

## REPORT No. B2022-LACUS-IN-172-2

CLIENT: **ISINAC ACOUSTIC WORLD, S.L.**  
Calle López de Neira 3, 3º - Oficina 301  
36203 VIGO

AIM: **Measurement of sound absorption in laboratory**

STANDARD: **EN ISO 354:2003**

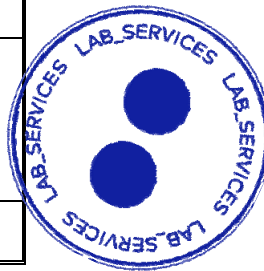
TEST SPECIMEN: **ABSORBRELLA 2.0**

TEST DATE: **17/05/2022**

ISSUE DATE: **22/06/2022**

Technical manager

Susana Lopez de Aretxaga



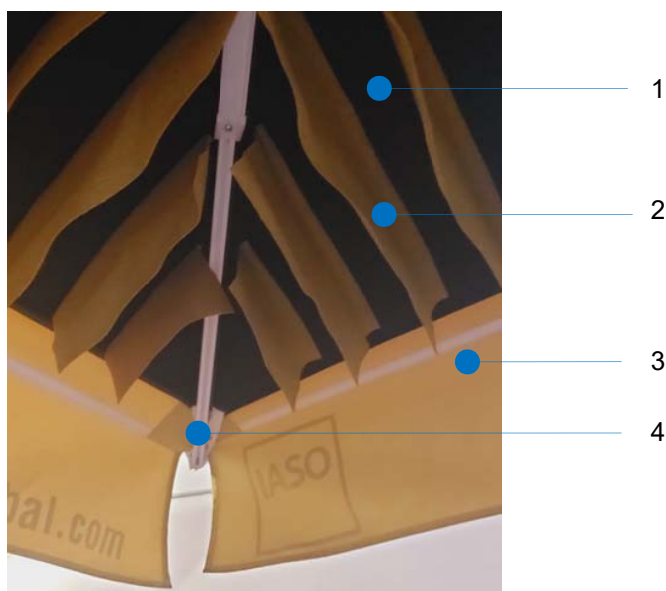
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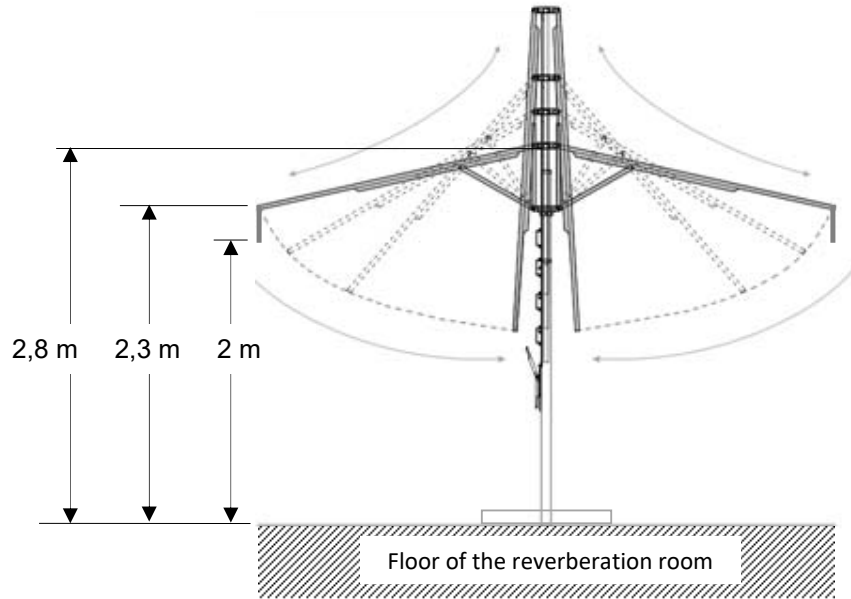
## 1. TEST SPECIMEN DESCRIPTION

The test specimen consists of a parasol with ABSORBRELLA 2.0 sound-absorbing material, as detailed below according to the information supplied by the client.



1. ILUCS - 100% POLYESTER TREVIRA CS – 265 gr/m<sup>2</sup>
2. IZZER - 100% LAMB WOOL – 460 gr/m<sup>2</sup>  
13 cm hanging and 10 cm separation between each other
3. PVC tarpaulin, 0,85mm thick
4. Steel frame





