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## Laboratory Evaluation of "In'flector" Window Insulator Panel

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**A Report to:** In'flector Control Systems Inc.  
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**ORTECH**



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## **1.0 ACCREDITATION**

Canadian General Standards Board #76002, Standards Council of Canada #101.

## **2.0 REGISTRATION**

As of March 1994, ORTECH was registered under the International Organization for Standardization ISO 9002 quality assurance standard by QMI (Registration #001109). ORTECH became the first independent technical services organization in Canada to achieve this status.

## **3.0 INTRODUCTION**

At the request of Mr. Guy Hamel of In'flector Control Systems Inc., ORTECH was contracted to evaluate the "In'flector" window insulator panel in terms of its impact on the air leakage characteristics, the thermal transmittance properties and the solar heat gain performance of windows.

It is the experience of In'flector Control Systems Inc. that the installation of the "In'flector" window insulator panel in buildings produces successful energy saving results. Laboratory testing was conducted in order to quantify the effect of the "In'flector" panel on windows.

## **4.0 PRODUCT DESCRIPTION**

The "In'flector" window insulator panel is a solar screen which is black on one side, laminated to a silvered polyester and perforated with a hole pattern. A second clear polyester is laminated onto the first to seal the hole openings and create an air tight membrane. The panel installs on the interior of existing window frame details and is fastened by means of perimeter style Velcro hook and felt system which is coupled with a closed cell rubber gasket. This system is shown in photographs #1 and #2 of

Appendix A. The solar screen is designed in such a manner that it does not touch the glass of the window system.

The "In'flector" panel is intended to reduce building energy costs by enhancing the window's heat transfer characteristics under both winter heating and summer cooling loads. During the winter the panel is oriented with the silver side in and the black side out, allowing it to absorb solar energy and reflect or retain heat inside a building. During the summer the panel is oriented with the silver side out to reflect the heat of the incoming solar radiation. The panel permits natural light to enter through the perforations while reducing solar heat gain.

According to In'flector Control Systems Inc., the "In'flector" solar panel offers several benefits which are not available in other single component systems and is the only known system that addresses problems associated with window air leakage (infiltration and exfiltration), window heat loss and window thermal heat gains. The system is not intended to replace cooling systems, rather it is designed to supplement air conditioning by reducing heat load on the interior space.

It is the experience of In'flector Control Systems Inc. that each application of the "In'flector" insulator panel system accomplishes interior comfort, energy savings, and may extend the life of the components of the HVAC system, as well as reduce maintenance costs on the HVAC system. In addition windows with severe infiltration and/or solar gain will often show the most significant improvement after the installation of "In'flector".

According to manufacturer's information "In'flector" is adaptable to almost every window system.

## 5.0 TEST PROGRAM

In order to evaluate the impact of the "In'flector" panel on the air leakage characteristics, the thermal transmittance properties and the solar heat gain performance of windows, laboratory tests were conducted by the Building Performance Group and the Energy and Environment Group at ORTECH.

### Air Leakage Testing

Laboratory testing was conducted in order to quantify the reduction in air leakage through windows that can be achieved with the installation of an "In'flector" panel. The ASTM E283 "Standard Test Method for Determining the Rate of Air Leakage Through Exterior Windows, Curtain Walls, and Doors Under Specified Pressure Differences Across the Specimen" was conducted on four different vinyl windows - both with and without the "In'flector" panel. The air leakage through the "In'flector" alone was also determined using the same test procedure.

Each window test sample consisted of a vinyl window installed inside a wooden test buck. For each air leakage test the window test sample was mounted onto the test frame apparatus and was sealed against the air leakage test chamber. In order to determine the extraneous air leakage through the test sample, a polyethylene sheet was sealed onto the outside face of the window. Air was exhausted from the test chamber at a rate required to maintain various test pressures across the system. The extraneous air leakage of the system was determined for pressure levels of 50, 75, 100, 125 and 150 Pascals. Following the extraneous air leakage testing, the polyethylene was removed.

The air leakage of the window system with the "In'flector" panel was determined for the same pressure levels specified above. The testing was conducted in both positive and negative directions, i.e. infiltration and exfiltration. The "In'flector" panel was then removed and the air leakage of

the window unit itself was determined for the same pressure levels. Again, the testing was conducted in both positive and negative directions. The extraneous air leakage was subtracted from the air leakage rates of each window and each window with the In'flector panel.

### Solar Heat Gain Testing

The net impact of the "In'flector" insulator panel on the daytime solar heat gain performance of a window system was determined using established laboratory-based calorimetric measurement procedures. Daytime summer solar conditions were simulated using the National Solar Test Facility's large area solar simulator lamp. A fixed double glazed vinyl frame window (3mm clear / 12.7mm air space / 3mm clear) with an aluminum spacer was mounted in a mask wall affixed to a window calorimeter. The calorimeter was then placed in an environmental chamber and testing was conducted under controlled steady-state climatic conditions.

Thermal performance measurements were performed under the following test conditions:

#### **Daytime Summer Solar Gain:**

Climatic Conditions:      Irradiance (direct normal) = 783 W/m<sup>2</sup>  
                                         Interior air space temperature = 21°C  
                                         Exterior ambient temperature = 21°C

Window System:            (i) Window (no panel)  
                                         (ii) Window with panel (sliver side exterior)

### Thermal Transmittance Performance Testing

The net impact of the "In'flector" insulator panel on the nighttime winter thermal loss of a window system was determined using established laboratory-based calorimetric measurement procedures. Nighttime winter conditions represent the most severe conditions for heat loss through a building envelope. A fixed double glazed vinyl frame window (3mm clear /

12.7mm air space / 3mm clear) with an aluminum spacer was mounted in a mask wall affixed to a window calorimeter. The window was subjected to the following test conditions:

**Nighttime Winter Thermal Loss:**

Climatic Conditions: Irradiance (direct normal) = 0 W/m<sup>2</sup>  
Interior air space temperature = 21°C  
Exterior ambient temperature = -20°C

Window System: (i) Window (no panel)  
(ii) Window with panel (black side exterior)

**6.0 TEST RESULTS**

**Air Leakage Testing**

The following windows were supplied by In'flector Control Systems Inc. and were delivered to ORTECH's Pilot Plant Facility on October 23, 1995.

