ENAC ENSAYOS Nº 4/LE162

REPORT No. 13_03699-a

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PURPOSE	AIR PERMEABILITY TEST ACCORDING TO UNE-EN 1026:2000 WATERTIGHTNESS TEST ACCORDING TO UNE-EN 1027:2000 RESISTANCE TO WIND LOAD TEST ACCORDING TO UNE-EN 12211:2000
TESTED SAMPLE	DOUBLE-LEAF TILTED PVC WINDOW PROFILES “ALUPLAST” WITH “FORNAX” HARDWARE
RECEPTION DATE	07/11/2013
TEST DATE	20/11/2013
ISSUE DATE	28/11/2013

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Technical Manager

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CHARACTERISTICS OF THE SAMPLE

On 7 November 2013 FUNDACIÓN TECNALIA R&I received from the company YELKEN KALIP PEN. KAPI AKS. VE MET. SAN. TIC. A.S., a PVC window profiles **«ALUPLAST»** with "FORNAX" hardware with the following main features:

WINDOW TYPE:		Double-leaf tilted window
OUTER DIMENSIONS (mm)		1,580 x 1,230
TOTAL SURFACE (m^2)		1.9434
USABLE SURFACE (m^2)		1.5696
JOINT LENGTH (m)		6.425
MATERIAL:		PVC
ACCESSORIES:		Overlapped
SECTION:		See Annex
FRAME ASSEMBLY:		Mitre
LEAF ASSEMBLY:		Mitre
GASKETS:		Rubber gasket
ANCILLARY SEALING ELEMENTS:		2 drains to the inside of the profile 2 drains from the inside to the outside of the profile
GLAZING:	TYPE:	Double
	THICKNESS:	4/16/4
	POSITION:	Jonquil
	WATER-TIGHTNESS:	Rubber gasket

The window photograph and construction cross sections can be found in the Annex.

TEST BENCH

KS MSD DIGITAL test bench by K. SCHULTEN FENSTERTECHNIK, with pneumatic cylinders for sample fastening.

REQUESTED TESTS

The requested tests were as follows:

- **Air permeability test**, according to UNE-EN 1026:2000
- **Watertightness test**, according to UNE-EN 1027:2000
- **Resistance to wind load** according to UNE-EN 12211:2000

The sequence of tests was the following:

1. **Air permeability test**
   - **Air permeability Positive Pressure**
   - **Air permeability Negative Pressure**
   - **Mean permeability values**
2. **Watertightness test**
3. **Resistance to wind load test**
   - 3.1. **Deflection test**
   - 3.2. **Repeated pressure test**
   - 3.3. **Air permeability test**
     - **Air permeability Positive Pressure**
     - **Air permeability Negative Pressure**
     - **Mean permeability values**
   - 3.4. **Safety test**

TESTS CONDUCTED

Sample conditioning

Before the test, the sample is left for at least 4 hours at a temperature comprised between 10 ºC and 30 ºC and a moisture comprised between 25% and 75%, according to the provisions of standards UNE-EN 12211:2000, UNE-EN 1027:2000 and UNE-EN 12211:2000.

AIR PERMEABILITY TEST

Air permeability is the ability of a closed window to allow air to pass when subject to differential pressure.

This test is performed as per Standard UNE-EN 1026:2000 and the window is classified in accordance with the guidelines set out in Standard UNE-EN 12207:2000.

The parasite leaks from the equipment are checked every 6 months with a blind panel simulating the sample. As a result, leaks are 5% lower than those leading to a Class 4.

WATERTIGHTNESS TEST UNDER STATIC PRESSURE

Watertightness is defined as the ability of a closed window to resist water leakage.

This test is performed as per Standard UNE-EN 1027:2000 applying spraying method A. The window is classified in accordance with the guidelines set out in Standard UNE-EN 12208:2000.

WIND RESISTANCE TEST

This test is performed as per Standard UNE-EN 12211:2000 and the window is classified in accordance with the guidelines set out in Standard UNE-EN 12210:2000 and UNE-EN 12210/AC:2010.

Under positive and negative pressures, the test verifies that the entire window:

- has an acceptable deflection (deflection test)
- maintains its properties (repeated pressure test)
- ensures the safety of users (safety test)

RESULTS

1.- AIR PERMEABILITY TEST

Positive pressures

Environmental conditions:

Temperature: **23 ºC** Relative humidity **32%** Atmospheric pressure: **100.9 kPa**

Upon completion of the air permeability test as per UNE-EN 1026:2000, the results obtained are shown in the following table:

Pressure (Pa)	V_X (m^3/h)	V_0 (m^3/h)	V_A (m^3/hm^2)	V_L (m^3/hm)
50	2.47	2.44	1.25	0.38
100	3.78	3.73	1.92	0.58
150	4.77	4.70	2.42	0.73
200	5.78	5.70	2.93	0.89
250	7.03	6.93	3.57	1.08
300	8.29	8.17	4.21	1.27
450	14.10	13.90	7.15	2.16
600	22.71	22.39	11.52	3.48

where: V_X = Measured air leakage
V_0 = Air leakage in normal environmental conditions (T=293 K and P_0=101.3 kPa)
V_A = Air permeability in accordance with the total surface area
V_L = Air permeability in accordance with the length of the joint opening

Negative pressures

Environmental conditions:

Temperature: **23 ºC** Relative humidity **32%** Atmospheric pressure: **100.9 kPa**

Upon completion of the air permeability test as per UNE-EN 1026:2000, the results obtained are shown in the following table:

Pressure (Pa)	V_X* (m^3/h)	V_0* (m^3/h)	V_A* (m^3/hm^2)	V_L* (m^3/hm)
50	2.04	2.01	1.03	0.31
100	3.25	3.20	1.65	0.50
150	4.02	3.96	2.04	0.62
200	4.62	4.56	2.34	0.71
250	5.39	5.31	2.73	0.83
300	6.11	6.02	3.10	0.94
450	8.14	8.03	4.13	1.25
600	9.92	9.78	5.03	1.52

where: V_X* = Measured air leakage
V_0* = Air leakage in normal environmental conditions (T=293 K and P_0=101.3 kPa)
V_A* = Air permeability in accordance with the total surface area
V_L* = Air permeability in accordance with the length of the joint opening

Mean permeability values

Upon completion of the air permeability test as per UNE-EN 1026:2000, the results obtained are shown in the following table:

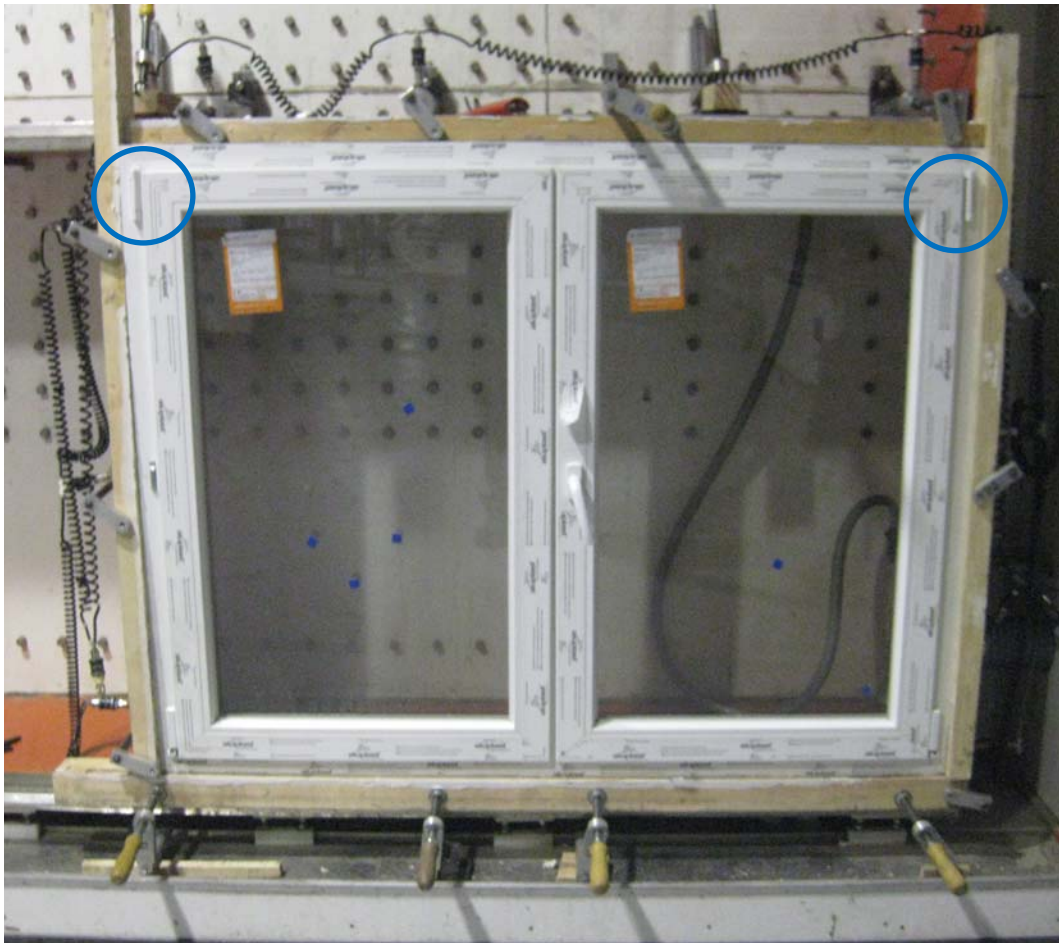
Pressure (Pa)	V_{AM} (m^3/hm^2)	V_{LM} (m^3/hm)
50	1.14	0.35
100	1.78	0.54
150	2.23	0.67
200	2.64	0.80
250	3.15	0.95
300	3.65	1.10
450	5.64	1.71
600	8.28	2.50

where:

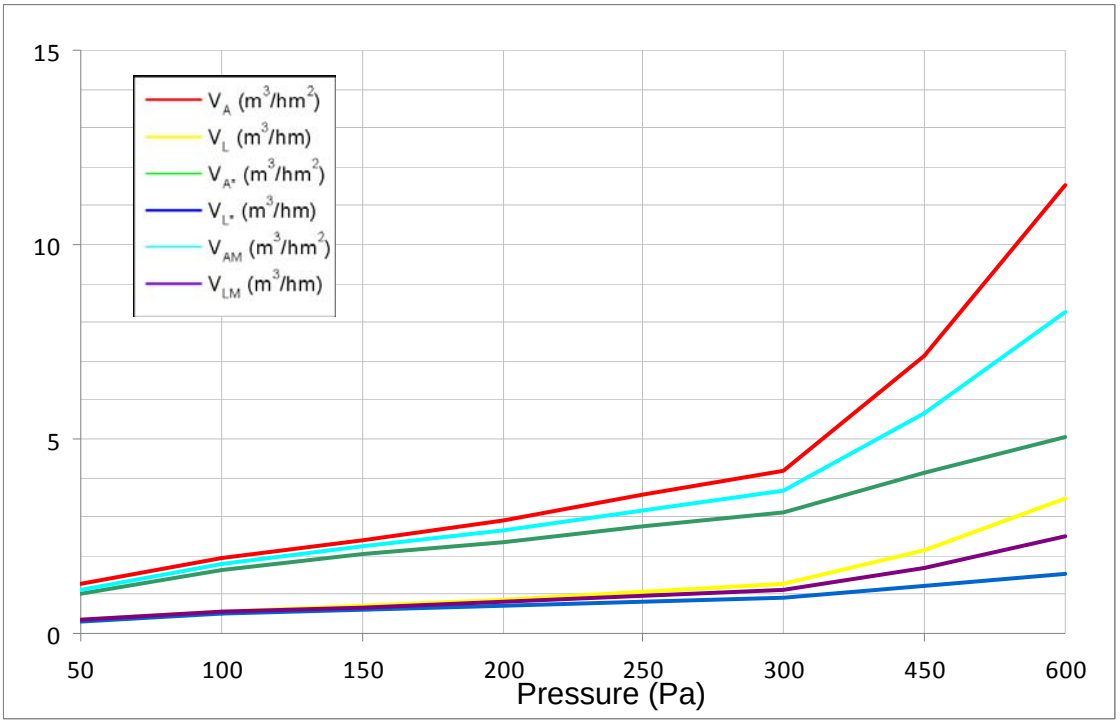
V_{AM} = Arithmetic mean of the positive permeability and negative permeability values in accordance with the total surface area.

V_{LM} = Arithmetic mean of the positive permeability and negative permeability values in accordance with the length of the opening joints.