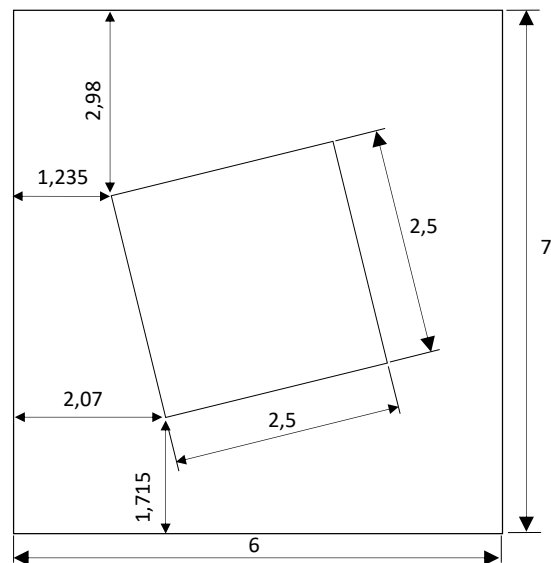
Open parasol dimensions:  $2,5 \times 2,5 \text{ m} = 6,25 \text{ m}^2$

Steel base dimensions:  $1,06 \times 1,06 \times 0,085 \text{ m}$  high

**Description of test specimen (B2022-172-M891)**

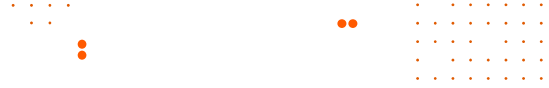
## 2. TEST ARRANGEMENT

Open parasol placed on the floor of the reverberation room, according to the following sketch:



**Photo and arrangement of test specimen. Cotes in m**





The specifications of the test standard are met except that, due to the size of the sample, it is not possible to meet the requirement to set 3 different sample positions separated at least 2 m between them. This is a deviation from the standard.

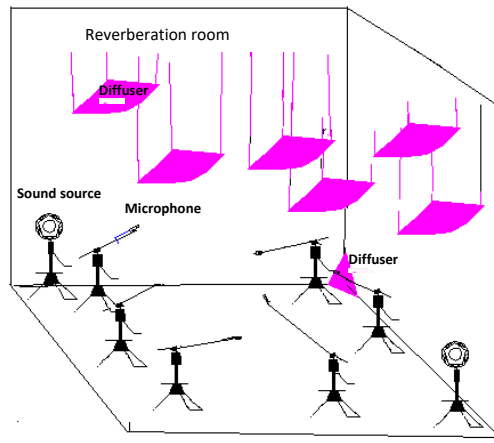
Material selected and delivered by: client.

Placement of test specimen in test room performed by: Tecnalía.

Placement date: 17th May 2022.

### 3. TEST FACILITIES

The test is performed in the reverberation room. This room is a regular parallelepiped of 7x6x5 meters with a total surface area of 211,8 m<sup>2</sup> (walls, floor and ceiling). The sound field diffusivity of the room is obtained by means of twenty diffusers (between 1 and 1,2 m<sup>2</sup>) suspended from the ceiling of the room and eight edged diffusers. The room complies with the requirements of EN ISO 354:2003.



Sketch of the reverberation room

### 4. EQUIPMENT AND TEST CONDITIONS

#### Equipment

Microphone	Brüel&Kjær 4943; N° serie 3188436	Brüel&Kjær 4943; N° serie 3188435
Preamplifier	Brüel&Kjær 2669; N° serie 1948764	Brüel&Kjær 2669; N° serie 2025844
Analyzer	Nor850-MF1; N° serie 8501186	
Sound source	Brüel&Kjær 4296; N° serie 2071428	
Amplifier	LAB 300; N° serie 970-967	
Equalizer	Sony, SRP-E100; N° serie 400238	
Calibrator	Brüel & Kjær 4231; N° serie 2061476	
Atmospheric conditions meter	Rotronic BL-1D; N° serie A21050028	





<b>Atmospheric conditions:</b>	Empty room	Room with test specimen	Uncertainty
Air temperature (°C)	20,1	20,1	±0,5
Relative humidity (%)	58	59	±4
Static pressure (mbar)	961	961	±2

## 5. TEST PROCEDURE AND EVALUATION

The equivalent sound absorption area of an individual object, for the one-third-octave band from 100 Hz to 5 kHz, is calculated according to EN ISO 354:2003, using the following formula:

$$A_{obj} = \frac{A_T}{n}$$

$A_T$ : Equivalent sound absorption area of test specimen, in square metres

$n$ : Number of objects used in the test

The equivalent sound absorption area of the 'n' objects is calculated according to the following formula:

$$A_T = 55,3 \cdot V \cdot \left( \frac{1}{c_2 \cdot T_2} - \frac{1}{c_1 \cdot T_1} \right) - 4 \cdot V (m_2 - m_1)$$

$V$ : Volume of the empty reverberation room ( $m^3$ ).