<u>Window Description</u>	<u>ORTECH Sample No.</u>
Vinyl Vertical Slider	95-J53-W0042
Vinyl Horizontal Slider	95-J53-W0043
Vinyl Casement	95-J53-W0045
Vinyl Fixed	95-J53-W0044
Wooden Frame with In'flector Panel	95-J53-W0046

The windows were delivered with fitted Velcro-style seals in order to accommodate "In'flector" Insulator panels.

The air leakage test results have been summarized in the following pages. Detailed test results have been included in Appendix B and are shown graphically in Appendix C.

The results have been compared to the air leakage criteria specified in the CSA A440 standard for windows, which is referenced in the National Building Code of Canada. According to this standard windows can be classified in the following way for air tightness:

Window Rating	Maximum Air Leakage Rate (m <sup>3</sup> /h)m <sup>-1</sup>
Storm	8.35 (max.) 5.00 (min.)
A1	2.79
A2	1.65
A3	0.55
Fixed	0.25

For an operable window, the best rating which can be achieved is an A3 rating since it has the lowest air leakage rate.

The test results are presented below:

**Window #1: Vinyl Vertical Slider Window**

ORTECH Sample No. 95-J53-W0042

**Infiltration**

**Air Leakage Rate of Window :**

0.637 (m<sup>3</sup>/h)m<sup>-1</sup> at 75 Pascals (A2 Window)

**Air Leakage Rate of Window with In'flector Panel :**

0.482 (m<sup>3</sup>/h)m<sup>-1</sup> at 75 Pascals (A3 Window)

**Reduction in Air Leakage: 24.33%**

**Exfiltration**

**Air Leakage Rate of Window :**

0.664 (m<sup>3</sup>/h)m<sup>-1</sup> at 75 Pascals (A2 Window)

**Air Leakage Rate of Window with In'flector Panel :**

0.526 (m<sup>3</sup>/h)m<sup>-1</sup> at 75 Pascals (A3 Window)

**Reduction in Air Leakage: 20.78%**



**Window #2: Vinyl Horizontal Slider Window**

ORTECH Sample No. 95-J53-W0043

**Infiltration**

**Air Leakage Rate of Window:**

3.165 (m<sup>3</sup>/h)m<sup>-1</sup> at 75 Pascals (exceeds CSA A440 limits)

**Air Leakage Rate of Window with In'flector Panel:**

1.028 (m<sup>3</sup>/h)m<sup>-1</sup> at 75 Pascals (A2 Window)

**Reduction In Air Leakage: 67.52%**

**Exfiltration**

**Air Leakage Rate of Window :**

3.803 (m<sup>3</sup>/h)m<sup>-1</sup> at 75 Pascals (exceeds CSA A440 limits)

**Air Leakage Rate of Window with In'flector Panel :**

0.267 (m<sup>3</sup>/h)m<sup>-1</sup> at 75 Pascals (A3 Window)

**Reduction In Air Leakage: 92.98%**

**Window #3: Vinyl Casement Window**

ORTECH Sample No. 95-J53-W0045

**Infiltration**

**Air Leakage Rate of Window:**

0.033 (m<sup>3</sup>/h)m<sup>-1</sup> at 75 Pascals (Fixed Window)

**Air Leakage Rate of Window with In'flector Panel:**

0.031 (m<sup>3</sup>/h)m<sup>-1</sup> at 75 Pascals (Fixed Window)

**Reduction In Air Leakage: 6.06%**

**Exfiltration**

**Air Leakage Rate of Window :**

0.266 (m<sup>3</sup>/h)m<sup>-1</sup> at 75 Pascals (A3 Window)

**Air Leakage Rate of Window with In'flector Panel :**

0.164 (m<sup>3</sup>/h)m<sup>-1</sup> at 75 Pascals (Fixed Window)

**Reduction In Air Leakage: 38.35%**

**Window #4: Fixed Vinyl Window**

**ORTECH Sample No. 95-J53-W0044**

**Infiltration**

**Air Leakage Rate of Window:**

**0.000 (m<sup>3</sup>/h)m<sup>-1</sup> at 75 Pascals (non-detectable leakage)**

**Air Leakage Rate of Window with In'flector Panel:**

**0.002 (m<sup>3</sup>/h)m<sup>-1</sup> at 75 Pascals (very low leakage)**

**Reduction in Air Leakage: 0.0%**

**Exfiltration**

**Air Leakage Rate of Window :**

**0.006 (m<sup>3</sup>/h)m<sup>-1</sup> at 75 Pascals (very low leakage)**

**Air Leakage Rate of Window with In'flector Panel :**

**0.006 (m<sup>3</sup>/h)m<sup>-1</sup> at 75 Pascals (very low leakage)**

**Reduction in Air Leakage: 0.0%**

**Note:** Since the fixed window represented an extremely airtight window, the addition of the "In'flector" panel did not improve the air leakage of the window.

