



Universitat de Girona

Departament d'Enginyeria  
Industrial

This report is developed after carrying out the corresponding trials established in the scientific collaboration agreement of mechanic-fluid behavior of rectangular airflow ducts.

## TECHNICAL REPORT

### REQUESTER

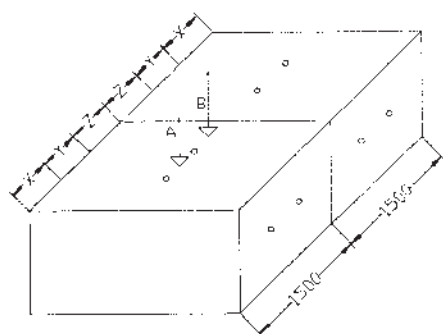
Mr. Francesc Bolló. Technical Director  
POLIURETANOS S.A.  
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### TRIAL OBJECTIVE

Determining the performance of a duct made up with a PIR-ALU panel submitted to pressure and depression. Material deformation was tried out as well as ducts rupture limits.

### SAMPLE CHARACTERISTICS

Duct PIR-ALU 45 of section 1000x600 mm<sup>2</sup> and length of 3000 mm sealed by a central joint as it is specified in the drawing (deformation areas are specified. Deformation A is centered in relation to reinforcing points, and deformation B is centered in relation to reinforcing point-joint space):



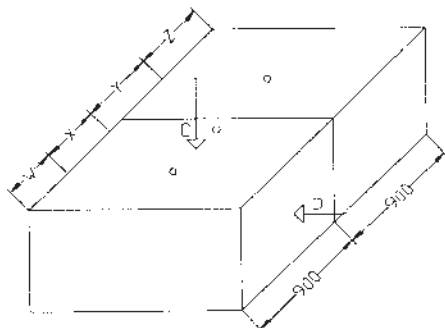
X=145 Y=527  
Z=527

Duct PIR-ALU 45 of section 800x400 mm<sup>2</sup> and length of 1800 mm sealed by a central joint as shown in the drawing below (Deformation areas are shown, deformation C in centered in relation to reinforcing points, and deformation D is centered in relation the to the front panel):



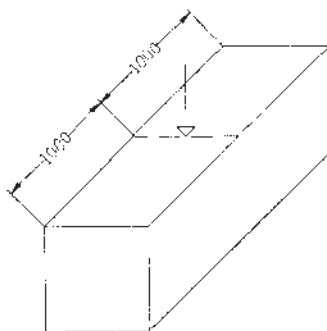
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W=365 X=445  
Y=445 Z=545

Duct PIR-ALU 35 of 400x400 mm<sup>2</sup> section and 2000 mm of length without a joint as it is specified in the drawing below (an arrow is pointing out the deformations area that is centered in relation to the front panel):



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## TRAIL METHOD

A deformation trial is carried out in two ducts sealed off by positive pressure and under depression according to the Norma project "Ductwork standard. Ductwork made of insulation ductboards" CEN/TC156/WG 3N207 section 6.3 (*see annex*).

## RESULTS

### \*Deformation trial under pressure and depression

-Duct PIR-ALU 45 of a 1000 x 600 section:

The trial was carried out in a way that pressure was gradually increased with a high pressure fan controlled by a frequency shifter. Deformations are measured by a hundredth of a millimeter precision comparison device.

Measurements were taken on specific points in the above drawing, and the results obtained are shown in the table below:

Duct PIR-ALU 45 : Section 1000 x 600 mm<sup>2</sup>



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Length: 1500 mm			
Pressure (Pa)	Measured reading		Calculated reading
	Deformation A (mm)	Deformation B (mm)	(*)Foreseen Deformation (mm)
150	0.48	0.65	0.81
250	0.78	1.05	1.35
350	1.11	1.62	1.89
460	1.50	2.35	2.49
570	1.78	2.95	3.08

(\*) The foreseen deformation (y) has been calculated in relation to the reinforcing points distance (L), trial pressure (P), and the product of Young module by the inertia moment, by using the following formula:

$$y = \frac{5}{0.384} \frac{PL^4}{EI}$$

Using relative depressions :

