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For the attention of Mr Pedro URIZ

Villeurbanne, 02/09/2005

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Signature :

Test Report N° 2514088-temporary
Version : 00

TEST OF GLASSWHOOL DUCT ACCORDING TO EN 13403

EQUIPMENT ID : P5858 – P6058
MANUFACTURER : URSA IBERICA AISLANTES SA
REFERENCE DOCUMENT(S) : EN 13403

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00	02/09/2005	First distributed	

Each new version cancels and replaces the previous one.

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1. INTRODUCTION

The objective of the tests was to characterise two kinds of glasswool ducts according to EN 13403 July 2003 "Ventilation for buildings – Non-metallic ducts – Ductwork made from insulation ductboards". Tests were :

- Erosion and Emission of particles (§7.2 of EN 13403)
- Resistance against pressure (§7.3 of EN 13403)
- Air leakage factor and airtightness class (§4.3 of EN 13403, referred to §5.2 of prEN 1507)
- Weighted acoustical absorption (§4.7.7 of EN 13403, referred to ISO 354 and ISO 11654)

Two samples were tested :

- P5858 (inside of the ducts, glasswool is covered with airtightness aluminium) ;
- P6058 (inside of the ducts, glasswool is covered with microperforated aluminium).

Summary of the results is in part 2.

Detailed results of erosion and emission of particles tests are in appendix 2.
Detailed results of resistance against pressure tests are in appendix 3.
Detailed results of air leakage factor and airtightness class tests are in appendix 4.
Detailed results of weighted acoustical absorption tests are in appendix 5.

2. SUMMARY OF THE RESULTS

EROSION AND EMISSION OF PARTICLES TEST Air velocity = 18,6 m/s			
	Requirements	P5858	P6058
Particles > 0,5 µm	< 60 µg/m^3	0,015	0,011
Particles > 5,0 µm	< 4,0 µg/m^3	0,007	0,006

The material from the inside surface of the ductwork does not break away, flake off and does not show evidence of delamination or erosion.

RESISTANCE AGAINST PRESSURE TEST Pressure = 2000 Pa	
P5858	P6058
The clamps did not move during the test. At one place, adhesive tape begins to peel off. There is no evidence of damage, which would cause the sample to become unusable.	

AIRTIGHTNESS TEST				
	Pressure	P5858	Pressure	P6058
Leakage factor (l/s/m^2)	-748 Pa	0,25	-746 Pa	0,38
Airtightness class		**B**		**B**
Leakage factor (l/s/m^2)	1008 Pa	0,33	991 Pa	0,61
Airtightness class		**B**		**B**

WEIGHTED ACOUSTICAL ABSORPTION TEST		
	P5858	P6058
αw	0,45	0,50M

APPENDIX 1 - REFERENCES

EN 13403-2003 : Ventilation for buildings – Non-metallic ducts – Ductwork made from insulation ductboards

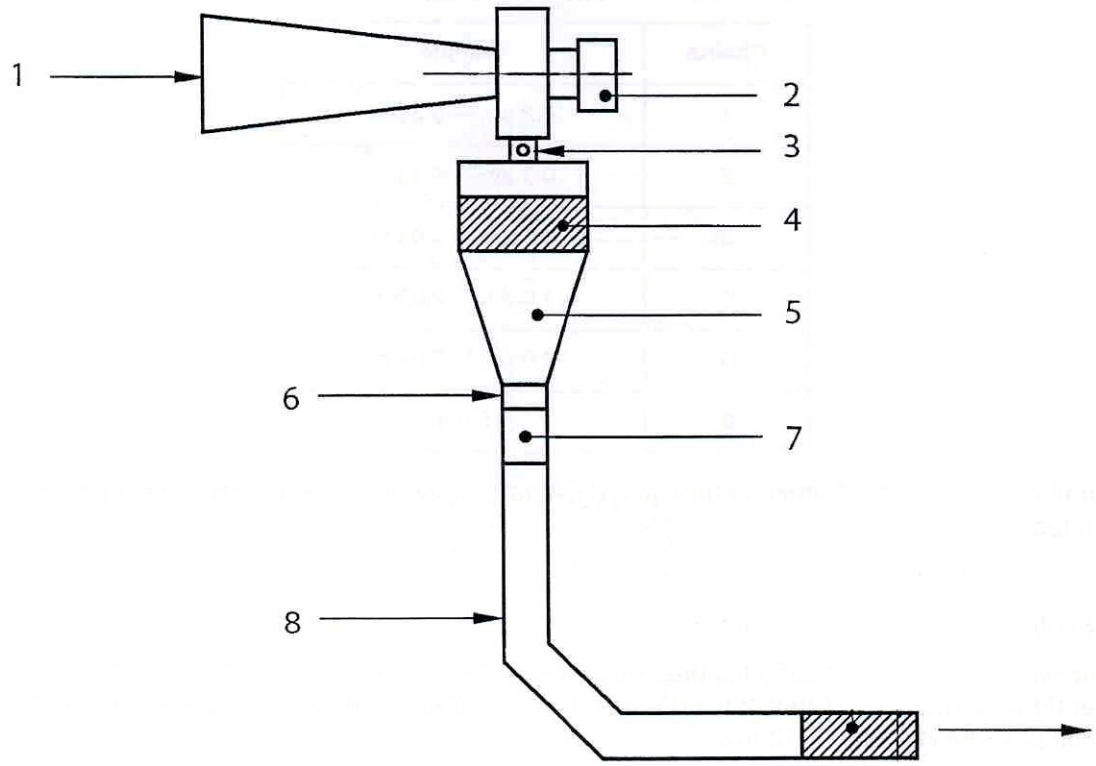
ISO 11654-2002 : Acoustics – Rating of sound absorption – Materials and systems

ISO 354:2003 : Acoustics – Measurement of sound absorption in a reverberation room

PrEN 12237 : Ventilation for buildings – Ductwork – Strength and leakage of circular sheet metal ducts

APPENDIX 2 - EROSION AND EMISSION OF PARTICLES

The samples are arranged in an L-shaped assembly. The entire assembly has similar cross-section (300 mm * 300 mm).