**In'flector Panel Only**

**ORTECH Sample No. 95-J53-W0045**

**Infiltration**

**Air Leakage Rate of Screen:**

**1.603 (m<sup>3</sup>/h)m<sup>-1</sup> at 75 Pascals (A2 Window)**

**Exfiltration**

**Air Leakage Rate of Screen:**

**0.727 (m<sup>3</sup>/h)m<sup>-1</sup> at 75 Pascals (A2 Window)**

**Note:** Test results are compared to CSA A440 Rating from Air Tightness of Windows, i.e. A1, A2, A3 and Fixed window ratings.

The method of simulating air infiltration through a window using the laboratory air leakage test apparatus involved exhausting air from the interior side of the window. In other words, air was pulled through the window, from the interior side to simulate infiltration. In an actual building situation, air infiltration would occur as a result of a higher air pressure on the exterior side of the window. Air would be pushed through the window from the exterior. During the laboratory testing, the air pressure difference was greatest across the "In'flector" panel rather than across the window as would be the case in an actual building situation. The "In'flector" panel which is intended to act as a secondary system had to withstand the greatest amount of load during the laboratory testing. It is therefore likely that the air leakage measured through the "In'flector" panel would be larger in the laboratory than in an actual building situation.

In addition, the laboratory testing was conducted under steady-state thermal conditions and did not address thermal expansion and contraction of window frames. Window frames tend to contract during cold winter conditions and expand during summer conditions. Therefore, it is possible that the "In'flector" insulator panel may result in more dramatic improvements in terms of air leakage reduction than what was shown through the laboratory testing.

## **8.0 CONCLUSIONS**

The air leakage test results showed that the "In'flector" insulator panel is effective in reducing the air leakage through windows. The testing also showed that the higher the air leakage rate of the window, the more dramatic the improvements or reduction in air leakage that was achieved with the installation of the "In'flector" panel.

The greatest reduction in air leakage was achieved on the vinyl horizontal slider window. The air infiltration rate of the window prior to the installation of the "In'flector" panel was  $3.165 \text{ (m}^3/\text{h)m}^{-1}$ . Following the installation of the In'flector panel, the air infiltration rate dropped to  $1.028 \text{ (m}^3/\text{h)m}^{-1}$  for a total reduction of 67.25%. The air exfiltration rate of the window prior to the installation of the "In'flector" panel was  $3.803 \text{ (m}^3/\text{h)m}^{-1}$ . With the panel, the air exfiltration rate dropped to  $0.267 \text{ (m}^3/\text{h)m}^{-1}$  for a total reduction of 92.98%.

An improvement or reduction in air infiltration and air exfiltration was noted for all windows fitted with the "In'flector" panel except for the fixed vinyl window. The air infiltration rate of the window unit itself was so low (less than  $0.00 \text{ (m}^3/\text{h)m}^{-1}$ ) that it was not detectable by the test apparatus. Therefore, the installation of the "In'flector" window did not produce a detectable improvement in the air leakage of the window unit.

The air infiltration and air exfiltration rate of the vinyl vertical slider window showed significant improvement. The window improved from an A2 rated window to an A3 rated window (according to the CSA A440 windows standard). The improvement in air infiltration for the window amounted to 24.33% and the improvement in air exfiltration amounted to 20.78%.


The vinyl casement window showed some improvement in air leakage, particularly for air exfiltration which amounted to 38.35%.

It is interesting to note that the air leakage rate of the "In'flector" panel alone was quite low. The air infiltration through the panel was measured to be  $1.603 \text{ (m}^3/\text{h)m}^{-1}$  while the air exfiltration through the panel was measured to be  $0.727 \text{ (m}^3/\text{h)m}^{-1}$ . Therefore the air leakage of the "In'flector" panel alone is comparable to a window unit with an A2 rating.

The solar heat gain and thermal performance test results showed a significant reduction in the solar heat gain coefficient (SHGC) and the thermal transmittance coefficient (U-value) of a window with an "In'flector" panel. Under daytime summer conditions, the panel reduced the SHGC of the window by 48.98% when installed with the silver side of the panel facing out. Under nighttime window thermal loss conditions the panel reduced the U-value of the window by 37.25% when installed with the silver side facing in.



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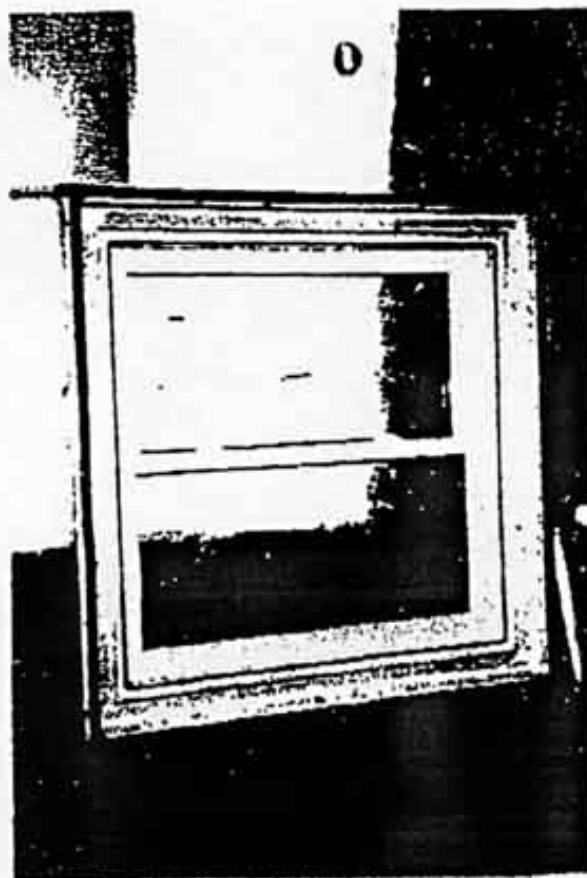
**APPENDIX A**

**Photographs of Air Leakage Test Samples**

**(6 Pages)**



Photographs #1 & #2 - Velcro hook and felt system with closed cell rubber gasket.