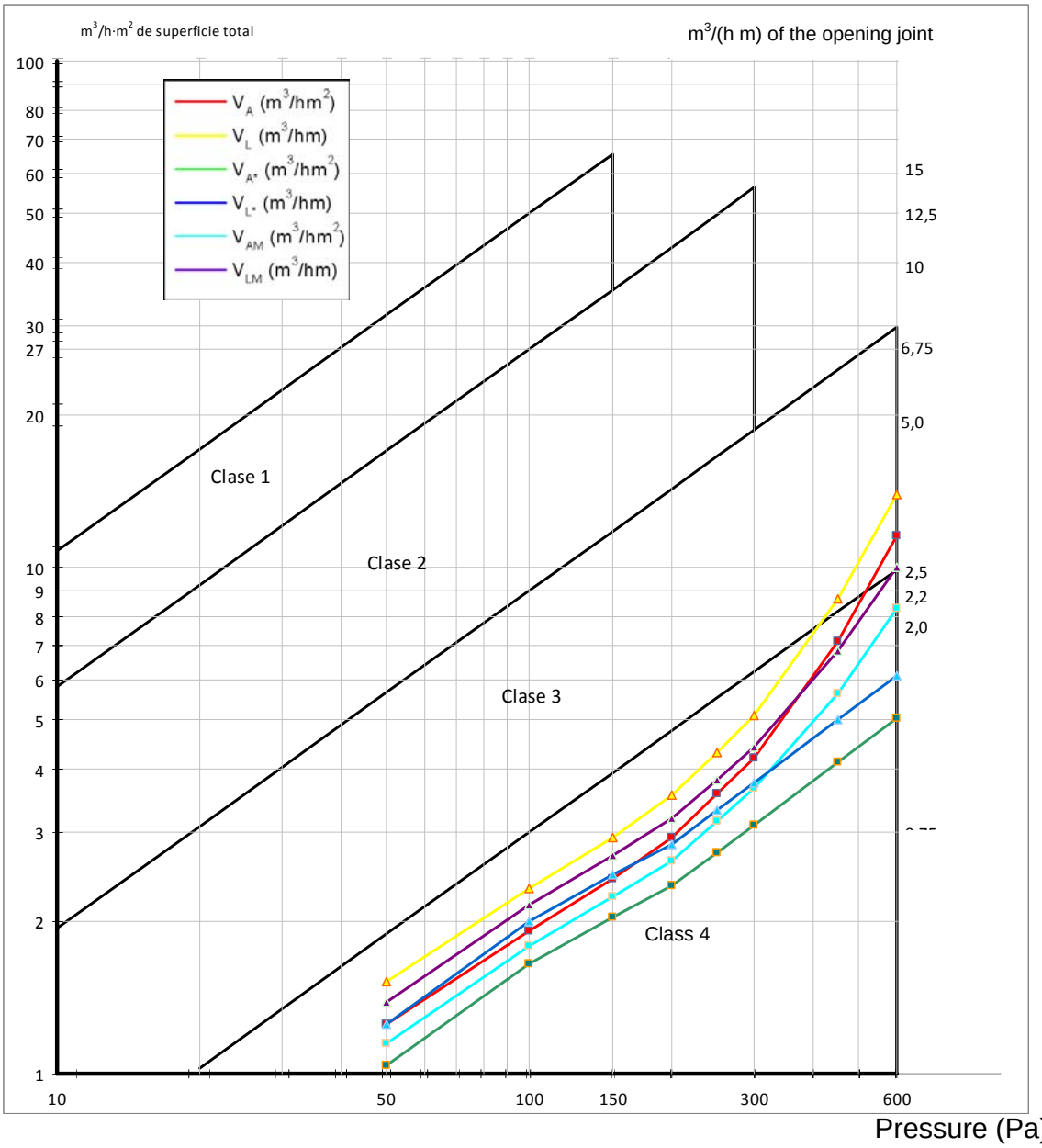
The most significant air leakage points are the following:



If the results obtained are shown in a graph, we can observe the following:



The following graph shows the volume of air that passes through the total surface area of the window (in m3/hm2) and the volume of air that passes through the opening joints (in m3/hm2) in accordance with the pressure, as set out in Standard UNE-EN 12207:2000 to obtain the air permeability window classification.



Classification according to the opening joint (Positive Pressures):	**Class 3**
Classification according to the total area (Positive Pressures):	**Class 3**
CLASSIFICATION OF POSITIVE PRESSURES	**CLASS 3**

Classification according to the opening joint (Negative Pressures):	**Class 4**
Classification according to the total area (Negative Pressures):	**Class 4**
CLASSIFICATION OF NEGATIVE PRESSURES	**CLASS 4**

Classification according to the opening joint (Average):	**Class 3**
Classification according to the total area (Average):	**Class 4**
AVERAGE CLASSIFICATION	**CLASS 4**

2.- WATERTIGHTNESS TEST

The test performed as per Standard UNE-EN 1027:2000 consists of spraying the window, whereby the pressure is increased in accordance with the following outline, making a note of the pressure at which water infiltration occurs.

Environmental conditions:

Temperature: **23ºC** Relative humidity **32%** Atmospheric pressure: **100.9 kPa**

Spraying method: **A** Flow rate **l/min**

Classif.	Pressure (Pa)	Length (min)	Observations
1A	0	15	CORRECT
2A	50	5	CORRECT
3A	100	5	CORRECT
4A	150	5	CORRECT
5A	200	5	CORRECT
6A	250	5	Points 1 and 2 min. 2
7A	300	5	
8A	450	5	
9A	600	5	

Drains to the inside of the profile

Drains from the inside to the outside of the profile

WATERTIGHTNESS LIMIT: 200 Pa

CLASSIFICATION: **CLASS 5A**

3.- RESISTANCE TO WIND LOAD TEST

The resistance to wind load test consists of three successive tests:

- Deflection test up to P_1 with positive and negative pressures
- Repeated pressure test up to P2, with positive and negative pressures
- Safety test at positive and negative pressures up to pressure P_3.