$c_1$ : Propagation speed of sound in air, in metres per second, in the empty reverberation room

$c_2$ : Propagation speed of sound in air, in metres per second, in the reverberation room with the test specimen

$T_1$ : Reverberation time, in seconds, of the empty reverberation room

$T_2$ : Reverberation time, in seconds, of the reverberation room with the test specimen installed

$m_1, m_2$ : Power attenuation coefficients, in reciprocal metres, calculated according to ISO 9613-1, using the climatic conditions in the reverberation room

The sound absorption coefficient,  $\alpha_s$ , for the covered surface of a configuration of objects is calculated for the one-third-octave band 100 Hz to 5 kHz according to standard EN ISO 354:2003, using the following formula:

$$\alpha_s = A_T/S$$

$A_T$ : Equivalent sound absorption area of test specimen, in square metres

$S$ : Area covered by the test specimen, in square metres

Reverberation time measurements for the one-third-octave frequency bands between 100 Hz and 5 kHz are obtained as the arithmetic average of measurements at 2 source positions and 6 fixed microphone positions for each source position. For each position, the





reverberation time is obtained as the arithmetic average of 5 repetitions. The sound emission is performed using an omnidirectional sound source by means of equalized pink noise.

Measuring chain is verified just before and after the execution of the test.

The guidelines indicated in the applicable internal procedures have been followed:

- PE.MC-AA-63-E: "Procedure to determine the sound absorption in a reverberation room, according to Standard EN ISO 354".
- PE.MC-AA-06-M: "Procedure to manage the test specimens for acoustic tests in laboratory".

## 6. RESULTS

The following results are featured for the test specimen:

In page 8:

The equivalent sound absorption area,  $A_{obj}$ , in  $m^2$ :

- for the one-third-octave bands from 100 to 5000 Hz
- for octave bands from 125 to 4000 Hz, according to ISO 20189:2018

The values in octave bands are calculated as an arithmetic mean of the values in the one-third-octave bands.

The equivalent sound absorption area of a single object,  $A_{obj}$ , is a frequency-dependent parameter, in  $m^2$ , used to describe the sound absorption capacity of an interior acoustic product of defined size and generally assembled in an independent way.

The intermediate data obtained in the test were:

f (Hz)	T <sub>1</sub>	T <sub>2</sub>	A <sub>T</sub>
100	8,87	7,09	1,0
125	7,92	5,55	1,8
160	8,91	4,98	3,0
200	9,87	4,46	4,2
250	9,90	4,20	4,6
315	8,94	3,81	5,1
400	8,98	3,56	5,7
500	9,42	3,57	5,9
630	8,82	3,35	6,2

f (Hz)	T <sub>1</sub>	T <sub>2</sub>	A <sub>T</sub>
800	8,40	3,27	6,3
1000	7,87	3,13	6,5
1250	7,07	2,93	6,8
1600	6,40	2,67	7,4
2000	5,56	2,46	7,7
2500	4,66	2,19	8,2
3150	3,75	1,96	8,2
4000	3,00	1,73	8,4
5000	2,26	1,46	8,3

As additional information, the single object sound absorption coefficient  $\alpha_{obj}$  is presented in octave bands from 125 Hz to 4 kHz (for use in 3D simulations), calculated from  $A_{obj}$  according to Annex B of ISO 20189:2018:

$$\alpha_{obj} = A_{obj} / S$$





$A_{obj}$ : Equivalent sound absorption area in octave bands of the object

S: Total exposed surface area of the simplified acoustic representation of the single object in the test mounting conditions. For this sample: 17,5 m<sup>2</sup>.

In page 9:

The sound absorption coefficient,  $\alpha_s$ , per one-third octave frequency bands from 100 to 5000 Hz, for the projected surface.

Likewise, the following parameters obtained according to Standard EN ISO 11654:1997, from the sound absorption coefficient  $\alpha_s$  in frequency bands:

- Practical sound absorption coefficient,  $\alpha_p$ , per one-third octave frequency bands from 125 to 4000 Hz
- Weighted sound absorption coefficient,  $\alpha_w$
- Shape indicators: L.M.H



## Sound absorption according to EN ISO 354:2003 Laboratory measurements

CLIENT: ISINAC ACOUSTIC WORLD, S.L.

TEST SPECIMEN: **ABSORBRELLA 2.0**

Acoustic parasol, of 2500x2500 mm (opened parasol), with sound-absorbing material suspended from the bottom, open on a mast, at a height of 2,3 m from the floor.

TEST DATE: 17/05/2022

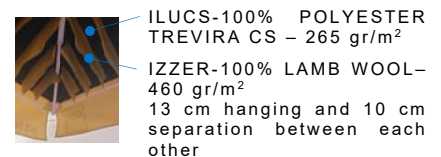
Result No.: B2022-172-M891-1

Single object.