Photographs #3 - Vinyl vertical slider window.





Photographs #4 - Vinyl horizontal slider window.



**Photographs #5 - Vinyl casement window.**



Photographs #8 - Vinyl fixed window.



Photographs #7 - In'flector screen only.

**APPENDIX B**

**Air Leakage Test Data**

**(3 Pages)**

<b>Vinyl Vertical Slider Window - ORTECH Sample No. 95-J53-W0042</b>						
Air Leakage Rates (m <sup>3</sup> /h)m <sup>-1</sup>						
Pressure (Pascals)	Infiltration			Exfiltration		
	Window	Window & Inflector	Reduction	Window	Window & Inflector	Reduction
50	0.477	0.344	0.133	0.496	0.379	0.117
75	0.637	0.482	0.155	0.664	0.526	0.138
100	0.817	0.641	0.176	0.856	0.653	0.203
125	0.985	0.787	0.198	1.024	0.770	0.254
150	1.144	0.911	0.233	1.190	0.881	0.329
Reduction @ 75 Pa = 24.33%			Reduction @ 75 Pa = 20.76%			

<b>Vinyl Horizontal Slider Window - ORTECH Sample No. 95-J53-W0043</b>						
Air Leakage Rates (m <sup>3</sup> /h)m <sup>-1</sup>						
Pressure (Pascals)	Infiltration			Exfiltration		
	Window	Window & Inflector	Reduction	Window	Window & Inflector	Reduction
50	2.423	0.719	1.704	2.820	0.298	2.522
75	3.165	1.028	2.137	3.803	0.267	3.536
100	3.824	1.316	2.508	4.755	0.260	4.495
125	4.410	1.590	2.820	5.583	0.267	5.316
150	4.940	1.859	3.081	6.285	0.279	6.006
Reduction @ 75 Pa = 67.52%			Reduction @ 75 Pa = 92.98%			

<b>Vinyl Casement Window - ORTECH Sample No. 95-J53-W0045</b>						
<b>Air Leakage Rates (m<sup>3</sup>/h)m<sup>-1</sup></b>						
<b>Pressure (Pascals)</b>	<b>Infiltration</b>			<b>Exfiltration</b>		
	<b>Window</b>	<b>Window &amp; In'flector</b>	<b>Reduction</b>	<b>Window</b>	<b>Window &amp; In'flector</b>	<b>Reduction</b>
50	0.021	0.012	0.009	0.173	0.097	0.076
75	0.031	0.031	0.000	0.266	0.164	0.102
100	0.050	0.050	0.000	0.372	0.266	0.106
125	0.069	0.071	n/a	0.614	0.339	0.275
150	0.078	0.092	n/a	1.781	0.446	1.335
<b>Reduction @ 75 Pa = 0.00%</b>				<b>Reduction @ 75 Pa = 38.34%</b>		

<b>Fixed Vinyl Window - ORTECH Sample No. 95-J53-W0044</b>						
<b>Air Leakage Rates (m<sup>3</sup>/h)m<sup>-1</sup></b>						
<b>Pressure (Pascals)</b>	<b>Infiltration</b>			<b>Exfiltration</b>		
	<b>Window</b>	<b>Window &amp; In'flector</b>	<b>Reduction</b>	<b>Window</b>	<b>Window &amp; In'flector</b>	<b>Reduction</b>
50	0.000	0.002	n/a	0.008	0.006	0.002
75	0.000	0.002	n/a	0.006	0.006	0.000
100	0.000	0.000	0.000	0.006	0.004	0.002
125	0.002	0.000	0.002	0.008	0.006	0.002
150	0.002	0.000	0.002	0.008	0.006	0.002
<b>Reduction @ 75 Pa = n/a</b>				<b>Reduction @ 75 Pa = 0.00%</b>		

<b>"In'flector" Screen Only ORTECH Sample No. 95-J53-W0046</b>		
<b>Air Leakage Rates (m<sup>3</sup>/h)m<sup>-1</sup></b>		
<b>Pressure (Pascals)</b>	<b>Infiltration</b>	<b>Exfiltration</b>
50	1.083	0.595
75	1.603	0.727
100	2.153	0.809
125	2.655	0.886
150	3.186	0.961



