ISTITUTO GIORDANO

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TEST REPORT No. 297996

Place and date of issue: Bellaria-Igea Marina - Italy, 19/09/2012

Customer: SEALED AIR S.r.l. - Via Trento, 7 - 20017 PASSIRANA DI RHO (MI) - Italy

Date test requested: 23/07/2012

Order number and date: 57275, 07/08/2012

Date sample received: 02/08/2012

Test date: 10/08/2012

Purpose of test: measurement in reverberation room of the sound absorption coefficient "α_S" of planes absorbers in accordance with standard UNI EN ISO 354:2003

Test site: Istituto Giordano S.p.A. - Via Erbosa, 78 - 47043 Gatteo (FC) - Italy

Sample origin: sampled and supplied by the Customer

Identification of sample received: No. 2012/1716/D

Sample name*

The panels forming the test sample are called "Stratocell Whisper FR 30mm black double drilling".

(*) according to that stated by the Customer.

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Description of sample*

The test specimen is formed by putting together 4 standard panels and 1 reduced panel, having the following specifications:

Measured length of sample	3590 mm
Measured width of sample	3340 mm
Nominal length of a single panel	2400 mm
Nominal width of a single panel	1100 mm
Effective acoustic surface of sample	11,99 m^2

More specifically, each panel consists of:

- material: low density polyethylene foam;
- nominal density: 25 kg/m^3;
- nominal thickness: 30 mm.

The outside edge of the specimen was covered with adhesive tape.

The sample is manufactured by the Customer and arranged for assembly in the reverberation room by the staff of Istituto Giordano S.p.A.

Photo of sample

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(*) according to that stated by the Customer, apart from characteristics specifically stated to be measurements.

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Normative references

The test was carried out in accordance with standard UNI EN ISO 354:2003 dated 01/12/2003 "Acustica - Misura dell'assorbimento acustico in camera riverberante" *("Acoustics. Measurement of sound absorption in a reverberation room")*.

Test apparatus

The following equipment was used to carry out the test:

- Behringer "EPX2000" 2000 W power amplifier;
- Behringer "DEQ2496" digital ⅓-octave equaliser;
- 2 omnidirectional speakers;
- 01 dB-Stell real-time analyser, type "Symphonie";
- 01 dB-Stell "Cal21" acoustic calibrator for microphone calibration;
- Brüel & Kjær ½" microphone - type "4192";
- Brüel & Kjær microphone preamplifier - type "2669";
- Kern "VB 150 K 50LM" electronic platform scale;
- Sola "Tri-Matic 5m/19mm" metric tape measure;
- Bosch "DLE 50 Professional" laser rangefinder;
- Delta "Ohm HD206-2/HD206S1" temperature and humidity logger with combined probe;
- complementary accessories.

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Test method

The test was carried out using detailed internal procedure PP016 revision 7 dated 06/12/2011 "Misura dell'assorbimento acustico in camera riverberante (metodo del rumore interrotto)" *("Measurement of sound absorption in a reverberation room (interrupted noise method)")*.

The test environment consists of a parallelepiped-shaped reverberation room with a rectangular base and the following size specifications:

Plan-view dimensions	8,111 × 6,744 m
Height "H"	4,003 m
Base surface area "S_b"	54,7 m^2
Total surface area "S_t"	228,3 m^2
Volume of the room	218,9 m^3
Net volume of room "V"	218,8 m^3

All surfaces of the test room were treated in such a way as to produce maximum sound reverberation; in addition, 14 slightly-curved diffusing elements having an overall surface area, including both faces, of approx. 40 m^2 were arranged and oriented randomly. The sample was installed on the floor of the reverberation room.

The test involves measuring reverberation times of the empty reverberation room "T_1" and reverberation room containing the specimen "T_2" in order to determine said specimen's sound absorption coefficient "α_S"; the reverberation time "T" corresponds to the time taken in seconds for the sound pressure level to decay 60 dB after the sound has stopped.

Measurements were taken in $\frac{1}{3}$-octave bands within the range 100 Hz to 5000 Hz using the interrupted noise method.

The test utilised a pink-noise generator, power amplifier and two dodecahedral omnidirectional speakers, alternatively working for each one of the six microphone positions, such as to measure twelve decays in sound pressure level for each frequency band.

