

TEST REPORT

DATE OF RECEPTION

Date Format: dd/MM/yyyy 24/04/2024

DATE TESTS

Starting: 08/03/2024

Ending: 24/03/2024

APPLICANT

ACTIU BERBEGAL Y FORMAS, S.A.
P.T. ACTIU; AUTOVIA CV.80 SALIDA
ONILCASTALLA
ES-03420 Castalla (Alicante/Alacant)
España

Att. Pablo Miró Aparisi

IDENTIFICATION AND DESCRIPTION OF SAMPLES

Reference by AITEX	Reference by customer	AITEX sample description
2024AU0491-S01	Cabina QYOS400	Material

TESTS CARRIED OUT

- VOICE LEVEL REDUCTION MEASUREMENT.



RESULTS

VOICE LEVEL REDUCTION MEASUREMENT

Standard

ISO 23351-1: 2020

Measurement date

March 2024

Material tested

2024AU0491-S01

Instrument used

Bruel and Kjaer sound level meter type 2270. SN: 3011089
Bruel & Kjaer micro ½" type 4189. SN: 3180898
Bruel & Kjaer preamplifier SN 28138
Bruel & Kjaer micro ½" type 4231. SN: 3019977
Bruel & Kjaer dodecahedron source OmniPower 4296. SN: 2498653.
Bruel & Kjaer Stage amplifier 2716. SN: 2551039.

Aim of the test

This study was carried out at the request of the company ACTIU and the acoustics of the Q400 booth were evaluated in the reverberation chamber of the Universitat Politècnica de Valencia's Escuela Politècnica Superior de Gandia.

The main aim of the study was to measure using the ISO 23351-1:2020 Standard. Acoustics — Measurement of speech level reduction of furniture ensembles and enclosures — Part 1: Laboratory method.

The standard stipulates a laboratory method to facilitate the comparison of furniture and enclosure units with respect to their ability to reduce the speech level of the occupant speaking inside the product. In this method, the sound strength level is measured in two scenarios:

- 1) without the product and
- 2) with the product.

During scenario 1), the test signal is reproduced by the sound source in an empty reverberation chamber without the product. During scenario 2), the test signal is reproduced by the sound source inside the product in the position of the occupant.

Level reduction is the difference in the measured sound strength levels in the two scenarios in octave frequency bands from 125 Hz to 8 000 Hz.

Speech level reduction is a single number that expresses the corresponding reduction in the A-weighted sound strength level of standard speech over the entire frequency range from 125 Hz to 8 000 Hz.

The method is applicable for complete furniture assemblies or enclosures which form a unit for the use of one or more occupants, and which are also used to provide greater speech privacy.

The measurements were carried out on 8 March 2024 in the acoustics laboratories and chambers of the Universitat Politècnica de Valencia's Escuela Politècnica Superior de Gandia. A description of the reverberation chamber appears in Annex 3 of this report.

Date of last report revision: 24 March 2024

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Procedure

This test was carried out in the reverberation chamber of the Escuela Politécnica Superior de Gandia (EPSG) of the Universitat Politècnica de Valencia on 8 March 2024. The environmental conditions were normal with no sudden changes in temperature or humidity. The tests with an empty chamber showed a temperature of 20.6° C and 39.6% relative humidity and the tests with the configuration showed a temperature of 20.1° C and 42.3% relative humidity.

Figures 1 and 2 show details of the reverberation chamber set up with only the source and inside the booth.