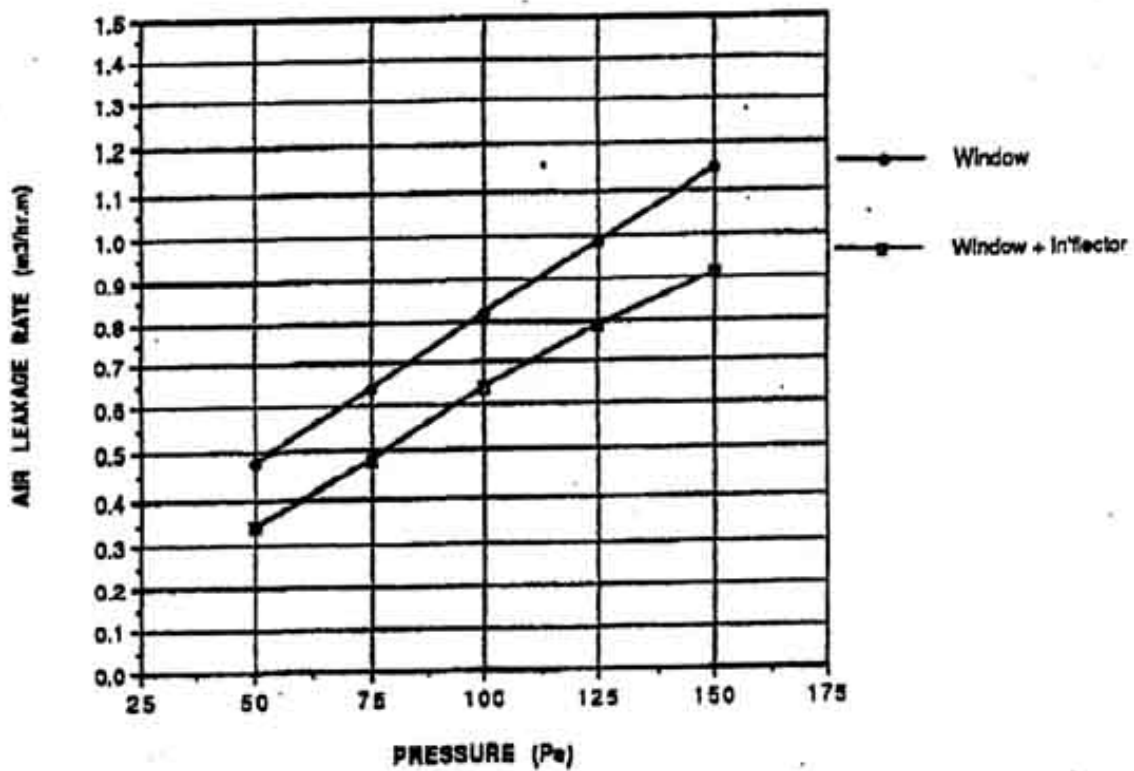
**APPENDIX C**

**Air Leakage Test Results - Graphs**

**(10 Pages)**

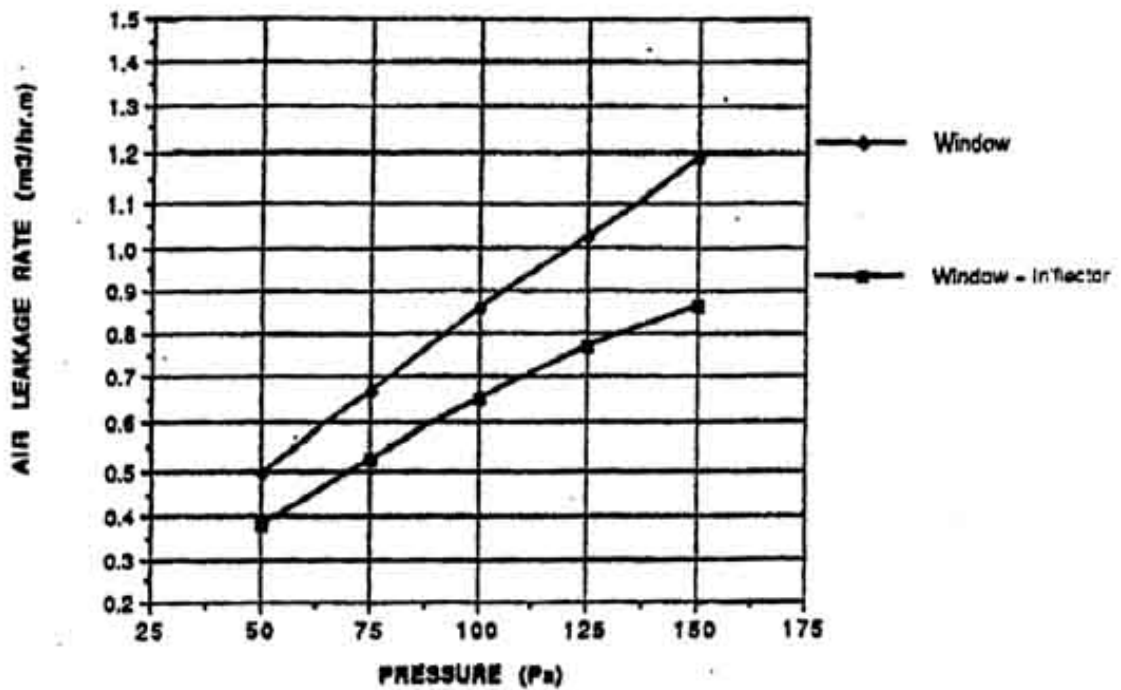
## INFILTRATION AIR LEAKAGE RATES

VINYL VERTICAL SLIDER WINDOW WITH AND WITHOUT INFLECTOR SCREEN



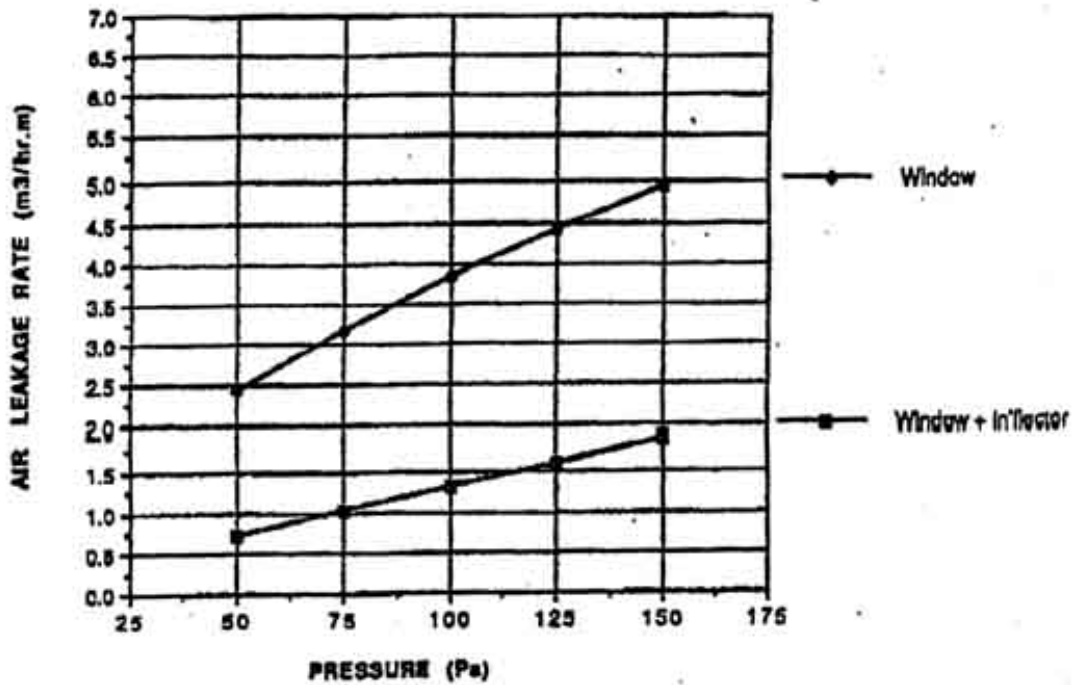
### EXFILTRATION AIR LEAKAGE RATES

VINYL VERTICAL SLIDER WINDOW WITH AND WITHOUT INFLECTOR SCREEN