The sound absorption coefficient "α_S" was calculated using the following equations:

$$\alpha_S = \frac{A}{S}$$

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$$A = A_2 - A_1 = 55{,}3 \cdot V \cdot \left(\frac{1}{c_2 \cdot T_2} - \frac{1}{c_1 \cdot T_1} \right) - 4 \cdot V \cdot (m_2 - m_1)$$

$$c_2 = 331 + 0{,}6 \cdot t_2$$

$$c_1 = 331 + 0{,}6 \cdot t_1$$

where : α_S = sound absorption coefficient;

A = equivalent sound absorption area of the test sample, in square metres;

S = the area, in square metres, covered by the test sample;

A_2 = equivalent sound absorption area, in square metres, of the reverberation room after the test sample has been introduced;

A_1 = equivalent sound absorption area, in square metres, of the empty reverberation room;

V = effective volume, in cubic metres, of the empty reverberation room;

c_2 = propagation speed of sound in air, in metres per second, of the reverberation room after the test sample has been introduced;

T_2 = reverberation time, in seconds, of the reverberation room after the test sample has been introduced;

c_1 = propagation speed of sound in air, in metres per second, of the empty reverberation room;

T_1 = reverberation time, in seconds, of the reverberation room that is empty except for the barriers bounding the sample;

m_2 = sound power attenuation coefficient, in reciprocal metres, calculated according to standard UNI ISO 9613-1:2006 dated 07/09/2006 "Acoustics - Attenuation of sound during propagation outdoors - Part 1: Calculation of the absorption of sound by the atmosphere", using the climatic conditions present in the reverberation room since the test sample was introduced;

m_1 = sound power attenuation coefficient, in reciprocal metres, calculated according to standard UNI ISO 9613-1:2006 using the climatic conditions present in the empty reverberation room during the measurement;

t_2 = air temperature, in degrees Celsius, in the reverberation room after introducing the test sample;

t_1 = air temperature, in degrees Celsius, in the empty reverberation room.

There was a gap of 10 minutes between completing the sample's preparation and carrying out the test.

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Uncertainty of measurement

Uncertainty of measurement was determined in accordance with standard UNI CEI ENV 13005:2000 dated 31/07/2000 "Guida all'espressione dell'incertezza di misura" *("Guide to the expression of uncertainty in measurement")*, by calculating for each frequency the number of effective degrees of freedom "ν_{eff}" and expanded uncertainty "U" of the sound absorption coefficient "α_S", using a coverage factor "k" representing a confidence level of 95 %.

Uncertainty of measurement of the weighted sound absorption coefficient "$U(\alpha_w)$" is calculated with a coverage factor k = 2 representing a confidence level of 95 %.

Classification has been determined on the basis of value "α_w", obtained by rounding off the measurement, in line with clause 2.6 ILAC-G8:03/2009 "Guidelines on the reporting of compliance with specification", having met the requirements specified in the test standard regarding measurements, equipment and rounding off.

Environmental conditions during test

	Test without sample	Test with sample
Atmospheric pressure	101800 Pa	101800 Pa
Ambient temperature "t"	28,5 °C	28,9 °C
Relative humidity	50,4 %	36,7 %

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Test results

Sample mounting method	A
Volume of reverberation room "V"	218,8 m^3
Area covered by the test sample "S"	11,99 m^2
Speed of sound "c_1" at temperature "t_1"	348,1 m/s
Speed of sound "c_2" at temperature "t_2"	348,3 m/s

Frequency [Hz]	**T_1** [s]	**T_2** [s]	**$4 \cdot V \cdot (m_2 - m_1)$** [$m^2$]	**A** [m^2]	**α_S**	**v_{eff}**	**k**	**U**
100	5,88	5,28	0,0	0,7	**0,06**	19	2,00	0,03
125	5,69	5,40	0,0	0,3	**0,03**	20	2,00	0,03
160	6,60	5,04	0,0	1,6	**0,13**	16	2,00	0,03
200	7,58	5,39	0,0	1,9	**0,16**	13	2,00	0,03
250	8,24	5,15	0,1	2,4	**0,20**	23	2,00	0,02
315	7,52	3,99	0,1	4,0	**0,33**	14	2,00	0,02
400	7,30	3,04	0,0	6,7	**0,56**	13	2,00	0,03
500	6,66	2,29	0,0	10,0	**0,83**	21	2,00	0,03
630	5,34	1,83	0,0	12,5	**1,04**	16	2,00	0,04
800	4,96	1,77	-0,1	12,7	**1,06**	14	2,00	0,04
1000	4,76	1,80	-0,1	12,1	**1,01**	18	2,00	0,02
1250	4,33	1,73	-0,1	12,2	**1,02**	12	2,00	0,08
1600	3,88	1,66	-0,1	12,1	**1,01**	14	2,00	0,04
2000	3,66	1,66	0,0	11,4	**0,95**	19	2,00	0,02
2500	3,45	1,62	0,2	11,2	**0,93**	16	2,00	0,02
3150	3,10	1,48	0,5	11,8	**0,98**	15	2,00	0,03
4000	2,84	1,47	0,9	10,5	**0,88**	15	2,00	0,03
5000	2,45	1,36	1,6	9,8	**0,82**	15	2,00	0,03