Figure 1: reverberation chamber assembly with source only

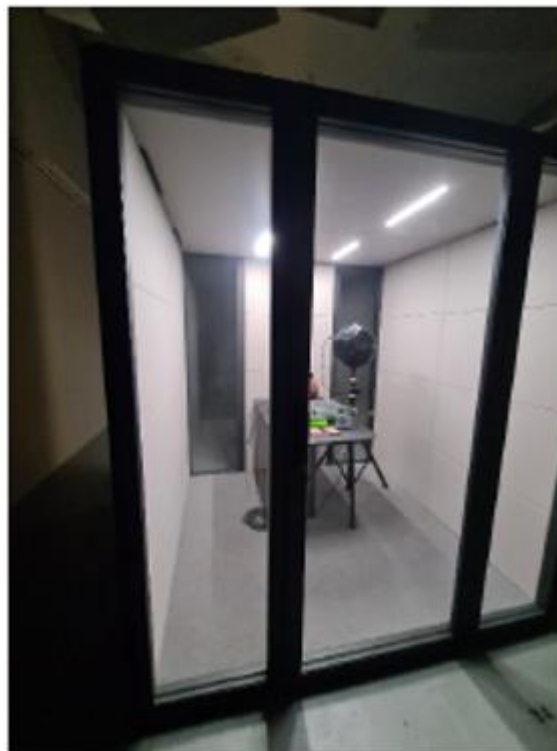


Figure 2: booth configuration 1 assembly

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The procedure that sets the standard is as follows:

The test took place inside the reverberation chamber and two sound strength level measurements were taken, one without the booth and one with the booth. The sound strength level of the sound source $L_{W,P,1}$ with the booth and $L_{W,P,2}$ without the booth was measured, and the level reduction of booth **Di** was obtained. Using the above values, the reduction in speech level (**DS,A**) was calculated.

To produce $L_{W,P,1}$ and $L_{W,P,2}$ a sound box generating pink noise from 125Hz to 8000Hz was used. An omnidirectional sound source can be used when testing closed spaces with high level reduction, as in these cases the background noise levels may not be exceeded using the sound box. When testing open spaces, only the sound box should be used. The source should be placed where the occupant's mouth is most likely to be (height of 1.2 m if the occupant is seated or 1.55 m if they are standing).

The booth should be tested in at least two different locations within the chamber, at least 1.7 m apart and the booth should be at least 1 m away from the microphone positions and chamber enclosures. The booth should be placed in its usual operating position. If the booth has doors or windows they should be opened and closed 5 times before taking the measurement. If it is intended that the booth has fixed accessories such as computers and computer screens, the test should be performed with these in place.

It is important for the booth to have a power socket inside it to avoid having to run cables through the door, which would compromise the booth's soundproofing. If the booth has internal noise sources (a fan for ventilation) these should be switched on both when measuring with the sound source on and when **measuring background noise** with the sound source off.

The number of **microphone positions** should comply with standard UNE-EN ISO 3741:2011. All the microphone positions should be located outside the testing booth. The minimum distance between the microphone position, the booth and the room boundary should comply with standard UNE-EN ISO 3741:2011. The testing method performed should comply with UNE-EN ISO 3741:2011.

The sound power level of the sound source is measured with the test sample $L_{W,P,1}$ and without the test sample $L_{W,P,2}$

Booth **Di**'s reduction level is determined by:

$$D_i = L_{W,P,1,i} - L_{W,P,2,i}$$

The 1/1 octave frequency band is indicated by i. P indicates broad-band steady state noise, such as pseudo-random pink noise produced by the sound source.

$L_{W,P,1,i}$ y $L_{W,P,2,i}$ should be determined in compliance with the direct ISO 3741 method, including the background noise correction procedure.

The $D_{S,A}$ calculation is based on a mathematical transformation in which the sound power level $L_{W,P,1,i}$ is replaced by the speech standardised sound power level $L_{W,S,1,i}$ shown in Table 1. In this case, the sound power level radiated by the test sample $L_{W,S,2,i}$ is determined by

$$L_{W,S,2,i} \text{ } D_{S,A} = L_{W,S,1,i} - D_i$$

Octave band frequency Frequency (Hz)							
	125	250	500	1000	2000	4000	8000
$L_{W,S,1}$ [dB re 1 pW]	60,9	65,3	69,0	63,0	55,8	49,8	44,5

Table 1. Unweighted sound power level of genderless speech.