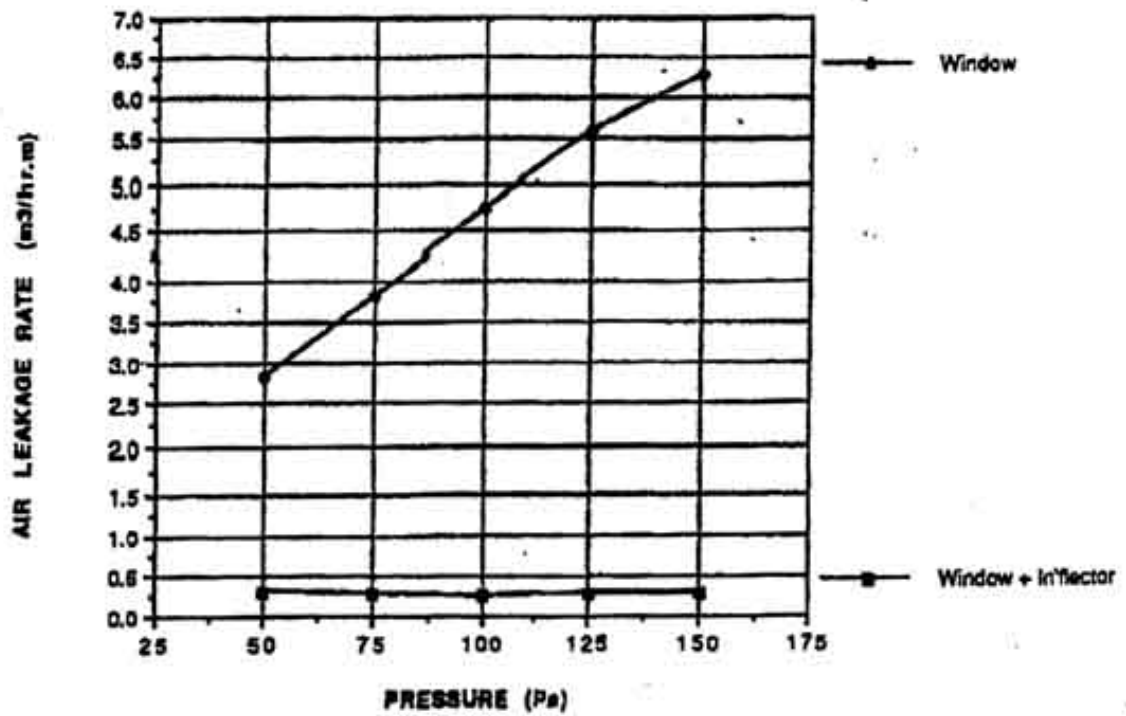
### INFILTRATION AIR LEAKAGE RATES

VINYL HORIZONTAL SLIDER WINDOW WITH AND WITHOUT INFLECTOR SCREEN



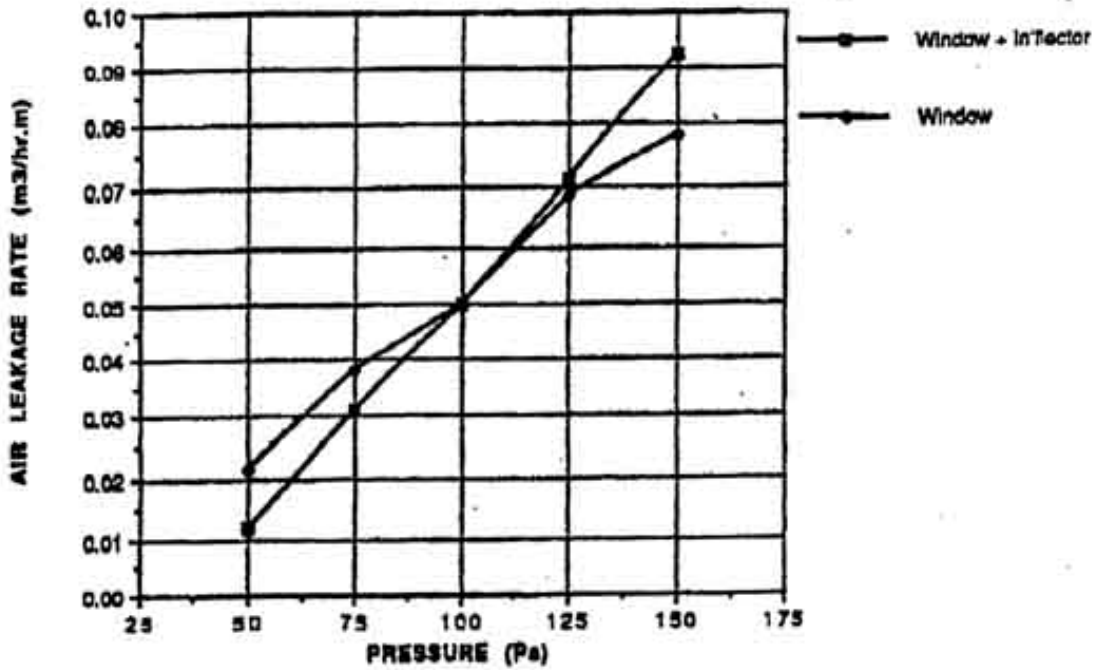
### EXFILTRATION AIR LEAKAGE RATES

VINYL HORIZONTAL SLIDER WINDOW WITH AND WITHOUT IN'FLECTOR SCREEN



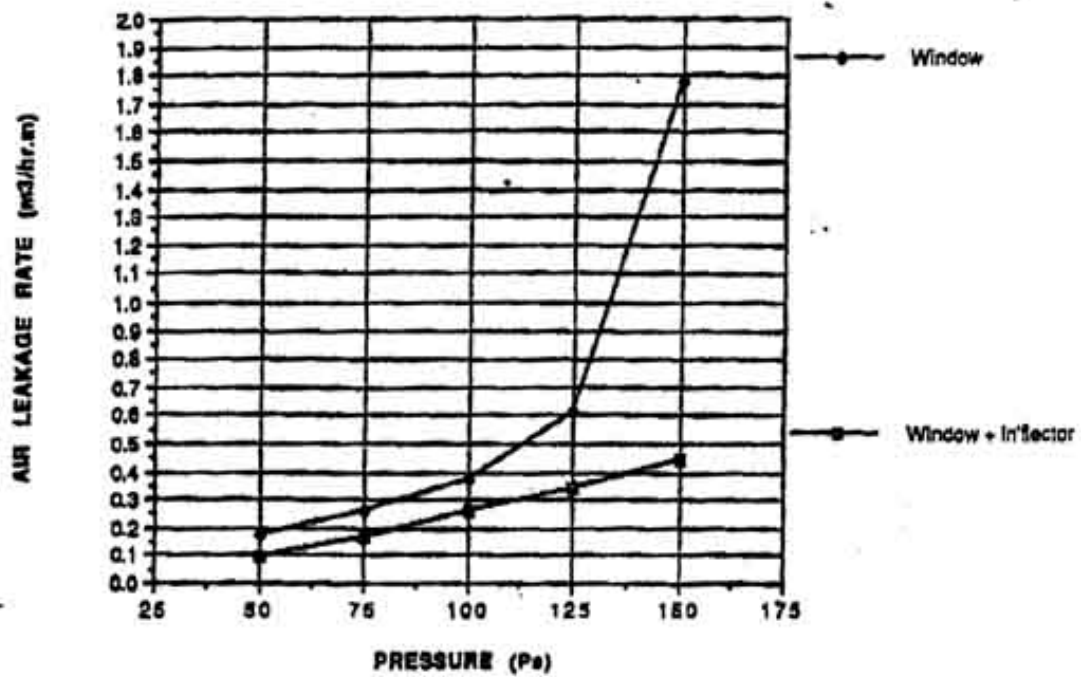