The same trial is done but in this case negative relative pressures were used and the following data is obtained:

Duct PIR-ALU 45 : Section 1000 x 600 mm <sup>2</sup>		
Length : 1500 mm		
Depression (Pa)	Measured deformation A (mm)	(*)Calculated deformation A (mm)
60	0.30	0.32
200	0.80	1.08
460	1.83	2.49
620	2.50	3.35
810	3.30	4.38
980	4.40	5.30
1210	5	6.54

-Duct PIR-ALU 45 of a 800 x 400 section:

The test is carried out on a duct PIR-ALU 45 of a 800 x 400 mm<sup>2</sup> section and 900 mm of length. During the test, pressure was gradually increased with a high pressure fan controlled by a frequency shifter. Deformations are measured by a hundredth of a millimeter precision comparison device

Measurements were taken at specific points in the above drawing, and the results obtained are shown in the table below:



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Duct PIR-ALU 45: Section 800 x 400 mm <sup>2</sup>			
Length : 900 mm			
Pressure (Pa)	Measured reading		Calculated reading
	Deformation C (mm)	Deformation D (mm)	(*)Foreseen Deformation (mm)
180	0.21	0.20	0.39
300	0.33	0.30	0.65
410	0.47	0.30	0.88
550	0.65	0.42	1.18
740	0.87	0.58	1.59
920	1.08	0.75	1.98
1130	1.30	0.92	2.43
1340	1.55	-	2.89
1500	1.83	-	3.23
2160	2.7	-	4.65

In this trials it is appreciated that the measured deformation has always been less than the calculated deformation. According to the results, this validates the calculation system used for the reinforcing point table for this type of ducts:

PIR-ALU 45 (EI= 230000 Nmm <sup>2</sup> and Maximum row 0.5 %)					
Inner Dimension	Pressure (Pa)				
	200	400	600	800	1000
100	0	0	0	0	0
200	0	0	0	0	0
300	0	0	0	0	0
400	0	0	0	0	0
500	0	0	0	1	1
600	0	0	1	1	1
700	0	1	1	1	1
800	1	1	1	1	1
900	1	1	1	1	2
1000	1	1	1	2	2
1200	1	1	2	2	2
1400	1	2	2	2	3
1600	2	2	3	3	3
Distance between reinforcing points	761	604	527	479	445

In all measure trials it was proven that deformation is elastic, in such a way that zero deformation is constant in the device.

## • Rupture trial

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-Duct PIR-ALU 35 of a 400x400 section:

At the beginning, data collected from deformation trials on duct PIR-ALU 35 of 800 x 400 mm was showing that a 2200 Pa pressure was reached without breaking the duct.

On the other hand, a new trial was carried out on a sealed off duct PIR-ALU 35 of a 400 x 400 mm section and 2000 mm of length following the corresponding guidelines. The following results were obtained:

Duct PIR-ALU 35 : Section 400 x 400 mm <sup>2</sup> .		
Length : 2000 mm.		
Depression (Pa)	Measured deformation A (mm)	(*)Calculated deformation A (mm)
100	0.07	0.21
200	0.22	0.41
300	0.33	0.62
390	0.62	0.81
490	0.9	1.01
590	1.13	1.22
690	1.3	1.43
780	1.57	1.61
880	1.85	1.82
980	2	2.03
1080	2.35	2.24
1180	2.75	2.44
1270	3	2.63
1370	3.4	2.84
1470	3.75	3.04
1570	4.05	3.25
1670	4.52	3.46
1760	5.18	3.64
1860	6.03	3.85
1960	6.6	4.06
2060	7.03	4.27
2150	7.5	4.45
2250	8.2	4.66
2350	8.8	4.87
4020	RUPTURE	RUPTURE
Approximately a 80 mm lateral joint crack		

As it is shown in the table the duct has resisted a 4020Pa pressure before braking up, given that rupture pressure is 2.5 times the working pressure for this duct of 950 Pa. Therefore, it has been observed that up to this value, the measured deformation is less than the calculated deformation.