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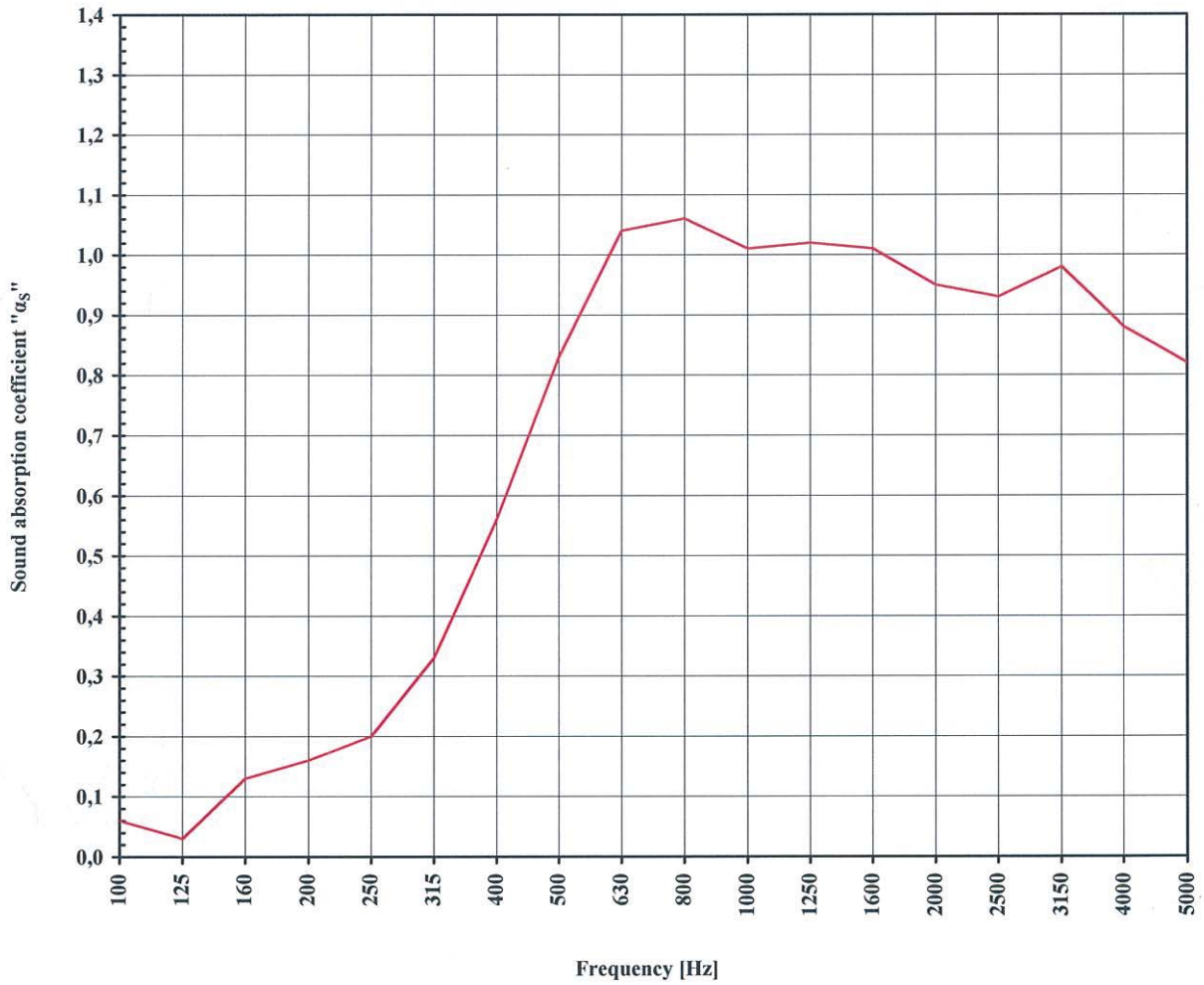
ONE-THIRD OCTAVE* SOUND ABSORPTION COEFFICIENT CURVE "α_S"



(*) Evaluation based on laboratory measurement results obtained by an engineering method.