### INFILTRATION AIR LEAKAGE RATES

VINYL CASEMENT WINDOW WITH AND WITHOUT INFLECTOR SCREEN



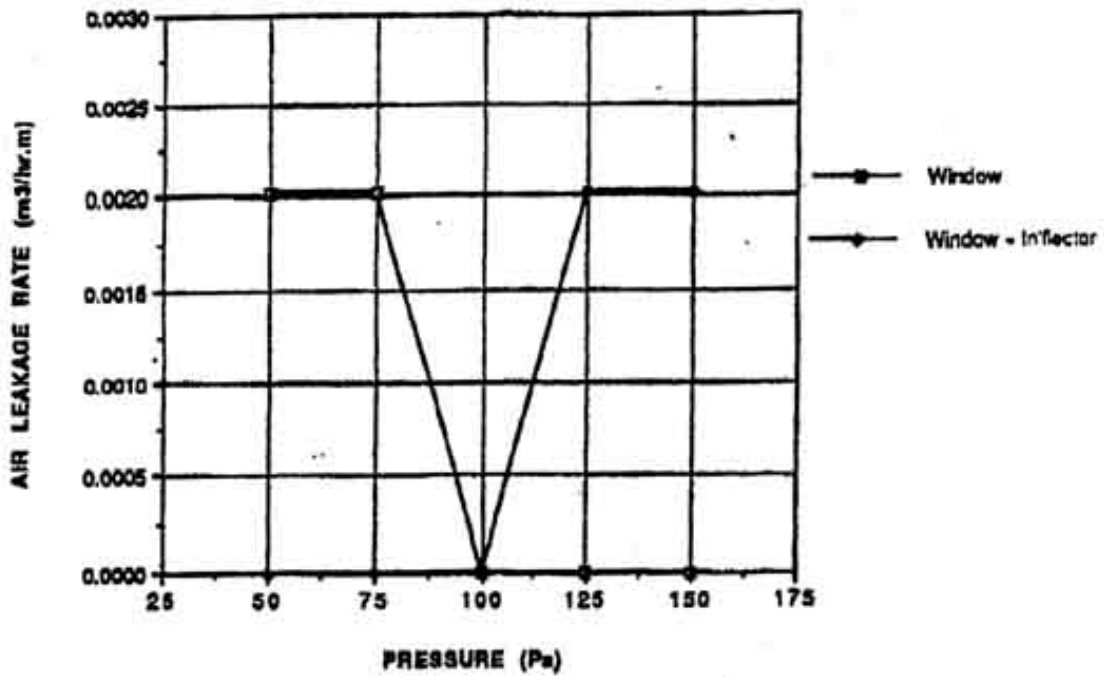
### EXFILTRATION AIR LEAKAGE RATES

VINYL CASEMENT WINDOW WITH AND WITHOUT IN'FLECTOR SCREEN



### INFILTRATION AIR LEAKAGE RATES

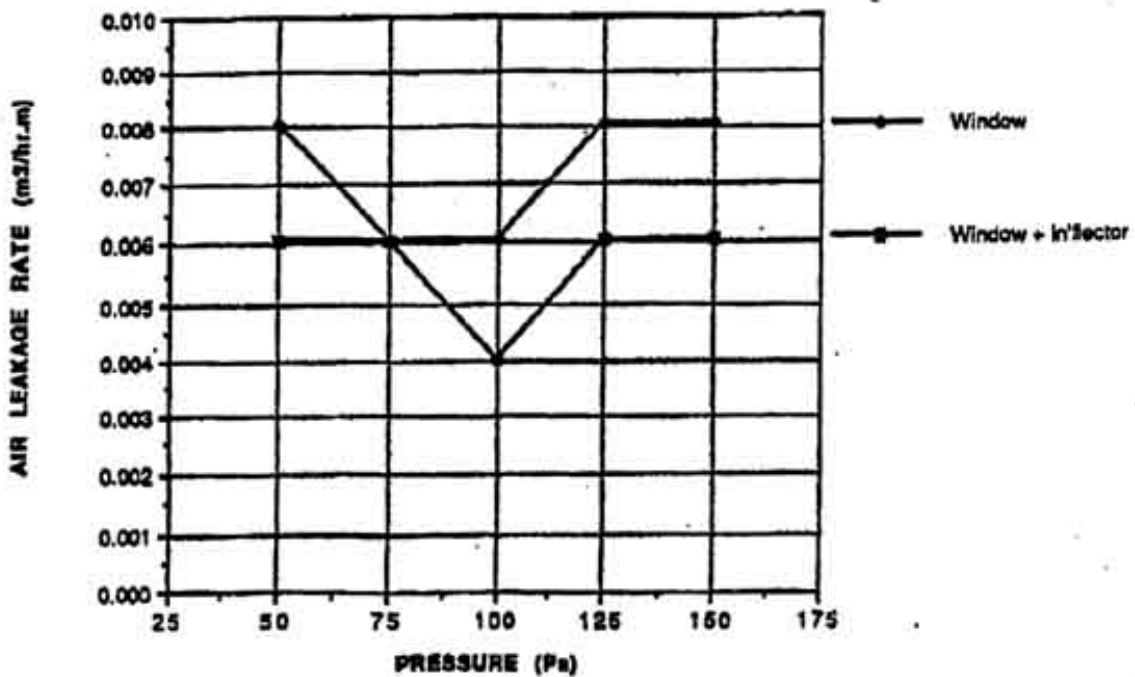
FIXED VINYL WINDOW WITH AND WITHOUT INFLECTOR SCREEN