1 : Sucking box
2 : Sucking fan
3 : Control valve
4 : Absolute filters
5 : Blowing plenum
7 : Connexion duct
8 : Duct to be tested

Figure 1 : Construction for particle emission

Tests consisted in :

- Purge during 1 h, air velocity = 12 m/s,
- Stop during 15 min,
- Erosion test during 5 h, air velocity = 18,6 m/s.

The particle accounting is made with an optical laser counter with different channels given in Table 1. The counting is not done during the purge.

Channel	Range
1	0,2 – 0,3 µm
2	0,3 – 0,5 µm
3	0,5 – 0,7 µm
4	0,7 – 1,0 µm
5	1,0 – 2,0 µm
6	2,0 – 3,0 µm
7	3,0 – 5,0 µm
8	> 5 µm

Table 1 : Laser counter range

The extracted flow rate is of 28,3 l/min.

The average particle concentration is calculated from the extracted air volume and the measurement of the particle's mass using the following formula :

$$C = \frac{M}{Q_v t}$$

Where :

C is the particle concentration in µg/m^3,

M is the particles' mass in µg,

Q_v is the extraction flow rate in m^3/s.

The mass of particles is determined from the number of counted particles and the relative density of the glass (2500 kg/m^3).

Figure 2 : View of the test facility before the installation of the tested ducts

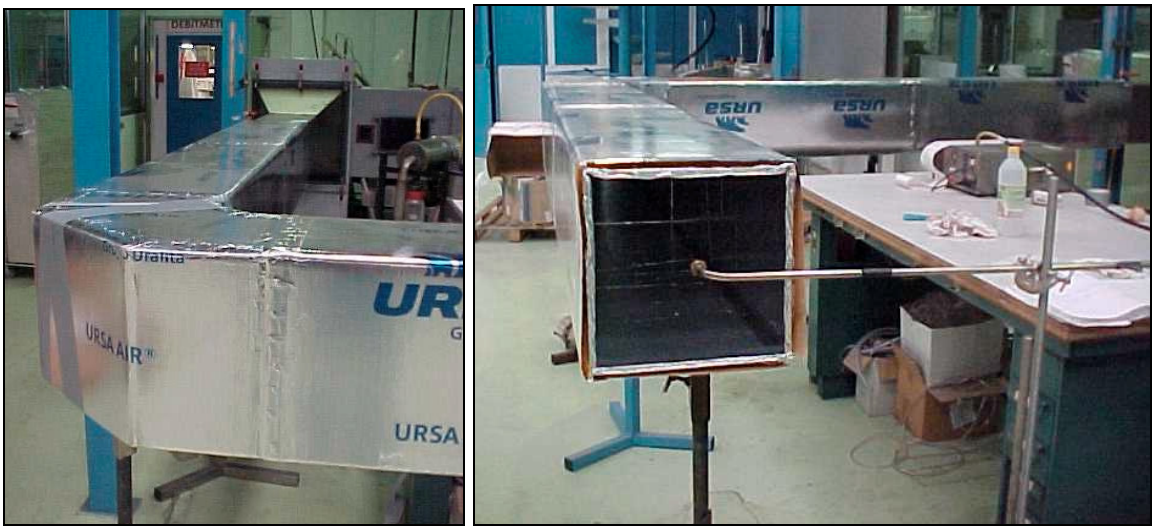


Figure 3 : Views of the installation with the tested ducts

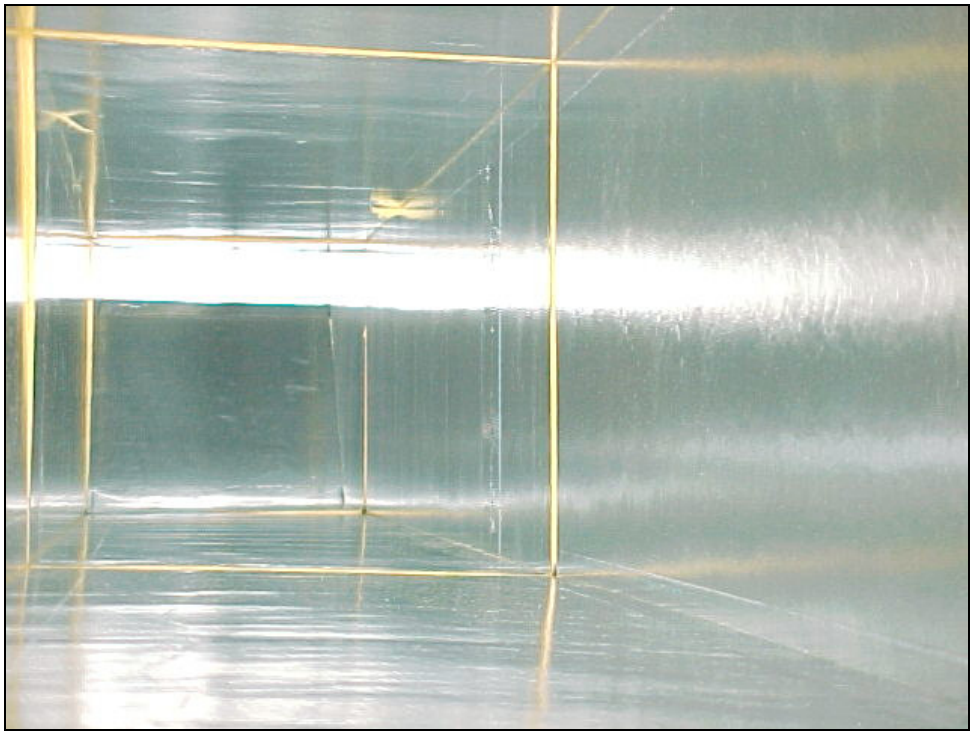


Figure 4 : View of the inside of the P5858 sample

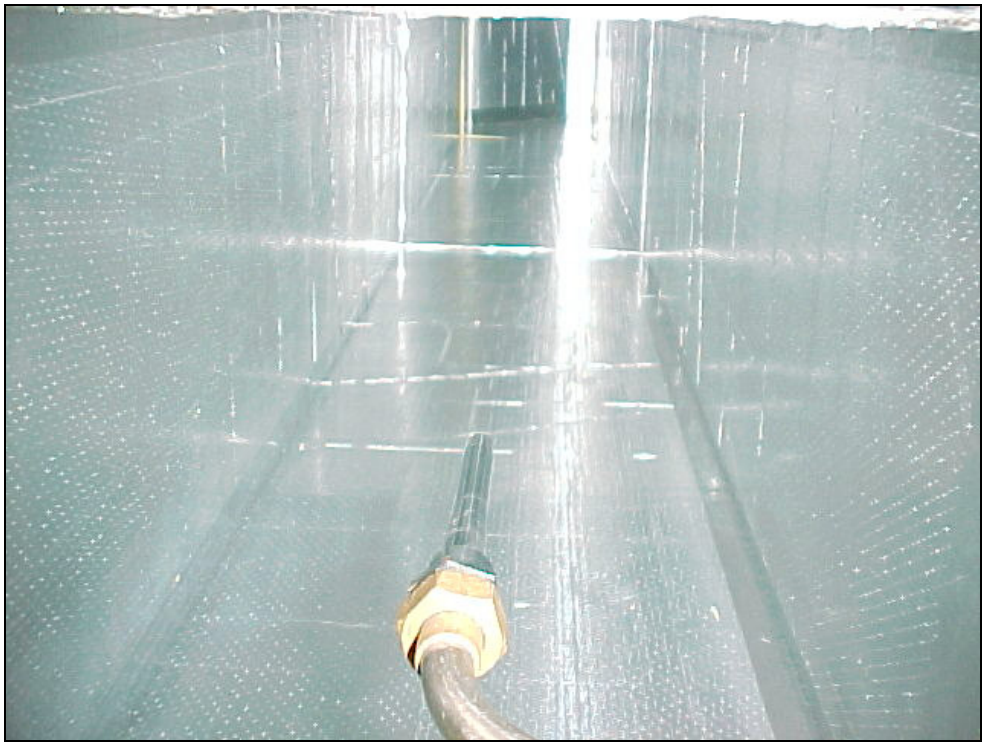


Figure 5 : View of the inside of the P6058 sample

It can be seen in Figure 4 and Figure 5 that connections seem less tight for the P5858 sample than for the P6058 sample.

Detailed results

Duration of extraction for the optical laser counter : 315 minutes

Extracted flow rate for the optical laser counter : 28,3 l/min = 0,0283 m^3/min

Extracted flow : 315 × 0,0283 = 8,91 m^3

Volume of a particle (diameter d) = $\frac{4}{3}\times\pi\times\left(\frac{d}{2}\right)^3$

P5858 sample

Air velocity in the duct : 18,6 m/s

Air temperature : 21.8°C < T < 25.8°C

Range of particles diameter (µm)	Nb of counted particles	Nb of particles/m^3	Particles mass in µg/m^3
0,2 - 0,3	37344	4189.1	8.57E-05
0,3 - 0,5	26614	2985.5	2.50E-04
0,5 - 0,7	4165	467.2	1.32E-04
0,7 - 1,0	1504	168.7	1.36E-04
1,0 - 2,0	1285	144.1	6.37E-04
2,0 - 3,0	557	62.5	1.28E-03
3,0 - 5,0	331	37.1	3.11E-03
> 5,0	326	36.6	5.98E-03

Table 2 : Detailed results of the erosion test – P5858 sample

