8,0	0,54
2000	4,83	2,16	4,7	13,0	8,3	0,56
2500	4,20	2,02	4,7	13,1	8,4	0,56
3150	3,37	1,82	5,2	13,4	8,2	0,55
4000	2,58	1,58	5,6	13,6	7,9	0,53
5000	2,02	1,35	5,6	13,4	7,9	0,52





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