Following the repeated pressure test, a new air permeability test is carried out as per UNE-EN 1026:2000

Environmental conditions:

Temperature: **24 ºC** Relative humidity **31%**

3.1. Deflection test

The window is subject to increasing pressure until the value P is reached. When this pressure has been applied for 30 s, shifts in the characteristic points are measured. The process is repeated applying negative pressures.
In this case, the front shift was measured at three different points:

Span of the element measured: 1,145 mm

The deflection obtained for the different pressure values at these points is the following:

Pressure (Pa)	Deflection in mm			Relative front deflection
	Point A	Point B	Point C	
0	0.00	0.00	0.00	0
400	1.10	1.55	0.66	1/1709
800	2.01	2.65	1.69	1/1431
1,200	3.22	4.01	2.11	1/854
1,600	4.99	5.98	3.51	1/662
2,000	6.11	7.04	5.42	1/902
0	0.41	0.52	0.30	1/7156
-400	1.15	1.59	0.71	1/1735
-800	2.14	2.88	1.94	1/1363
-1,200	2.99	3.79	2.44	1/1070
-1,600	4.76	5.53	3.02	1/698
-2,000	5.89	6.51	3.66	1/662
0	0.20	0.33	0.15	1/7633

According to the UNE-EN 12210:2000 and UNE-EN 12210/AC:2010 Standards, there are three possible classifications depending on the front relative deflection of the most deformed element in the test sample. These three classifications are:

Class	Front relative deflection
A	<1/150
B	<1/200
C	<1/300

In this case, the front relative deflection classification is:

CLASS C

3.2.- Repeated pressure test

After subjecting the sample to 50 cycles with a pressure variation between –1,000 and 1,000 Pa, no damage or operating defects are observed in the window.

3.3.- Air permeability test

Positive pressures

Environmental conditions:

Temperature: **23 ºC** Relative humidity **32%** Atmospheric pressure: **101.0 kPa**

Upon completion of the air permeability test as per UNE-EN 1026:2000, the results obtained are shown in the following table:

Pressure (Pa)	V_X (m^3/h)	V_0 (m^3/h)	V_A (m^3/hm^2)	V_L (m^3/hm)
50	2.53	2.50	1.28	0.39
100	3.81	3.76	1.93	0.59
150	4.85	4.79	2.46	0.75
200	5.79	5.71	2.94	0.89
250	7.11	7.02	3.61	1.09
300	8.32	8.21	4.23	1.28
450	14.21	14.02	7.22	2.18
600	22.85	22.55	11.60	3.51

where: V_X = Measured air leakage
V_0 = Air leakage in normal environmental conditions (T=293 K and P_0=101.3 kPa)
V_A = Air permeability in accordance with the total surface area
V_L = Air permeability in accordance with the length of the joint opening

Negative pressures

Environmental conditions:

Temperature: **22 ºC** Relative humidity **32%** Atmospheric pressure: **101.0 kPa**

Upon completion of the air permeability test as per UNE-EN 1026:2000, the results obtained are shown in the following table:

Pressure (Pa)	V_X* (m^3/h)	V_0* (m^3/h)	V_A* (m^3/hm^2)	V_L* (m^3/hm)
50	2.01	1.99	1.02	0.31
100	3.29	3.26	1.68	0.51
150	4.12	4.08	2.10	0.64
200	4.56	4.52	2.32	0.70
250	5.44	5.39	2.77	0.84
300	6.17	6.11	3.14	0.95
450	8.34	8.26	4.25	1.29
600	10.11	10.01	5.15	1.56

where: V_X* = Measured air leakage
V_0* = Air leakage in normal environmental conditions (T=293 K and P_0=101.3 kPa)
V_A* = Air permeability in accordance with the total surface area
V_L* = Air permeability in accordance with the length of the joint opening

Mean permeability values

Upon completion of the air permeability test as per UNE-EN 1026:2000, the results obtained are shown in the following table:

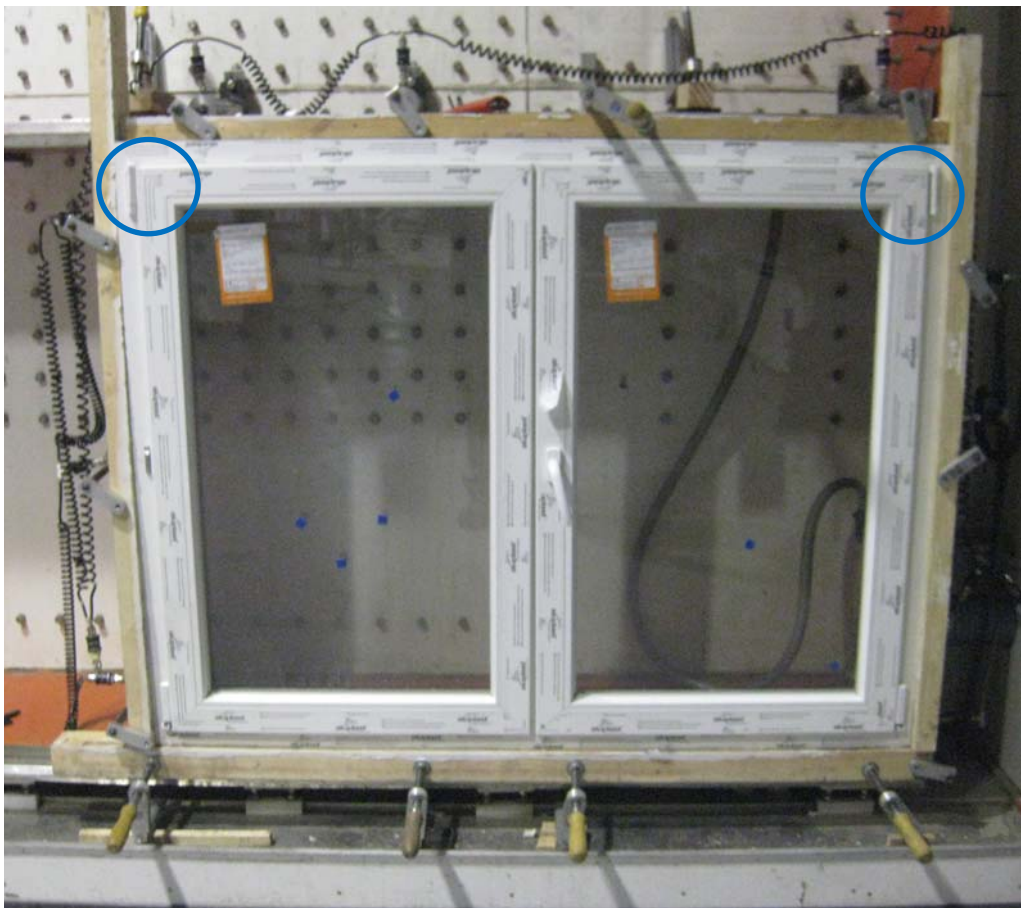
Pressure (Pa)	V_{AM} (m^3/hm^2)	V_{LM} (m^3/hm)
50	1.15	0.35
100	1.81	0.55
150	2.28	0.69
200	2.63	0.80
250	3.19	0.97
300	3.68	1.11
450	5.73	1.73
600	8.38	2.53

where:

V_{AM} = Arithmetic mean of the positive permeability and negative permeability values in accordance with the total surface area.

V_{LM} = Arithmetic mean of the positive permeability and negative permeability values in accordance with the length of the opening joints.

The most significant air leakage points are the following:



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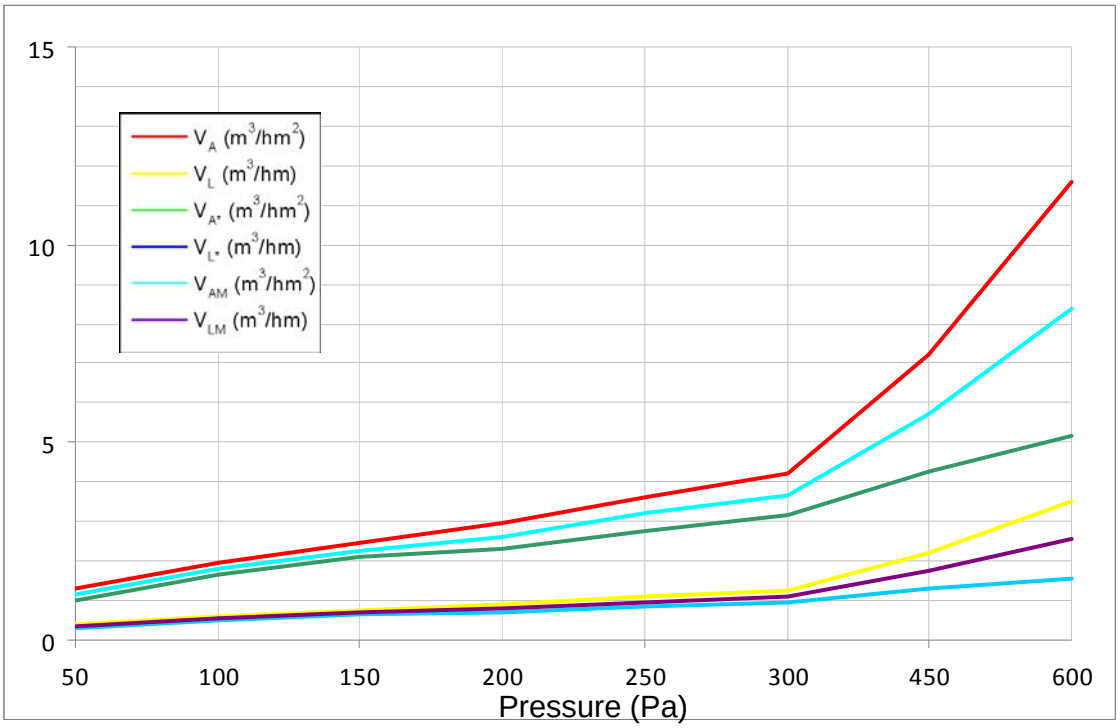