	Requirements	Test results
Particles > 0,5 µm	< 60 µg/m^3	0,015
Particles > 5,0 µm	< 4,0 µg/m^3	0,007

Table 3 : Comparison with the requirements – P5858

The material from the inside surface of the ductwork does not break away, flake off and does not show evidence of delamination or erosion.

The requirements concerning the maximum particle concentration are fulfilled for the P5858 sample.

P6058 sample

Air velocity in the duct : 18,6 m/s
Air temperature : 22.4°C < T < 24.7°C

Range of particles diameter (µm)	Nb of counted particles	Nb of particles/m^3	Particles mass in µg/m^3
0,2 - 0,3	58367	6547.4	1.34E-04
0,3 - 0,5	35953	4033.1	3.38E-04
0,5 - 0,7	3902	437.7	1.24E-04
0,7 - 1,0	1424	159.7	1.28E-04
1,0 - 2,0	1832	205.5	9.08E-04
2,0 - 3,0	884	99.2	2.03E-03
3,0 - 5,0	519	58.2	4.88E-03
> 5,0	396	44.4	7.27E-03

Table 4 : Detailed results of the erosion test – P6058 sample

	Requirements	Test results – P6058
Particles > 0,5 µm	< 60 µg/m^3	0,011
Particles > 5,0 µm	< 4,0 µg/m^3	0,006

Table 5 : Comparison with the requirements – P6058

The material from the inside surface of the ductwork does not break away, flake off and does not show evidence of delamination or erosion.

The requirements concerning the maximum particle concentration are fulfilled for the P6058 sample.

APPENDIX 3 - RESISTANCE AGAINST PRESSURE TEST

The pressure test determines the fitness for purpose of the ductboard assembly. A test sample is prepared like it can be seen in Figure 6.

Two typical rectangular section ducts were constructed by the URSA IBERICA AISLANTES SA company and assembled with a peripheral joint. The used internal section is 300 mm * 300 mm. The connections along the ducts have been made airtight with additional adhesive tape by CETIAT, to keep only the median peripheral joint.

A pressure tap is sealed on the test sample and connected to a manometer. The manometer is checked for zero reading at the beginning and end of each test.

An air supply tape is sealed on the test sample to supply specified air pressure.

Figure 6 shows a sample in test.

Figure 6 : View of the test facility

The manufacturer's rated pressure is 800 Pa.

This pressure is gradually reached in a time between 45 and 60 s, and is maintained during 1 min. It is then increased to 2000 Pa (2,5 times 800 Pa), and maintained during 1 h.