Test Technician
(Geom. Omar Nanni)

Head of Acoustics and Vibrations Laboratory
(Dott. Ing. Roberto Baruffa)

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ANNEX "A"
TO TEST REPORT No. 297996

Place and date of issue: Bellaria-Igea Marina - Italy, 19/09/2012

Customer: SEALED AIR S.r.l. - Via Trento, 7 - 20017 PASSIRANA DI RHO (MI) - Italy

Purpose: calculation of the weighted sound absorption coefficient "α_w" in accordance with standard UNI EN ISO 11654:1998 dated 31/10/1998 "Acustica - Assorbitori acustici per l'edilizia - Valutazione dell'assorbimento acustico" *("Acoustics - Sound absorbers for use in buildings - Rating of sound absorption")*

Frequency [Hz]	**α in $\frac{1}{3}$ octaves**	**α_p* in octave bands (approximate value at 0,05 with maximum value of 1,00)**	**Reference curve**
100	0,06		
125	0,03	**0,05**	//
160	0,13		
200	0,16		
250	0,20	**0,25**	**0,35**
315	0,33		
400	0,56		
500	0,83	**0,80**	**0,55**
630	1,04		
800	1,06		
1000	1,01	**1,00**	**0,55**
1250	1,02		
1600	1,01		
2000	0,95	**0,95**	**0,55**
2500	0,93		
3150	0,98		
4000	0,88	**0,90**	**0,45**
5000	0,82		

(*) $\alpha_{pi} = \frac{\alpha_{i1+}\alpha_{i2+}\alpha_{i3}}{3}$

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Comp. AV Revis.	This annex consists of 2 sheets.	Sheet 1 of 2

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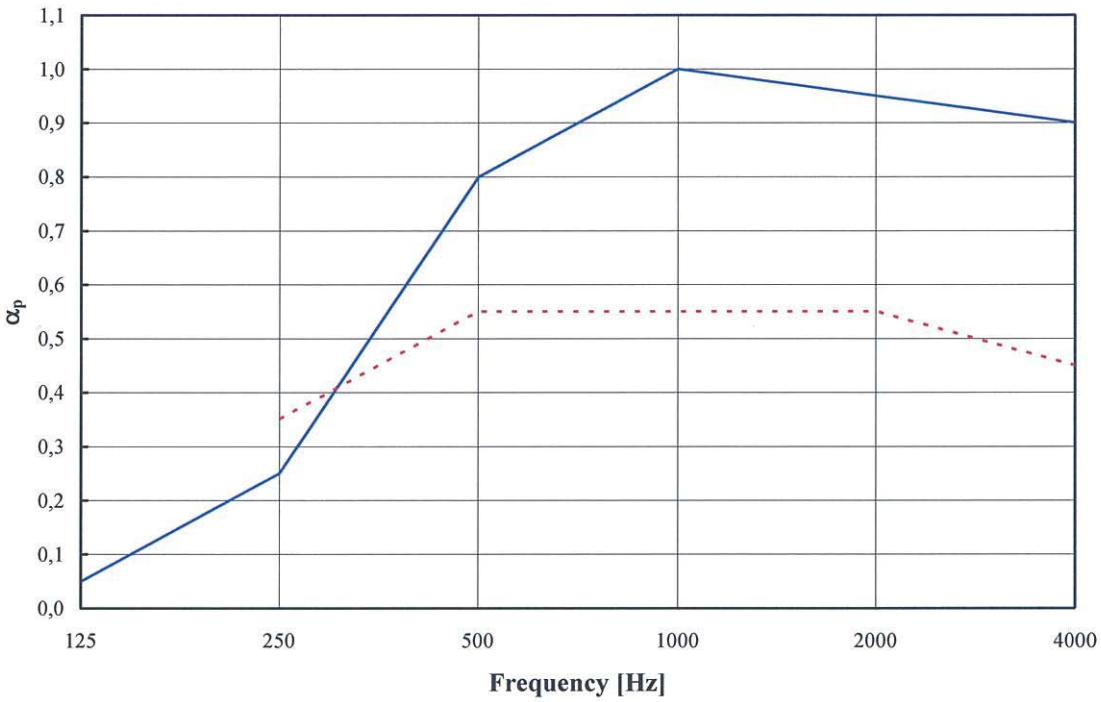

Weighted sound absorption coefficient "α_w" Value of the reference curve at 500 Hz	**0,55**
Uncertainty of measurement "U(α_w)"	0,02
Shape indicator* Frequency range in which the "α_p" curve exceeds the shifted reference curve by 0,25 or more	**M - H**
Sound absorption class**	**D**

(*) **L** = Low;
M = Medium;
H = High.

(**) **A**: α_w = 0,90, 0,95 or 1,00;
B: α_w = 0,80 or 0,85;
C: α_w = 0,60, 0,65, 0,70 or 0,75;
D: α_w = 0,30, 0,35, 0,40, 0,45, 0,50 or 0,55;
E: α_w = 0,15, 0,20 or 0,25;
Not Classified: α_w = 0,00, 0,05 or 0,10.

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