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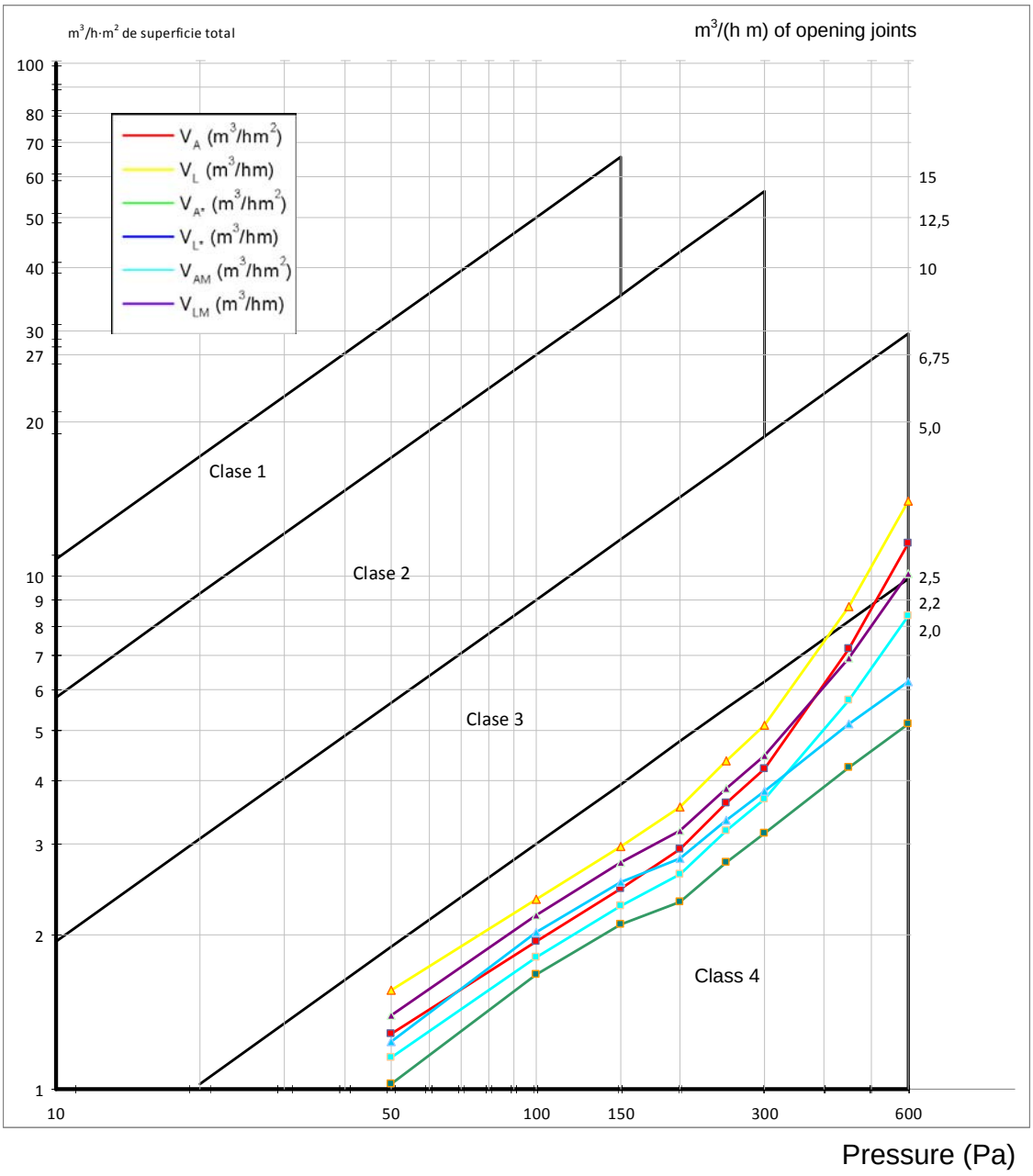


Classification according to the opening joint (Positive Pressures):	**Class 3**
Classification according to the total area (Positive Pressures):	**Class 3**
CLASSIFICATION OF POSITIVE PRESSURES	**CLASS 3**

Classification according to the opening joint (Negative Pressures):	**Class 4**
Classification according to the total area (Negative Pressures):	**Class 4**
CLASSIFICATION OF NEGATIVE PRESSURES	**CLASS 4**

Classification according to the opening joint (Average):	**Class 3**
Classification according to the total area (Average):	**Class 4**
AVERAGE CLASSIFICATION	**CLASS 4**

The increase in the air permeability is no greater than 20% of the maximum permitted air permeability for the air permeability classification obtained in the previous test.

Classification according to UNE-EN 12210:2000 and UNE-EN 12210AC:2010

P_1 = 2,000 Pa

P_2 = 1,000 Pa

3.4. Safety test

Bearing in mind the P_1 and P_2values, the window is subject to a cycle of positive and negative pressures with a value of 3,000 Pa.