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The A-weighted sound power level radiated by the test sample within the frequency range 125 Hz to 8 000 Hz is determined by:

$$L_{W,S,A,2} = 10 \log_{10} \left(\sum_{i=1}^7 10^{(L_{W,S,2,i} + A_i)/10} \right)$$

where A_i is the A-weighting for the 1/1 octave i frequency band.

The speech reduction level is determined by:

$$D_{S,A} = L_{W,S,A,1} - L_{W,S,A,2}$$

where $L_{W,S,A,1} = 68.4$ dB is the A-weighted sound power level of normalised speech over the entire frequency range from 125 Hz to 8 000 Hz.

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Reverberation chamber set-up

In order to obtain the power levels that meet the standard, the reverberation time and the background noise inside the reverberation chamber must also be measured. Table 2 shows the background noise measurements in the reverberation chamber before the measurements.

Frequency (Hz)	Recorded background noise levels (db)
100	26,6
125	20,5
160	17,6
200	15,4
250	13,4
315	9,8
400	6,0
500	4,6
630	2,7
800	2,0
1000	2,0
1250	2,6
1600	3,3
2000	4,1
2500	5,0
3150	5,8
4000	6,5
5000	7,1
6300	7,6
8000	7,9
10000	7,9

Table 2. Background noise levels recorded during the tests versus maximum background noise levels.

The average background noise value of the reverberation chamber in the defined frequency range is $L_{PA} = 18.3 \text{ dBA}$.

Table 3 below shows the reverberation time data.

Frequency (Hz)	Reverberation time (s)
100	8,8
125	6,4
160	5,8
200	6,0
250	6,6
315	7,1
400	7,1
500	7,3
630	7,3
800	7,2
1000	6,9
1250	6,4
1600	5,7
2000	5,0
2500	4,3
3150	3,5
4000	2,8
5000	2,1
6300	1,5
8000	1,1
10000	0,9

Table 3. Reverberation time recorded during tests



Sound strength measurement

The sound power results are shown below. As specified in the procedure, the sound power must be determined WITHOUT A BOOTHE and WITH A BOOTH. The determination of sound strength was carried out according to standard UNE-EN ISO 3741:2011. Acoustics. Determination of the sound strength levels and sound energy levels of noise sources from sound pressure. Laboratory methods in reverberation chambers. (ISO 3741:2010).

The table shows the sound strength level results according to UNE-EN ISO 3741:2011 with or without booth, for configuration Q400.

f (Hz)	LW (dB) WITHOUT BOOTH	LW (dB) WITH BOOTH
100	95.2	78.9
125	95.8	75.4
160	96.5	71.4
200	97.3	71.0
250	96.8	70.6
315	98.0	69.1
400	97.6	67.5
500	97.2	63.6
630	97.3	61.2
800	97.2	58.9
1000	97.1	56.7
1250	96.9	56.0
1600	97.6	58.2
2000	96.9	56.8
2500	96.6	54.3
3150	96.6	53.9
4000	96.2	54.7
5000	95.9	53.7
6300	94.9	52.7
8000	95.7	54.9
10000	92.8	50.7

Table 4. Sound strength levels (dB) for booth Q400

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Rating according to ISO 23351-1:2020

This section shows the results obtained from applying ISO 23351-1:2020 to the two configurations. Table 5 shows the calculations according to ANNEX A - the standard for the Q400 booth.