### EXFILTRATION AIR LEAKAGE RATES

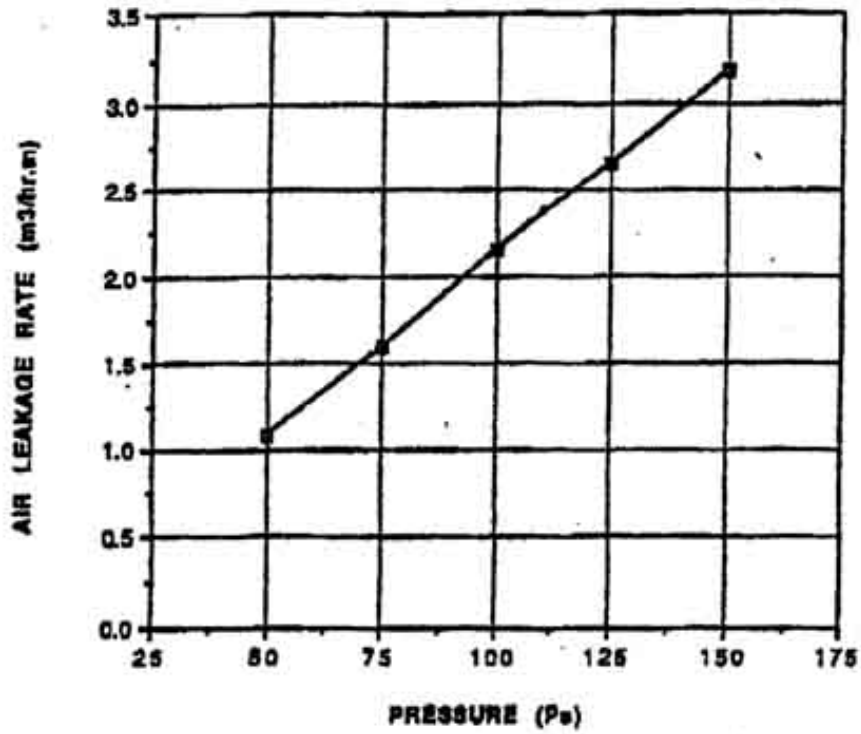
FIXED VINYL WINDOW WITH AND WITHOUT IN'LECTOR SCREEN



**ORTECH**  
Evaluation of "In'flector" Panel  
For: In'flector Control Systems Inc.

Report # 95-J53-B0343

**INFILTRATION AIR LEAKAGE RATES**  
**INFLECTOR SCREEN ONLY**



**EXFILTRATION AIR LEAKAGE RATES**

INFLECTOR SCREEN ONLY