Following the test, the sample remains closed and does not present any damage or breakages.

Classification according to UNE-EN 12210:2000 and UNE-EN 12210/AC:2010:

P_3 = 3,000 Pa

Bearing in mind the results obtained in the three tests, namely:

P_1 = 2,000 Pa
P_2 = 1,000 Pa
P_3 = 3,000 Pa

The resistance to wind load classification according to standards UNE-EN 12210:2000 and UNE-EN 12210/AC:2010 is as follows:

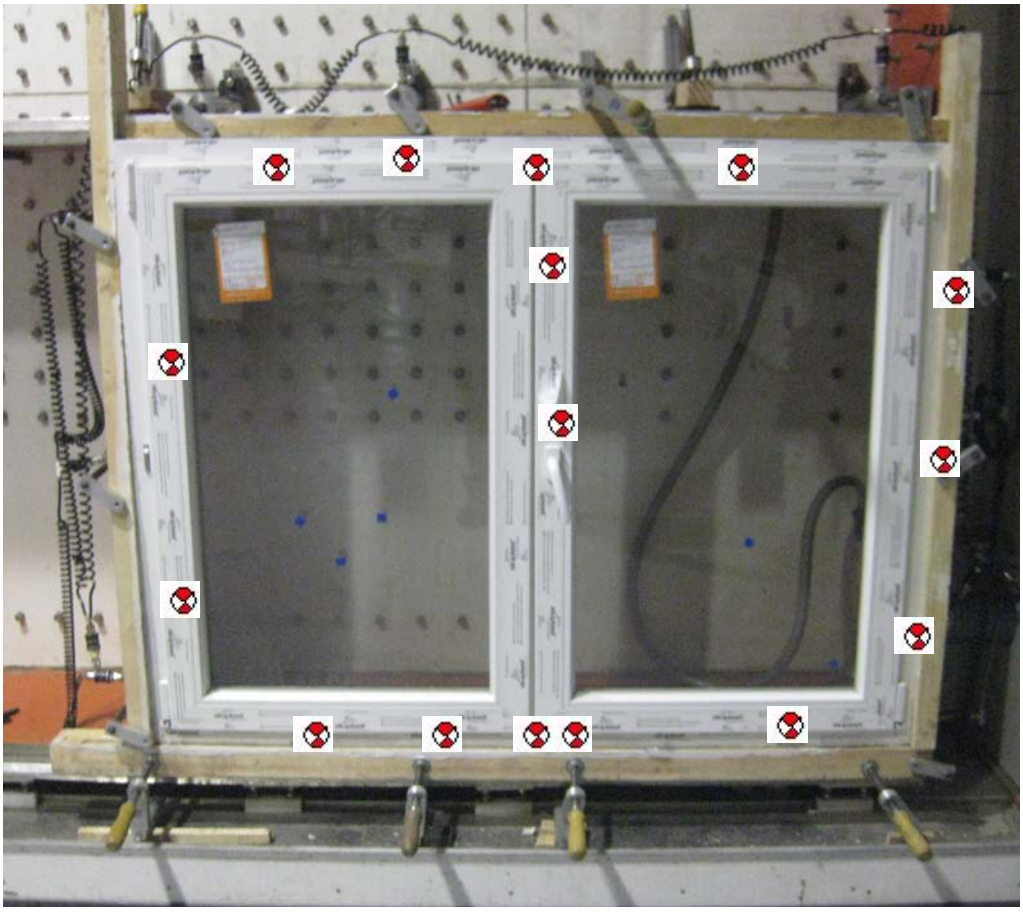
CLASSIFICATION: **CLASS C5**

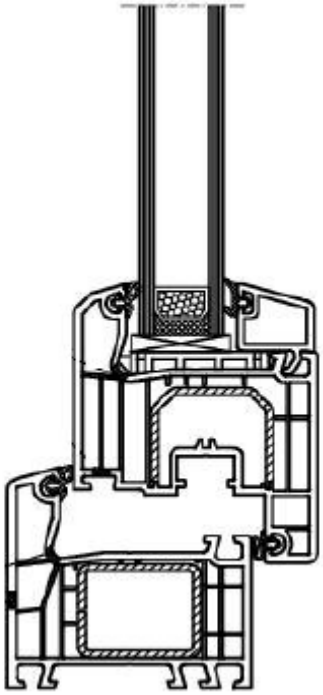
SUMMARY OF RESULTS

AIR PERMEABILITY	**CLASS 4**
WATERTIGHTNESS	**CLASS 5A**
RESISTANCE TO WIND LOAD	**CLASS C5**

ANNEX

PHOTOGRAPH OF THE WINDOW



Closure points

WINDOW CONSTRUCTION CROSS SECTIONS