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Also, the trial carried out on duct PIR-ALU 35 of 400 x 400 section the rupture value was reached with a pressure of 4000 Pa and keeping deformation bigger than 12 mm.

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Trial date: Girona. July 24, 1998.

Fluids Laboratory Manager

Josep R. González Castro.  
Fluid Mechanics Associated Teacher

This document has six sealed pages.

## **ANEXO**

(2 páginas)

Proyecto de Norma Europea "Ductwork standard. Ductwork made of insulation ductboards"  
CEN/TC156/WG3N207. 4ª revisión. Apartado 6.3.

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The air speed is to be measured by a pitot tube, or direct reading velometer, positioned in the center of the outlet end of the sample. Room air handled by the fan and ranging in temperature between 15 °C and 38 °C may be employed.

To regulate and control the air speed, the fan can be commanded by a variable speed motor or a damper is to be located between the fan and the inlet of the test sample.

A collecting screen consisting of a double layer of cheesecloth (5 to 6 g/m<sup>2</sup>) stretched taut on a frame sized to provide for an area not less than 5 times the inside cross sectional area of the test sample, is to be located 300 mm from the outlet end of the test sample.

Samples are not to be exposed to relative humidities greater than 70 % during the 24 hour period prior to the test.

Air is to be passed through the sample at approximately test speed with the collecting screen removed for a period of at least 1 hour but not more than 24 hours. The collection screen then is to be placed in position.

The test then is to proceed at test speed and continued for a period of 4 hours. The collecting screen is to be examined for macroscopic particles at the end of each hour during the test period by taping the screen with the adhesive side of transparent tape, or tapes, in order to remove and record any eroded particles.

The section to be used is 300 x 300 mm.

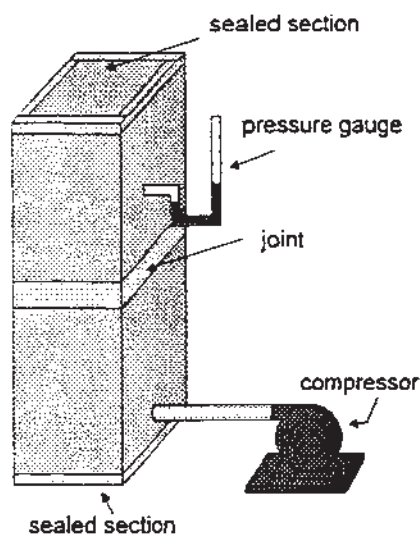
### 6.3.- Pressure test

The present test has as goal to determine the fitness for purpose of the ductboard.

An air duct and connector section is to be prepared in accordance with the following figure. Each end of the sample to be tested is to be sealed airtight by any means consistent with the use of the material under test.

*[Faint, illegible text or signature]*





Samples are going to be used to built 2 typical rectangular sections ducts with a length of the nominal ductboard width, assembled with a peripheral joint.

The joint shall be made following the manufacturer's instructions taking into consideration that any adhesives or cements are to be allowed to cure for a period of at least 24 hours. Samples are not to be exposed to relative humidity greater than 70 % during the 24 hour period prior to the test.

A pressure tap consisting of pipe or tubing is to be sealed into one end of the test sample and connected to a water manometer or manometer wich can read directly 10 Pa. The manometer is to be checked for cero reading at the beginning and at the end of each test.

An air supply tap consisting of pipe or tubing is to be sealed into the same or the other end of the sample and connected to a source of air pressure capable of maintaining the especified air pressure in the sample.

The manufacturer's rated pressure is to be gradually attained in not less than 45 seconds nor more than 60 seconds from the initial application of the test presure. This presure is to be held for 1 minute and then is to be increased to 2,5 times the manufacturer's rated pressure in not less than 45 seconds nor more than 60 seconds. The air pressure in the test sample is to be maintained at the designated value for a period of 1 hour.