Detailed results

As it can be seen on Figure 7, clamps of the peripheral joint did not move during the pressure test, for both samples.

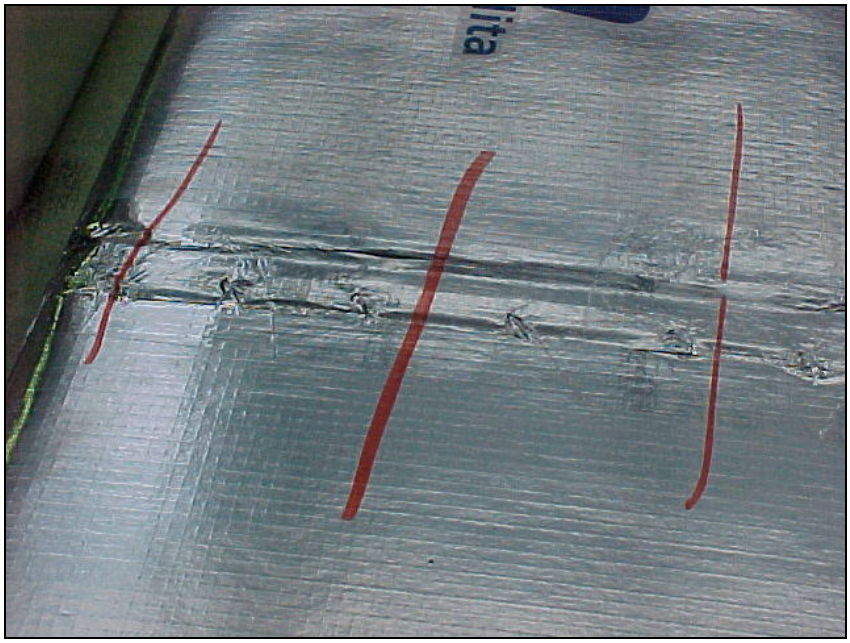


Figure 7 : View of the peripheral joint after the test (P5858 sample)

For each sample, it can only be noted that adhesive tape began to peel off at one place (Figure 8 and Figure 9)

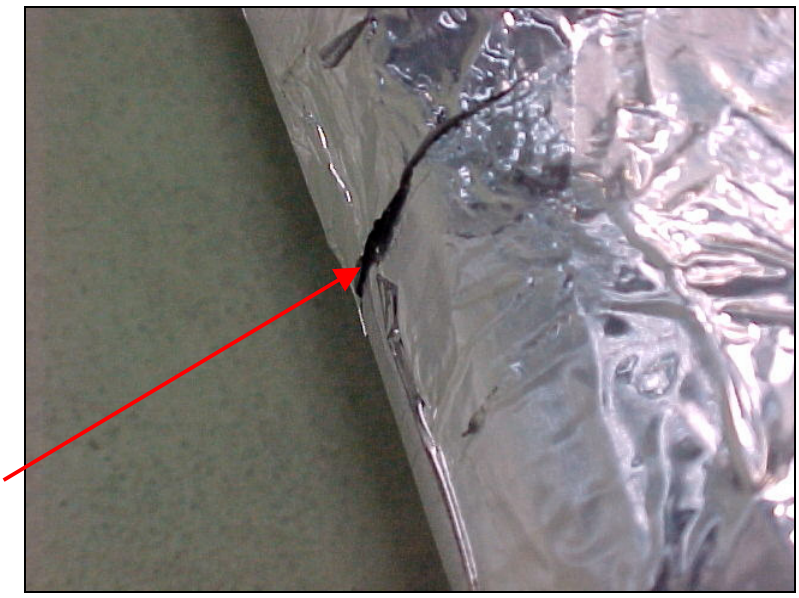


Figure 8 : Adhesive tape begins to peel off – P5858 sample

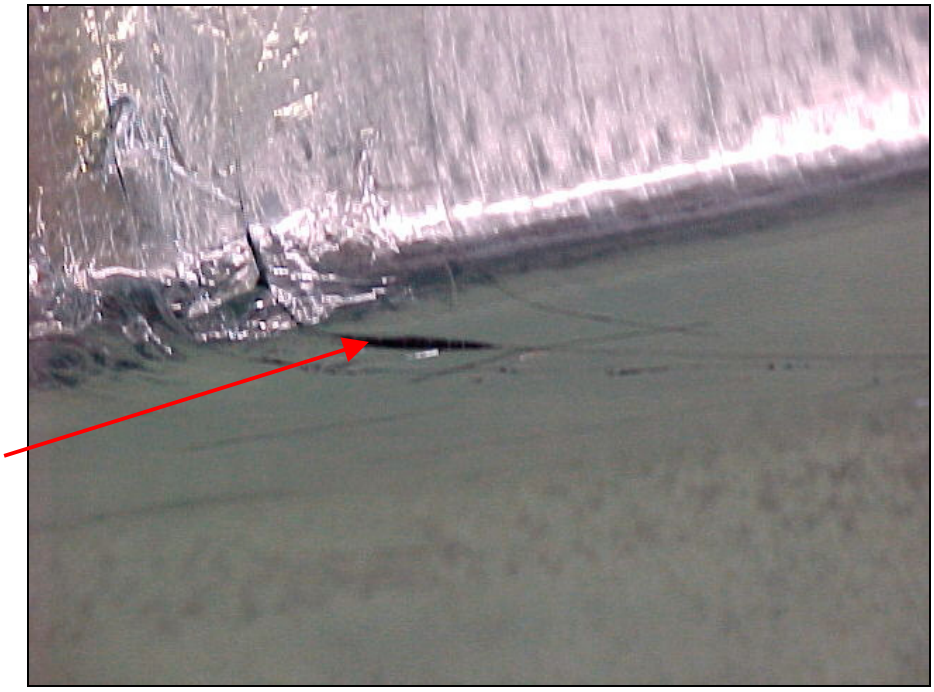


Figure 9 : Adhesive tape begins to peel off – P6058 sample

APPENDIX 4 - ARTIGHTNESS TEST

Tests are made following prEN1507 standard.