1/1 octave frequency band	Unweighted values		Dj	Unweighted values		Ai	A-weighted values	
Hz	$L_{w,p,1,i}$ (dB)	$L_{w,p,2,i}$ (dB)	dB	$L_{w,s,1,i}$ (dB)	$L_{w,s,2,i}$ (dB)	dB	$L_{w,s,A,1,i}$ (dB)	$L_{w,s,A,2,i}$ (dB)
125	100,6	81,0	19,6	60,9	41,3	16,1	44,8	25,2
250	102,2	75,1	27,1	65,3	38,2	-8,6	56,7	29,6
500	102,2	69,7	32,5	69,0	36,5	-3,2	65,8	33,3
1000	101,9	62,2	39,7	63,0	23,3	0,0	63,0	23,3
2000	101,8	61,5	40,3	55,8	15,5	1,2	57,0	16,7
4000	101,0	58,9	42,1	49,8	7,7	1,0	50,8	8,7
8000	99,4	57,9	41,5	44,5	3,0	-1,1	43,4	1,9

Table 5. Calculations according to ISO 23351-1:2020

The overall results are as follows:

$L_{w,p,1}$ (dB)	109,8				
$L_{w,p,2}$ (dB)	82,3		D (dB)	27,5	
$L_{w,s,1}$ (dB)	71,8				
$L_{w,s,2}$ (dB)	43,9		D_s (dB)	27,8	
$L_{w,s,A,1}$ (dB)	68,4				
$L_{w,s,A,2}$ (dB)	35,6		$D_{s,A}$ (dB)	32,8	CLASS A

The sound strength level of the source without booth $L_{w,p,1}$ was 109.8 dB while with booth it was 82.3 dB, giving a booth D reduction level of 27.5 dB. The standardised speech strength level without booth was $L_{w,s,1}$ and with booth $L_{w,s,2}$ was 71.8 dB and 43.9 dB respectively, giving a standardised speech reduction D_s of 27.9 dB. The A-weighted speech strength level without booth $L_{w,s,A,1}$ and with booth $L_{w,s,A,2}$ is 68.4 dB and 35.6 dB giving a speech level reduction $D_{s,A}$ of 32.8 dB.

ANNEX I shows the results sheets for the two configurations tested, according to the recommendations in ANNEX B of ISO 23351-1:2020.

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Summary

For the application of ISO 23351-1:2020 the reference standard for sound power measurement in a reverberation chamber (UNE EN ISO 3741:2011) was followed, as set out in the standard. Booth Q400 was tested:

Frequency	Speech reduction level
f (Hz)	D (dB)
125	19,6
250	27,1
500	32,5
1000	39,7
2000	40,3
4000	42,1
8000	41,5

D_{s,A}

32,8

CLASE/CLASS

A

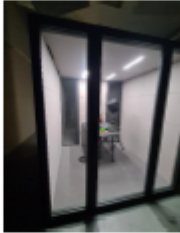
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APPENDIX 1. DATA SHEETS ACCORDING TO ISO STANDARD 23351-1: 2020

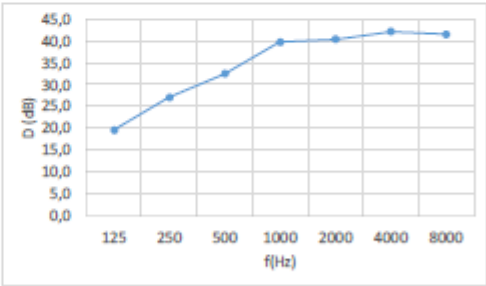
Cámara reverberante. Escuela Politécnica Superior de Gandía
Determinación del nivel de reducción del habla según ISO 23351-1:2020

Solicitante: ACTIU		Fecha ensayo: 08/03/2024	
Muestra Ensayada: Q400		Fecha Informe: 24/03/2024	



Cálculos acorde a norma / Calculations according to norm

Freuencia Frequency	Nivel de reducción de habla Speech level reduction
f (Hz)	D (dB)
125	19,6
250	27,1
500	32,6
1000	39,7
2000	40,3
4000	42,1
8000	41,6




D_{SA} 32,8

CLASE/CLASS A

f 1/1 banda de frecuencias de octava / 1/1-octave frequency band (Hz)

D nivel de reducción / level reduction (dB)

D_{SA} Nivel de reducción del habla / speech level reduction (dB)



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