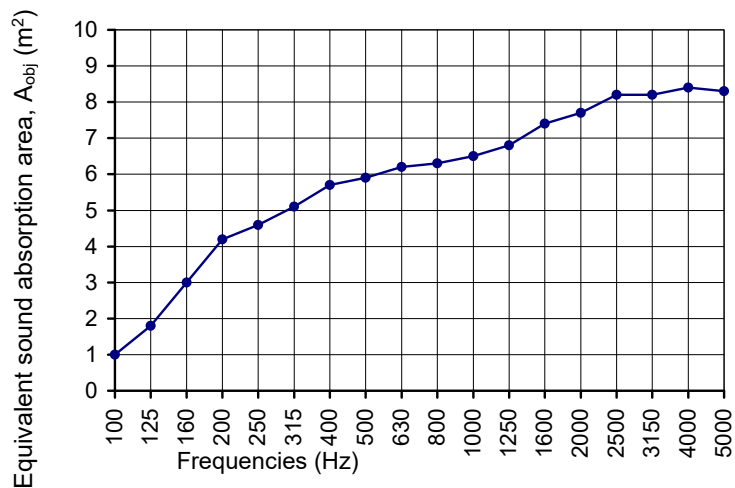
No. of objects used (n): 1 Arrangement: Randomly distributed

Mounting type: VI.2 according to Annex E of ISO 20189:2018

Reverberation room volume: 209,6 m<sup>3</sup>



Equivalent sound absorption area of a single object $A_{obj}$ (m <sup>2</sup> )		
f (Hz)	1/3 octave bands	Octave bands
100	1,0	<b>1,9</b>
<b>125</b>	1,8	
160	3,0	
200	4,2	<b>4,6</b>
<b>250</b>	4,6	
315	5,1	
400	5,7	<b>5,9</b>
<b>500</b>	5,9	
630	6,2	
800	6,3	<b>6,5</b>
<b>1000</b>	6,5	
1250	6,8	
1600	7,4	<b>7,8</b>
<b>2000</b>	7,7	
2500	8,2	
3150	8,2	<b>8,3</b>
<b>4000</b>	8,4	
5000	8,3	



Evaluation based on laboratory measurements obtained by an engineering method

## Sound absorption according to EN ISO 354:2003 Laboratory measurements

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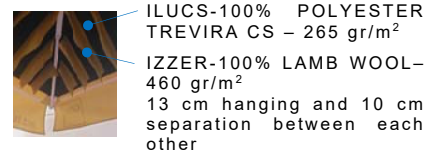
TEST DATE: 17/05/2022

Result No.: B2022-172-M891-2

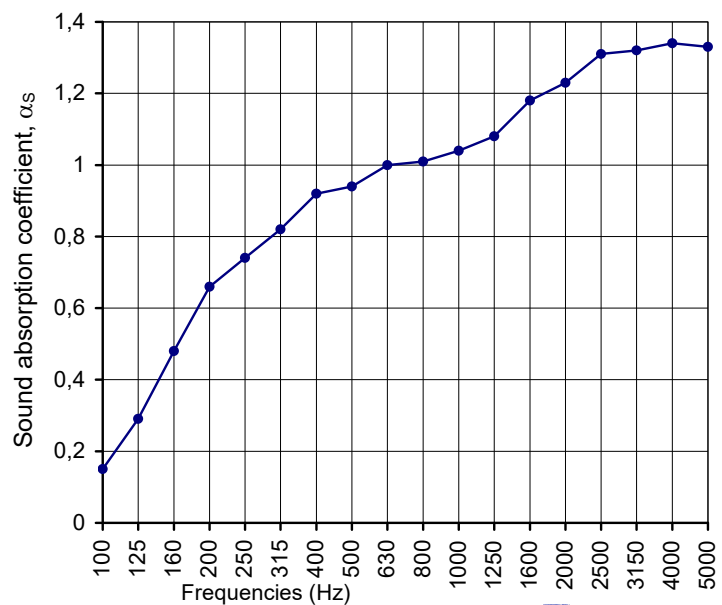
Specified array of objects.

Area, S, covered by the test specimen: 6,25 m<sup>2</sup>

Reverberation room volume: 209,6 m<sup>3</sup>



f (Hz)	$\alpha_s$	$\alpha_p$
100	0,15	
<b>125</b>	0,29	<b>0,30</b>
160	0,48	
200	0,66	
<b>250</b>	0,74	<b>0,75</b>
315	0,82	
400	0,92	
<b>500</b>	0,94	<b>0,95</b>
630	1,00	
800	1,01	
<b>1000</b>	1,04	<b>1,00</b>
1250	1,08	
1600	1,18	
<b>2000</b>	1,23	<b>1,00</b>
2500	1,31	
3150	1,32	
<b>4000</b>	1,34	<b>1,00</b>
5000	1,33	



Evaluation according to EN ISO 11654:1997:

Weighted sound absorption coefficient:  $\alpha_w = 1,00$



Evaluation based on laboratory measurements obtained by an engineering method