The test samples built by URSA IBERICA AISLANTES consist of 7 modules of 1,2 m of length and section of 300 mm × 300 mm.
For each sample :
Ductwork surface area (A) = 7 × 1,2 × 4 × 0,3 = 10,1 m²
Total joint length (L) = 6× 4 × 0,3 + 7 × 1,2 = 15,6 m

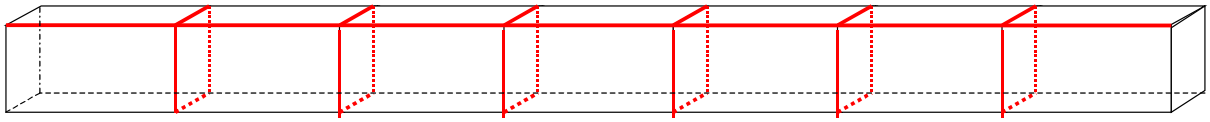


Figure 10 : Diagram of the samples

CETIAT closed the ends of each sample with metal sheets.

Table 6 shows the airtightness classification defined in the prEN 1507 draft standard.

Air tightness class	Air leakage limit	Static gauge pressure limits (Pa)	
	$l.s^{-1}.m^{-2}$	Negative	Positive
A	$0,027.p_{test}^{0,65}$	-200	1000
B	$0,009.p_{test}^{0,65}$	-500	1000
C	$0,003.p_{test}^{0,65}$	-750	1000
D*	$0,001.p_{test}^{0,65}$	-750	1000

Table 6 : Definition of the airtightness classes – prEN1507

The limit for the positive pressure test is defined by the manufacturer, following the design operating pressure of the ducts.
The limit for the negative pressure test depends of the class to be aimed. Tests are then made until –750 Pa.

Detailed results – P5858 sample

Atmospheric pressure : 99300 Pa
Air temperature : 21°C
Wet bulb temperature : 15°C

Negative pressure

Measured air leakage	Air density	Air leakage at 20°C and 101325 Pa	Air leakage at 20°C and 101325 Pa	Pressure
m^3/h	kg/m3	m^3/h	l/s	Pa
4.7	1.17	4.6	1.3	-193
6.2	1.16	6.0	1.7	-312
7.0	1.16	6.8	1.9	-399
7.7	1.16	7.5	2.1	-493
8.5	1.16	8.2	2.3	-598
9.5	**1.16**	**9.1**	**2.5**	**-748**
10.3	1.16	10.0	2.8	-897

Positive pressure

Measured air leakage	Air density	Air leakage at 20°C and 101325 Pa	Air leakage at 20°C and 101325 Pa	Pressure
m^3/h	kg/m3	m^3/h	l/s	Pa
4.6	1.17	4.5	1.3	197
7.1	1.17	7.0	1.9	401
9.1	1.18	8.9	2.5	592
10.8	1.18	10.6	2.9	791
12.3	1.18	**12.1**	**3.4**	**1008**
13.4	1.18	13.2	3.7	1200

	Air leakage rate (l/s/m²)	Air leakage limit class B (l/s/m²)	Air leakage limit class C (l/s/m²)	Class
-493 Pa	0,21	0,51	0,17	B
-748 Pa	0,25	0,66	0,22	B
1008 Pa	0,33	0,81	0,27	B

Detailed results – P5858 sample

Atmospheric pressure : 99100 Pa
Air temperature : 23°C
Wet bulb temperature : 13,5°C

Negative pressure

Measured air leakage	Air density	Air leakage at 20°C and 101325 Pa	Air leakage at 20°C and 101325 Pa	Pressure
m^3/h	kg/m3	m^3/h	l/s	Pa
7.1	1.16	6.9	1.9	-204
8.9	1.16	8.5	2.4	-298
10.4	1.15	10.0	2.8	-396
11.8	1.15	11.3	3.1	-497
12.9	1.15	12.4	3.4	-597
14.4	1.15	13.8	3.8	-746

Positive pressure

Measured air leakage	Air density	Air leakage at 20°C and 101325 Pa	Air leakage at 20°C and 101325 Pa	Pressure
m^3/h	kg/m3	m^3/h	l/s	Pa
7.1	1.16	6.9	1.9	197
11.6	1.16	11.2	3.1	394
15.8	1.17	15.4	4.3	599
19.0	1.17	18.5	5.1	790
22.5	1.17	21.9	6.1	992
25.5	1.17	24.9	6.9	1175

	Air leakage rate ($m^3/s/m^2$)	Air leakage limit class B ($m^3/s/m^2$)	Air leakage limit class C ($m^3/s/m^2$)	Class
-497 Pa	0,31	0,51	0,17	B
-746 Pa	0,38	0,66	0,22	B
992 Pa	0,61	0,80	0,27	B

Both samples are in the class B. There is less air leakage for the P6058 sample than for the P5858 sample.

Air leakage comes mostly from the clamp, where the adhesive tape is worn and pierced.

For information, we added new adhesive tape on half of the clamps for the P6058 sample and the air leakage rate was divided by two : 3 m^3/h for 992 Pa.

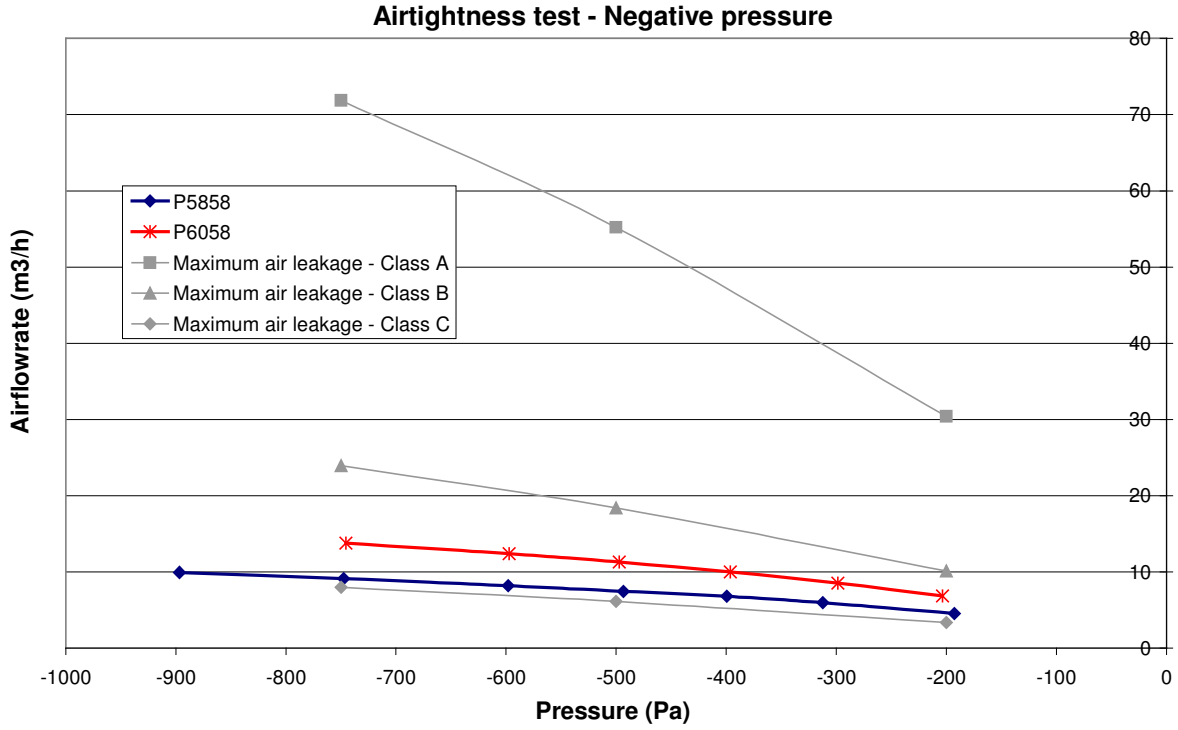


Figure 11 : Leakage flow rate according to the negative pressure – P5858 and P6058 samples

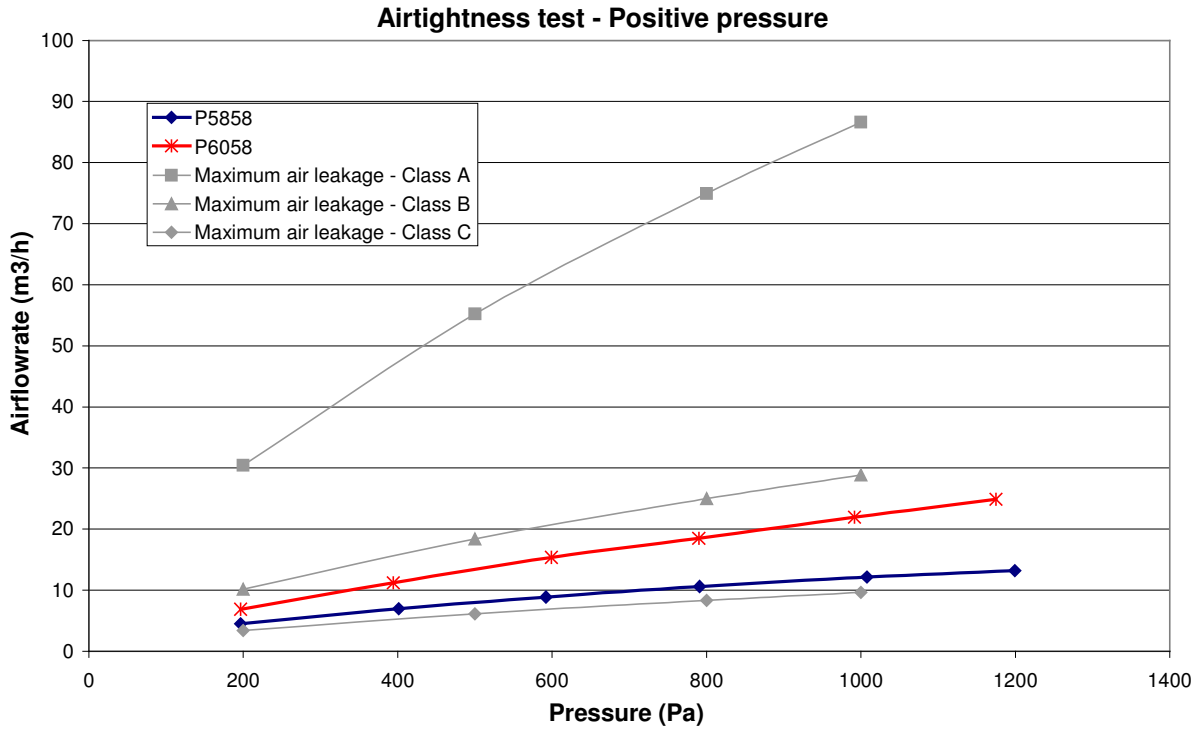


Figure 12 : Leakage flow rate according to the positive pressure – P5858 and P6058 samples

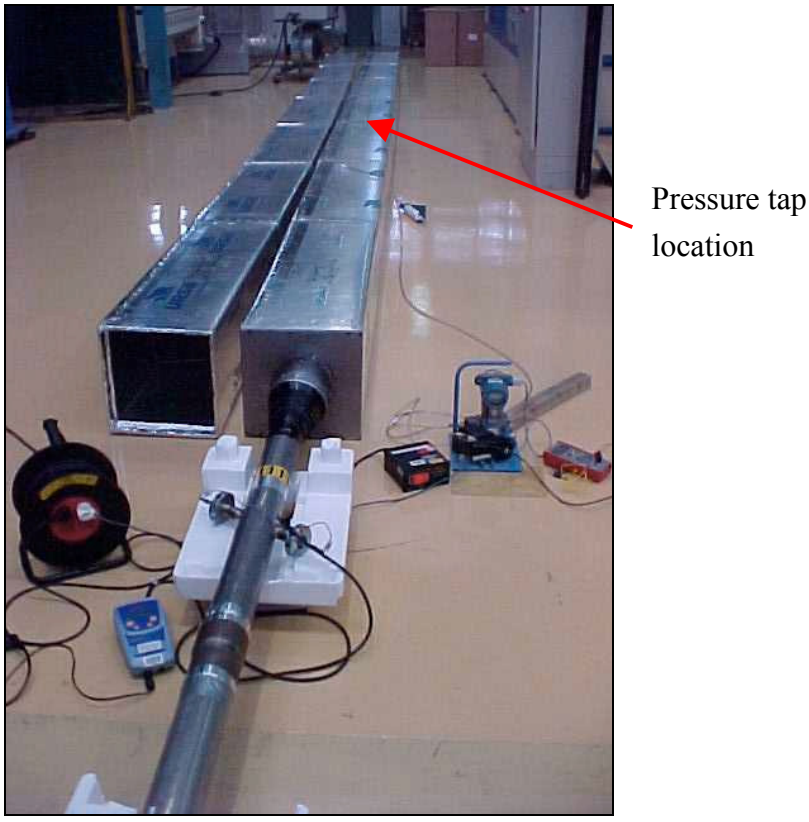


Figure 13 : View of the test facility

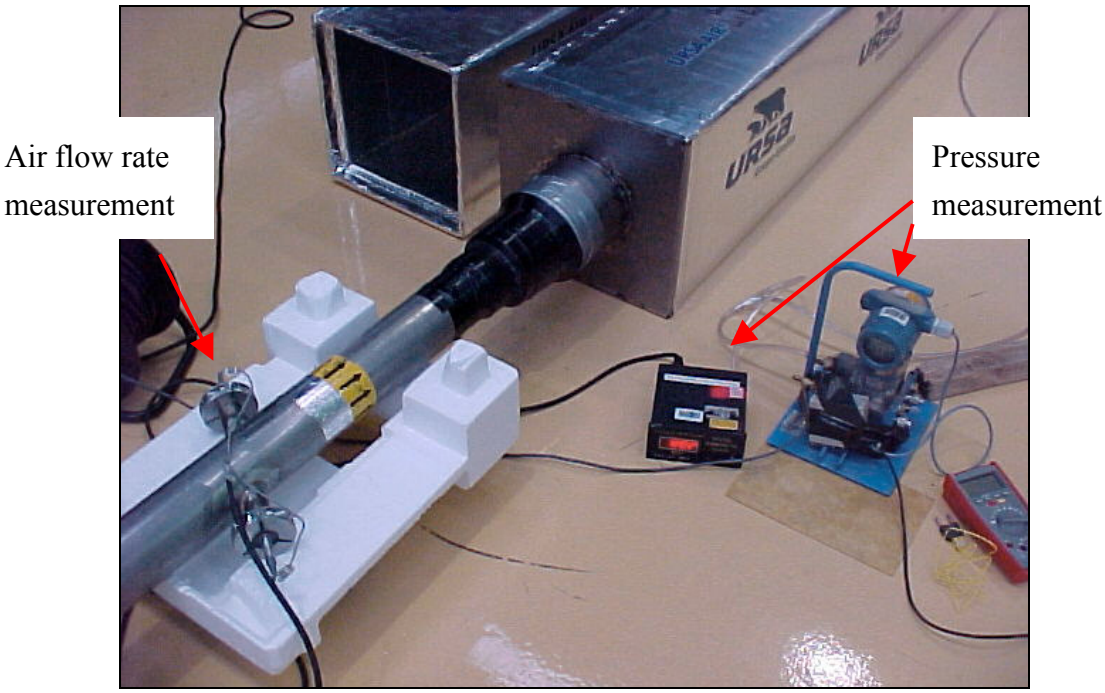


Figure 14 : View of the metrology

APPENDIX 5 - WEIGHTED ACOUSTICAL ABSORPTION TEST

The acoustical absorption characterises the properties of a material composition to convert sound energy into heat thereby reducing the amount of sound energy that can be reflected.

The acoustical absorption tests are made according to ISO 354 standard. Results are treated with the ISO 11654 standard to determine weighted acoustical absorption.
ISO 354 specifies a method of measuring the sound absorption coefficient of acoustical materials used as wall or ceiling treatments, or the equivalent sound absorption area of objects, such as furniture, persons or space absorbers, in a reverberation room.
ISO 11654 specifies a single number rating that can be used to formulate requirements and to describe acoustical properties of sound-absorption products used for routine applications in buildings.

Figure 15 : View of the testing chamber with diffusers

There are 7 diffusers in th test chamber (15 m^2).
The surface of the tested samples is 11,7 m².

Figure 16 : View of the P5858 sample in test

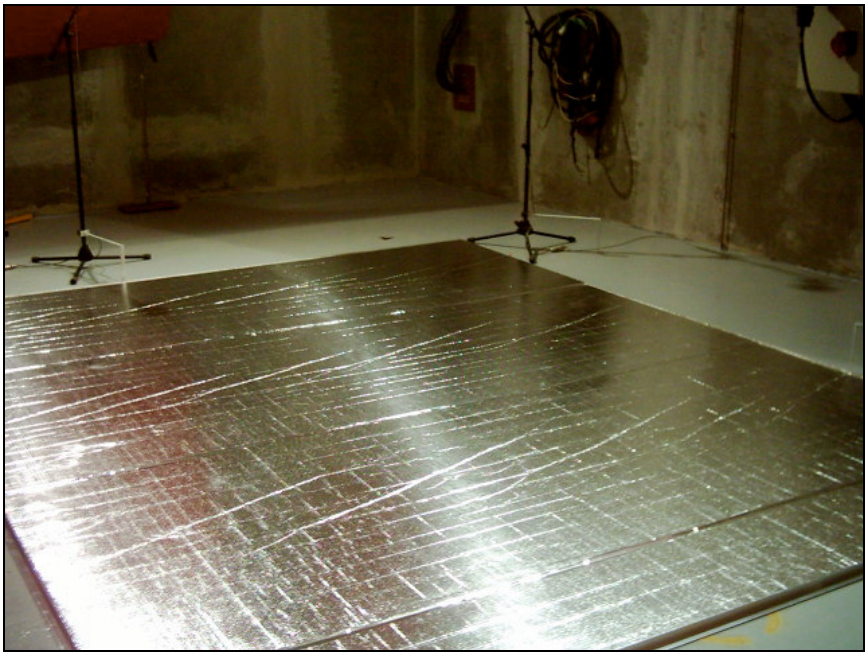


Figure 17 : View of the P6058 sample in test

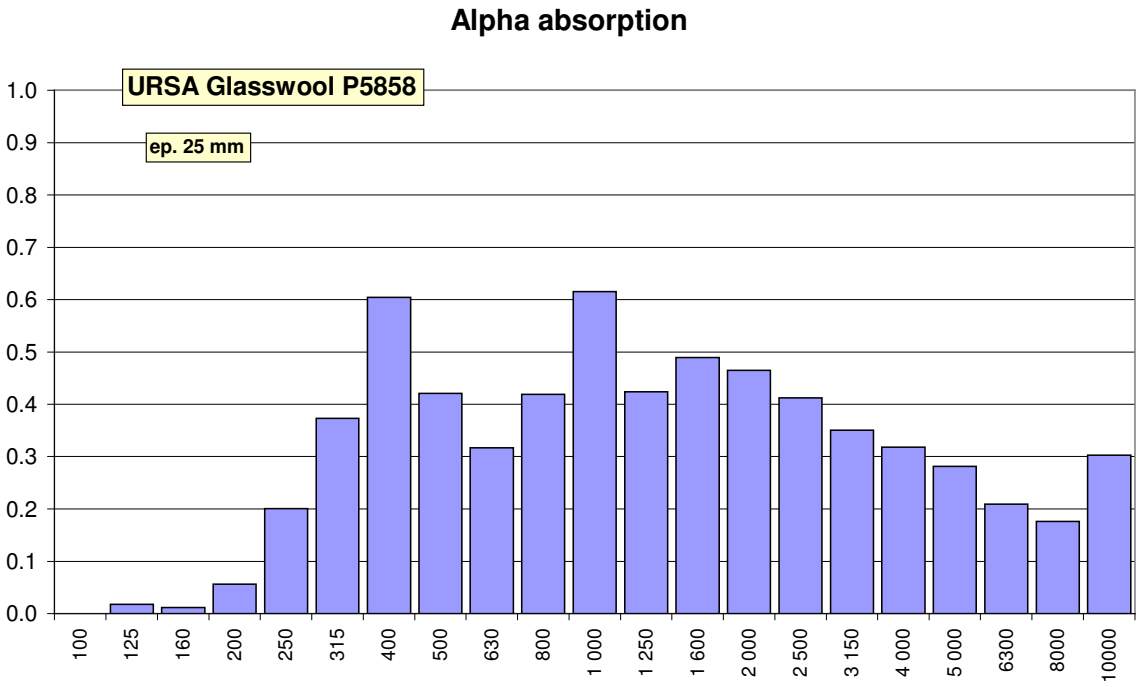


Figure 18 : Alpha absorption for P5858 sample

The weighted acoustical absorption α_p = 0,45 for the P5858 sample.

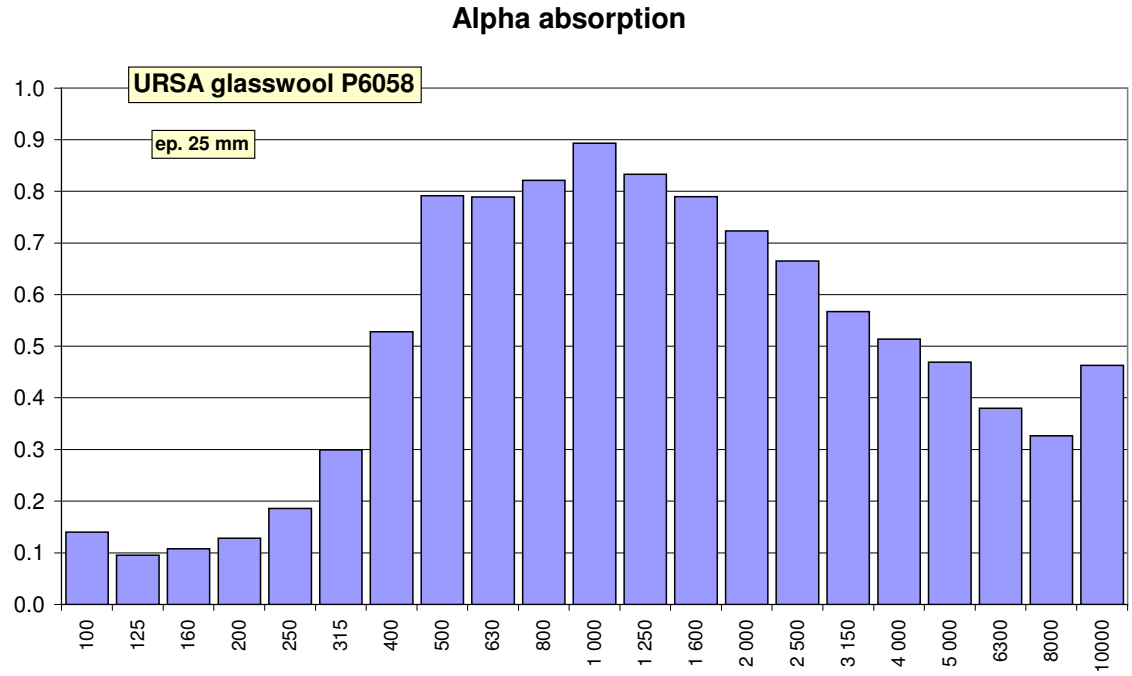


Figure 19 : Alpha absorption for P6058 sample

The weighted acoustical absorption α_p = 0,50M for the P6058 sample. The "M" letter indicates that absorption is particularly good at medium frequencies.

The calculation of α_p does not represent the good acoustical absorption of the microperforated sample. Figure 19 shows that absorption for P6058 sample is really better particularly for the mean frequencies, around 1000 Hz.
The calculated α_p is not very good because of the less good performance at low frequencies.